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November 2011

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OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION OF AUSTRALIA

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WaterWorks is the publication of the Water Industry Operators Association of Australia (WIOA). It is published twice yearly and distributed with AWA *Water Journal*.

Contributions Wanted

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 Peter Mosse, *WaterWorks* Editor, c/o WIOA, 22 Wyndham Street, Shepparton, Vic 3630.

CONTENTS

DRIVING OPERATIONAL CHANGE

George Wall

Readers of previous editions of *WaterWorks* would note WIOA's ongoing efforts to bring about some positive change in the water industry operational landscape. On a number of occasions we have raised our concerns in areas including training and its delivery, the need for a national system specifying the minimum training and skill requirements, the need for certification, the need to develop a system that encourages the implementation of new skills in the workplace and the need to enhance the "career" prospects for operational staff in recognition of their important role in the water industry.

Many of these "needs" are outside the direct control of WIOA. As a water industry peak body, we have a responsibility to investigate, discuss, advise and influence change for the betterment of the industry and our members. We do this through a variety of mechanisms, including having active representatives on industry working groups, working collaboratively with other organisations on specific projects, and raising and discussing issues with regulatory bodies.

We are starting to see reform in some areas, which in many ways vindicates the hard work undertaken to date, but there is still a long way to go.

Operator Certification Framework

After meeting for the first time in 2007, WIOA has continued to work with the Victorian Department of Health (DH) as well as VicWater to develop the "Framework for Water Treatment Operator Competencies – Best Practice Guidelines". This framework came into effect on 31 March 2011 and is the first of its type in Australia.

Victoria now has specified minimum training, competency and experience requirements in place to match the public health risk associated with a water supply system. In addition, there is a requirement to undertake refresher training to keep skills updated in a way similar to the requirements for OHS and First Aid. Further, operators will be "certified" under a new scheme offered by WIOA, as having the appropriate training and experience to match the types of systems and processes they are operating. WIOA is the only organisation "endorsed" by the Victorian Department of Health to act as a certifying body.

The certification of operators has now also gained national importance as a result of the commencement of the Government Skills Australia (GSA) project to develop a National Certification Framework for Potable Water Treatment Operators. This project is funded by the National Water Commission (NWC) and will report to the Council of Australian Government (COAG). A project steering committee, which includes water industry and regulator representatives as well as WIOA, AWA and WSAA, has been established. A pleasing outcome of some preliminary project work is that the Victorian Framework is viewed very favourably when compared to schemes already implemented in the USA, Canada and New Zealand.

The next step in the project will be a meeting of regulators in order to develop a draft framework. The draft developed will be discussed during the first round of consultation programmed to occur during October 2011, with the draft Certification Framework and Preliminary Report due for completion in December, 2011. A second round of consultation will occur during January and February, 2012, with the final Certification Framework and Report due for completion in March 2012.

The project is limited to development of the Certification Framework and does not include its implementation; however, the report will consider possible options for the future implementation of the framework nationally.

Operator Training

Another area of concern to WIOA is that despite the implementation of the Victorian Framework and, presumably, in the future, a National Framework, there is nothing in the Framework to ensure that the quality or level of training provided is appropriate. There is also nothing to ensure that the skills learnt during training are being implemented.

(continued overleaf)

OUR COVER

Our cover shot this month is the cover of the newly released *Practical Guide to Odour Control in Sewage Transport Systems,* showing Gippsland Water operator Daniel Robie testing for levels of hydrogen sulfide going into a biotrickling filter at a sewage pump station. An order form can be downloaded from www.wioa.org.au

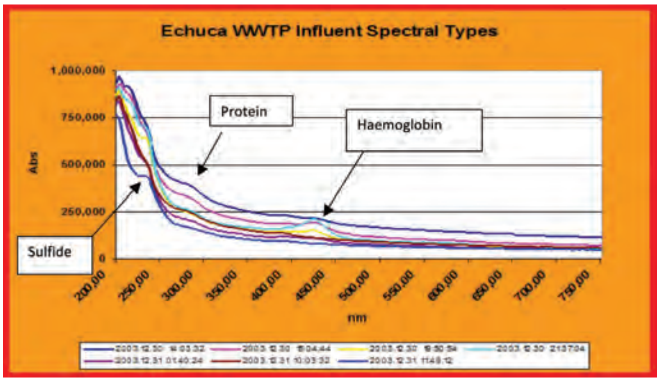
Commonsense Approach to Online Monitoring of COD

Dear Editor,

The recent article in *WaterWorks* by Kay White on "On Line Monitoring of COD at Echuca" was very informative and showed a very commonsense approach to verifying the online data. The acceptance of lab results without verifying the chain of custody and the lab testing itself via duplicates is a common source of tail chasing when it comes to instrument calibration/data verification.

Kay is well ahead of many in actually implementing a control strategy using the data and this is great to see. More recent work with the spectrolyser system described in the paper has revealed the ability to provide additional information from UV Vis spectra. Although there are only a small number of full spectra published in Figure 3, detailed analysis of the spectra show the site has issues with sulfide, protein and haemoglobin.

- Since sulphide is a major issue with respect to production of odour and reduction of sewer asset life, its presence and the causes of it being present are important.
- Protein is a factor common in most wastes including municipal sewage; however, the levels of it help determine the source. Meat works produce large amounts of it, as do dairy factories and other food producers. Proteins will break down to ammonia and readily degradable carbon so they constitute an important part of soluble TKN. This information can augment ammonia and COD measurement to enable better control of loadings to the biological process.
- Haemoglobin is literally wasted product as blood is typically used for a variety of valuable byproducts of the meat industry. Its presence in the waste stream in significant concentrations indicates that some "housekeeping" may be beneficial as it will see a reduction of other loadings at the same time.



The original Figure is shown above with the areas of the spectra relating to sulfide, protein and haemoglobin arrowed. Although at this resolution not a lot can be seen, higher level analysis using first and second derivatives of the curve make the areas easy to "see".

Rob Dexter

DCM Process Control

EDITORIAL (continued)

For years there has been talk, but little action. To try to DO something, WIOA initiated a national meeting in Brisbane in May 2011 to investigate a way to resolve a range of training related issues. This meeting was attended by invited delegates representing a wide cross-section of the water industry, all of whom were involved with training issues. All the usual concerns were raised at the meeting, including: the lack of mandated training drivers; lack of access to trainers Australia-wide; the variability in quality of training and trainers; and the cost and inconvenience of some delivery methods, along with the limited demand which was hindering development of training courses and materials for some units.

It was agreed that the certification process would increase the numbers of staff requiring training nationally and, therefore, may help drive an increase in the number of organisations participating in water industry training. With respect to the quality of training, the quality of the trainers and their resource materials, there was agreement that some form of "industry approved" endorsement process for training providers was necessary. WIOA confirmed our commitment to help facilitate the development of such a system.

Issues related to training were also discussed at length at the Water Industry Skills Taskforce (WIST) meeting in July 2011, in which WIOA participated as an invited guest. As a result of our input, WIOA has been requested to provide an issues paper to the next WIST meeting outlining our ideas on how to ensure trainers provide quality services. We will keep our members and the industry informed of developments in future publications.

As described, the process of change takes a long time and requires a great deal of committed effort. To succeed in developing and implementing a system to address all the issues will require some big picture thinking, devoid of parochial interest. Therein lies the challenge – can everyone work together to get the best outcome for the industry?

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SELF-PRIME PUMP SAVES ON COSTS

Adrian Harper

The Moe WWTP was commissioned in 1996 for an average summer and winter flow of 6.5ML/d and 9ML/d respectively, with a peak flow of 17ML/d. The inlet pump station comprises two 37kW submersible pumps that operate on VSDs to control the wet well level to an operator adjustable set point. Since the plant was commissioned, average flows to the site have decreased, with the average summer and winter flows for the last five years being 5.0ML/d and 5.8ML/d respectively (Table 1). These average flows would be even lower if the last summer and winter seasons were not included.

This reduction in flows is thought to have contributed to a higher than usual maintenance cost on the inlet pumps over the last couple of years. The operator was finding that the submersible pumps were blocking up with rags quite easily, and it got to the point where both pumps were consistently blocking up every fortnight. The cause was thought to be the fact that the pumps were not often running at 100% speed, which was allowing the rags to block the pump impeller. Most of the time the pumps were operating between 70–75% speed.

The process for unblocking the submersible pumps requires hiring a crane to lift them, which adds to the overall maintenance cost. From February 2010 to December 2010, the cost to unblock the submersible pumps totalled over $27,000. In an attempt to improve the operation of the inlet pump station, the Gippsland Water Wastewater Treatment Group (WWTG) investigated various options. These included:

- Install two new submersible pumps with no clog impellers;
- Install two new cutter/grinder submersible pumps in conjunction with a pinch valve and recycle line on the pump discharge line to allow the pumps to run at 100% speed all the time;
- Install two self-priming, dry-mounted pumps.

Figure 1. Installing the self-priming pump.

Table 1. Average summer and winter flows over the last five years.

Summer period (Dec–Mar 121 days)	Average daily flow ML/d	Winter period (Jun-Sept 122 days)	Average daily flow ML/d
2006/07	4.53	2006	5.26
2007/08	4.70	2007	5.73
2008/09	4.64	2008	5.84
2009/10	4.66	2009	5.24
2010/11 (Dec–Feb)	6.42	2010	7.11

After assessing the advantages and disadvantages of each option, the WWTG decided to trial a self-priming pump with an open impeller to see if this would reduce the incidence of blocking and also allow easier access for maintenance in the event of a blockage. Owing to the lower average flows, it was also decided to limit the output of the pump to 9.5ML/d.

The WWTG chose to trial a Gorman Rupp "T" Series 22kW self-priming pump for three months and arranged with the supplier that the pump would have to meet the following criteria for the trial to be considered a success:

1. Unlimited pump blockages in the first seven days and then three blockages for the rest of the trial period;
2. The pump would deliver 110L/s at 8.9m total head.

A similar control program to that used for the existing submersible pumps was used to control the pump. An added function was to limit the minimum speed to 80% of full speed. In addition, to aid in priming the pump, the control ramped to full speed on start-up and was maintained at this until the outlet flow meter registered a flow in excess of 80L/s for 30 seconds, and then the pump speed control reverted to plant inlet well level control.

The trial pump was installed (Figure 1) in mid-December 2010 and operated well right from the start. Initially the pump was not supplied with the correct pulleys, which reduced the output of the pump, but once this was rectified the pump was able to achieve the trial flow criterion of 110L/s. Due to the initial lower pump speed and the fact that the pump performed without blockage while running at minimum speed for prolonged periods, it was decided to reset the minimum speed limit to give the same pump speed with the higher full speed pulleys. This then reduced the minimum running speed to 74% of full speed. For the duration of the trial, the pump did not completely block up once; however, it did partially block at one point, which reduced the output by about 20%. Once the impeller was cleared and the wear plate adjusted, the pump was able to achieve its full output again.

When the impeller was inspected during this outage, it was observed that the rate of wear on the impeller and wear plate was greater than that expected given the running hours on the machine, and a decision was taken to replace these items with versions made from a harder wearing alloy. Gippsland Water's maintenance contractors provided feedback to the effect that the pump was easy to work on and provided a safer working environment than the submersible pumps.

There had been some concern that the pump may struggle to reprime if it turned off due to a low wet well level, but it demonstrated many times during low overnight influent flows that it could reprime in 1–2 minutes with no difficulty.

Following the successful outcome of the trial, the WWTG has decided to go ahead and install a second Gorman Rupp pump in a duty/follow/stand-by configuration. From a financial perspective, the total cost of the project was $65k, with the purchase of the pump contributing $30k to the total. It is expected that the total cost to install both pumps will be recovered in less than five years in maintenance savings alone. This does not allow for the savings in energy by the reduced installed power of 22kW compared to 37kW for each of the submersible pumps.

The Author

Adrian Harper (adrian.harper@gippswater.com.au) is a Waste Water Technologist with Gippsland Water in Victoria.

MANAGEMENT OF PROTOZOAN RISK

Late in 2009 a meeting was held involving a large number of water treatment and water quality managers from utilities across Australia. The aim of the meeting was to discuss the management of Protozoan risk, principally of that posed by Cryptosporidium*, and to get some idea how different Australian utilities were managing that risk. The approaches were quite varied.*

The group was aware that the NHMRC was well advanced concerning the revision of the ADWG. A submission was therefore made to NHMRC to include guidelines for the management of Protozoan risk. The following document is the submission. NHMRC has indicated that they have intentions to review this matter in the next edit of ADWG.

Since the document reproduced here represented strong consensus of the many utilities involved, it seemed a pity for the good work not to be published in one form another. While the publication of this in WaterWorks *in no way represents an official statement, water quality managers, water treatment managers and risk managers may find the content useful and be able to use it in the management of Protozoan risk in their own utilities.*

I highly commend it for consideration.

– Peter Mosse, Editor

When the source water for a drinking water supply is drawn from multi-use surface water catchments there is a high probability that protozoan pathogens, such as *Cryptosporidium* and *Giardia*, will be present in the untreated source water. Depending on the types of activities that occur in the catchment, the densities and species of *Cryptosporidium* and *Giardia* will vary spatially and temporally.

Current analytical techniques for the isolation and identification of *Cryptosporidium* and *Giardia* in untreated and treated water have improved markedly over recent years, but the techniques are still relatively slow and expensive.

The management of protozoan risk is centred primarily on the operation and maintenance of catchment and treatment barriers. Consistent with the ADWG Framework, the first treatment barrier is source protection. Source waters for drinking water supplies should be drawn from the best available source. The best available source would be a catchment area that is undisturbed and free of point sources of contamination (for example, septic tanks, stormwater, cattle feed lots).

The reality is that many drinking water supplies have source water that is drawn from multi-use catchments, which present multiple potential sources of protozoan pathogens. A key management strategy is to work with landholders, natural resource management agencies and other stakeholders to manage potential sources of contamination, with the goal being improved raw water quality.

Even with effective catchment management, there still exists a probability that protozoan pathogens will be periodically present in the source water, either after a storm event, or as the result of some incident or accident at one of the point sources.

After source water protection, the operation and maintenance of robust water treatment processes is the most effective management tool for preventing protozoan pathogens entering drinking water supplies. Given that *Cryptosporidium* and *Giardia* cannot yet be continuously monitored in either raw or treated water, there needs to be commitment to operating and maintaining the treatment processes.

Chlorine disinfection does not inactivate *Cryptosporidium* and has limited success with *Giardia*; it **cannot** be used as a sole treatment barrier where the source water for a drinking water supply is drawn from multi-use surface water catchments where sources of protozoan pathogens are known to exist.

Filtration can be a most effective treatment barrier to *Cryptosporidium* and *Giardia*. Filtration preceded by effective coagulation and flocculation physically removes protozoan pathogens, but the effectiveness of this process is highly dependent on how well the filters are operated and maintained.

Based on the need to remove waterborne pathogens, where filtration is used as part of the water treatment process, the turbidity of water leaving filters, under the normal operating conditions, should not exceed 0.1 NTU, unless validation data indicate that water of higher turbidity is microbiologically safe.

Depending on the level of assessed risk posed by protozoan pathogens, an additional treatment barrier of ultraviolet (UV) light should be installed, particularly in the case where the assessed risk is high or very high (based on a qualitative risk assessment).

As with filtration, the effectiveness of UV light units at inactivating protozoa is highly dependent on how well the units are operated and maintained. The use of validated units is considered essential.

Once treated, water is distributed to the consumer. Recontamination can occur in the distribution system. The most common causes of recontamination are backflow, cross connections and during repairs to mains. Low-pressure events in the mains increase the likelihood of such contamination via these routes. Contamination also occurs in treated water storages as a result of birds and vermin gaining access through poorly maintained tank and roof structures. Once recontamination occurs, the chlorine residuals are not sufficient to manage anything other than minor bacterial contamination. Therefore, recontamination must be prevented at all times.

The risk of recontamination can be minimised by ensuring the integrity of storage structures, use of high quality and, where appropriate, testable back flow prevention devices and thorough disinfection after repair work to mains, particularly where dewatering of the main has been necessary to effect repair. After a mains break, water should not be returned to consumers until it is safe to do so.

Table 1 *(see overleaf)* details recommended source water protection barriers, water treatment processes, and operational limits based on catchment type and level of protozoan risk. Recommendations for the management of mains breaks are also included. The table can be used as a guide to designing and operating water treatment processes to manage protozoan risk.

Table 1. Recommended water treatment processes and operational limits based on catchment type and level of protozoan risk.

Catchment Type	Fully Protected	Moderate Impact	High Impact
Description of Catchment	Native bushland catchment. No human settlement or agriculture. Human access only for essential maintenance.	No point source inputs. Land use characterised by unimproved pasture, forest and rural residential. No dairies or STPs or septic tank run-off or use of manure on pastures.	Intensive inputs. Land used characterised by intensive animal farming (in particular, cattle and sheep) with irrigated grazing, dairies. Crop growth with irrigation and use of manure. Urban development (sewered or unsewered). Wastewater or manure may be discharged into the catchment without treatment.
Cryptosporidium	*Cryptosporidium* oocysts may be sporadically present. Typically 0.001/L.	*Cryptosporidium* are occasionally present. Typically 0.1/L.	*Cryptosporidium* are generally present. Typically 10–100/L.
Raw Water Intake	Not under direct influence of wastewater discharges.	Not under direct influence of wastewater discharges.	May be under the direct influence of wastewater or manure discharges.
Source Barriers	No specific requirement.	Effective catchment management program including annual auditing of all septic tanks in critical source areas, tertiary treatment on any small STPs present and no direct access by calves to streams, and no intensive calf or lamb facilities.	Effective catchment management program including annual auditing of all septic tanks in critical source areas, tertiary treatment on any small STPs present and no direct access by calves to streams, and no intensive calf or lamb facilities. Identification of and removal of point sources. Annual audits.
Treatment Barriers Required	No specific requirement.	One *Cryptosporidium* barrier IF there is an active and effective catchment management program (see above). Otherwise, two *Cryptosporidium* barriers required.	Two *Cryptosporidium* barriers required.
Barriers	Chlorine disinfection.	At least filtration and chlorine disinfection. Water from catchments where there is potential for human-infectious *Cryptosporidium* (stock, humans, septics or STPs) must be filtered unless validated UV or membranes are included. In catchments with a very small number of stock or humans, filtration may not be necessary, but full quantitative microbial risk assessment (QMRA) is required to establish adequacy.	Media filtration and validated UV or ozone, or ultrafiltration membranes.
Treatment			
Clarification		Clarified water target <2 NTU critical limit 3 NTU.	Clarified water target <1 NTU critical limit 3 NTU.
Filtration	Generally not applicable.	Individual filtered water turbidity <0.15 NTU 95th%ile, <0.5 NTU 98th %ile, max 1.0 NTU. Ripening period <0.3 NTU, <15 minutes.	Individual filtered water turbidity <0.15 NTU 95th%ile, <0.2 NTU 98th %ile, max 0.3 NTU. Ripening period filtered to waste. 2-15um counts target <20/mL, critical <100/mL.
Plant Operation		Any supernatant return should be continuous and < 10% inflow. Continuous operation if possible. Plant operation should be slowed during turbidity events. Continuous online monitoring of individual filters and chlorine residual.	Untreated supernatant must not be returned to the head of the plant. Supernatant can be returned if media filtration, UV or ozone disinfection is carried out. Filter to waste capability should be included in new plants and retrofitted to existing plants if possible. Plant operation should be continuous. Increases in plant inflow should be as slow as practical. As a guide <10% per hour. During turbidity events plant should be taken offline or slowed significantly. Continuous online raw water turbidity monitoring at the raw water source strongly recommended. Continuous online clarified water turbidity monitoring strongly recommended. Individual turbidity meters for individual filters. Continuous online analysis of at least one critical limit parameter for both filtration and disinfection, linked to alarms and automated shut off.

Catchment Type	Fully Protected	Moderate Impact	High Impact
Treatment Disinfection	Chlorine only disinfection generally satisfactory. Turbidity <1 at point of disinfection or proof that disinfection is occurring. Ct>15 mg/L.min.	Chlorine disinfection. Turbidity <1 NTU at point of disinfection. Ct>30 mg/L.min. UV disinfection >40 mJ/cm2.	Ultrafiltration or validated UV disinfection >80 mJ/cm2.
Monitoring	Monitoring of *Cryptosporidium* not recommended.	Event monitoring of *Cryptosporidium* recommended.	Routine and event monitoring of *Cryptosporidium* recommended.
Reporting	Annual reporting of Ct performance.	Annual reporting of individual filter turbidity performance. Annual reporting of Ct performance.	Monthly reporting of individual filter turbidity performance. Monthly reporting of UV performance.
Distribution System Management of Mains Breaks	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes (Ct 100,000). If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break.	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes (Ct 100,000). If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break.	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes (Ct 100,000). If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break.
Operator Competency and Experience (based on Vic DH COP for Water treatment Operator Competencies)	Certificate II in Water Operations (NWP07/NWP01).	Certificate III in Water Operations (NWP07/NWP01). 3 years' experience including 2 years assisting in the operation of a Level 3 facility.	Certificate IV (Technical) in Water Operations (NWP07/NWP01). 5 years' experience including 2 years responsibility for Level 3 facility.
Refresher Training		Yes	Yes
Operator Certification			Yes

Notes: The values of Cryptosporidium *provided are for guidance only and are not necessarily prescriptive. They may be useful for utilities that have little (or no) monitoring data and are unsure how to interpret the data. However, the description of the catchment type is probably a better system of classification of the catchment type and, therefore, the barriers necessary. The values are taken from World Health Organisation guidelines.*

FROM DROUGHT TO FLOOD IN 3 EASY STEPS!

Marcus Boyd
Winner of the Ecolab Prize for the Best Operator Paper at the 2011 WIOA Qld Conference

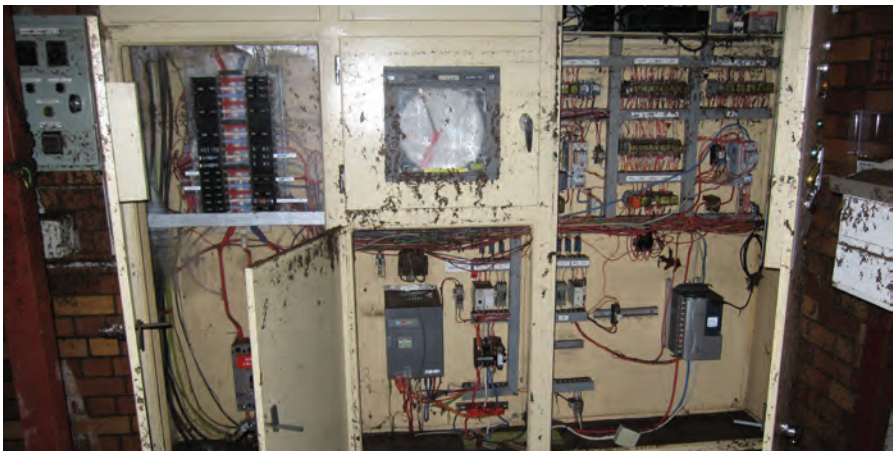
The Big Dry

Up until January 2011 the Toowoomba region was in the grip of one of the worst droughts on record. From late 2004 until early 2010 Toowoomba's three surface storage supplies – Cressbrook, Perseverance and Cooby Dams – received little to no inflow, resulting in declining storage levels down to the lowest recorded combined storage of 7.8% in late February 2010.

As drought conditions worsened during 2004, Council investigated a range of options to ensure a sustainable water supply to the Toowoomba region. The primary option considered was the recycling of wastewater through a 4-step process of BNR, ultrafiltration, reverse osmosis and ultraviolet treatment, producing a 6-star quality final product suitable for potable use. Due to the controversial nature of this proposal, a vote was held to determine whether recycling would go ahead. Following a long and well publicised campaign, the vote on the addition of purified recycled water to the water supply was lost and additional measures had to be considered.

The option to increase bore water production into the city's water supply to supplement the dwindling surface water storages was considered to be the most effective short-term strategy. At this time, extraction from existing groundwater sources averaged 1,800ML/a. With the potential to extract up to an additional 2,000ML/a under the current licence, Council provided funding in its 2005/06 Budget to investigate and construct additional basalt aquifer bores. This project resulted in an additional eight basalt aquifer bores pumping into the reticulation system, producing an extra 1409ML/a to supplement the surface water storages.

As a further measure, Council received approval to drill a number of Great Artesian Bores to supplement the Cooby Dam storage. Following an unsuccessful drilling near the wastewater treatment plant, five boreholes were drilled around Cooby Dam and three were subsequently



Flood damage to Queens Park Bore switchboard.

equipped to supply artesian water to supplement the Cooby Dam storage.

Following the continued decline of surface water storage levels, in late 2008 the Queensland Government commissioned a project to construct a pump station and pipeline to deliver water from Wivenhoe Dam to Toowoomba's Cressbrook Dam, at a cost of $187M. This pipeline was commissioned in January 2010, merely two months before the rain started.

Throughout this time Council implemented a strong water conservation campaign, including a strict 5-tier water restriction policy. From September 2006, when the combined surface storage first dropped below 20%, Level 5 restrictions were in effect, completely prohibiting outdoor water use. This level of restrictions is far more stringent than even the strictest water restrictions used in other areas of South-East Queensland.

In March 2010, 188mm of rain fell in the catchment and lifted the combined storage to 17.2%, followed by significant further rainfall in December 2010 and January 2011, which resulted in the filling of Toowoomba's dams for the first time in 10 years. The extensive rainfall caused significant flood damage across the region,

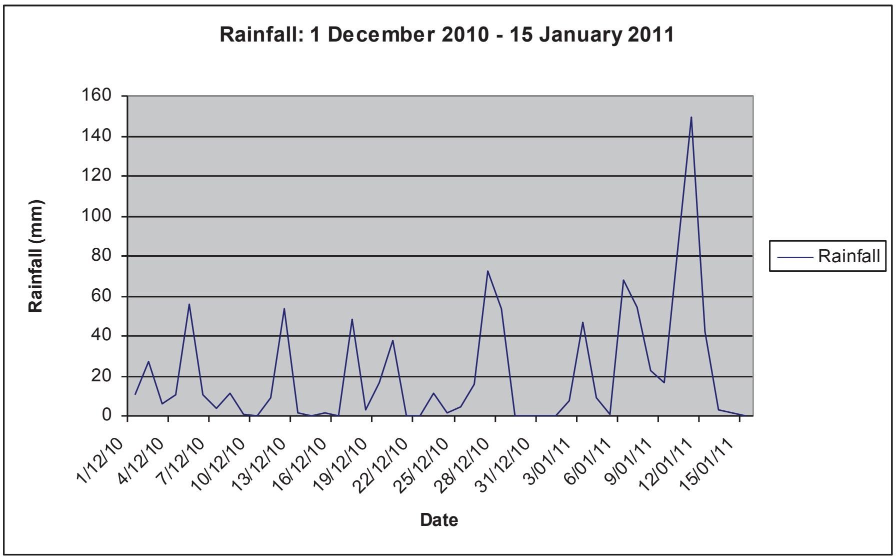


Figure 1. Rainfall for the period 1 December 2010 to 15 January 2011.

Cressbrook Spillway – approximately 1m over the crest.

The East Creek pedestrian crossing over the railway line.

and took Council teams to their limit in order to continue operating the water and wastewater systems.

Amalgamations

In March 2008 Toowoomba City Council amalgamated with seven Shire Councils to form Toowoomba Regional Council (TRC). This brought about further challenges in ensuring water supply, as the onus to supply water for the entire new Council rested with TRC's newly formed Water Services Department. Following review of each district's water networks, work on ensuring a sustainable water supply for the entire Council began.

Fortunately several areas, particularly those to the south of Toowoomba, were fully reliant on bore water, which at least for the moment did not appear to be suffering due to the drought. Other areas, including the previous Crows Nest, Jondaryan and Rosalie Shires, were almost fully reliant on surface water from Toowoomba's three dams, making it all the more important that sustainable solutions were investigated.

Rain is Coming... (March 2010)

In March 2010, 188mm of rain fell on the catchment and lifted the combined surface water storage level to 17.2%. This was the first significant rainfall event the Toowoomba dams had seen in over 10 years and, as such, resulted in some minor issues, in particular a number of slips on the downstream side of Cressbrook Dam wall. Investigation of the slips revealed that they were caused by a lack of drainage on the dam berms, and that there were no structural implications. Fortunately machinery was in the vicinity finalising work on the Wivenhoe pipeline, enabling repairs to be undertaken quickly and with minimal issues. While these slips turned out to be purely cosmetic, the lessons learned during the rectification process held us in good stead for the immense rainfall to come.

... And More (December–January Rainfall)

In December 2010 rain began to fall consistently across the TRC catchments, with widespread localised flooding occurring in almost all towns. By mid-December the catchments were fully saturated and significant run-off was evident with minimal rainfall. During this time the combined storage level at the dams was steadily rising, with the first of the dams reaching their Dam Safety alert level on Boxing Day.

Figure 1 shows the consistent heavy rainfall throughout December and January. At 2:05pm on Friday 7 January 2011, Perseverance Dam reached 100% and began to spill for the first time in 10 years. By Sunday night Cooby was also spilling, and with Cressbrook level quickly rising, two Dam Safety teams were stationed around the clock at the relevant dam sites. On Tuesday the combined storage reached 100% and continued to climb (see Figure 2).

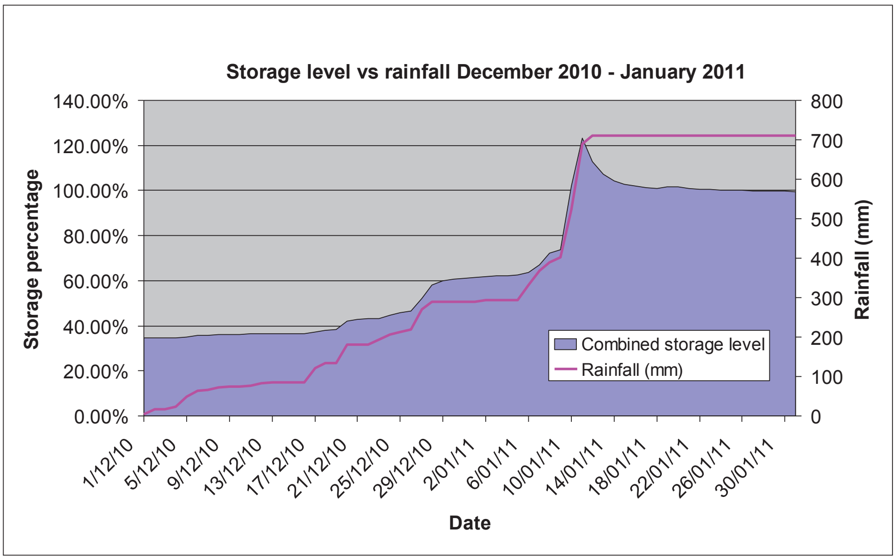


Figure 2. Combined surface water storage level vs. cumulative rainfall for the period 1 December 2010 to 30 January 2011.

... And Floods

Just after lunch on January 10, 2011, Toowoomba was hit by a storm that brought with it extremely heavy rainfall across the entire catchment. The storm came in from the north-east and moved slowly across the district, flooding all in its path. Average rainfall data for the storm within the city area has been tentatively assessed as a 1-in-200-year event; however, significantly greater rainfall fell along the escarpment. The volume of water that flowed through East and West Creeks, however, has been estimated as a 1-in-500-year event, primarily due to the completely saturated condition of the catchment prior to the storm.

The extreme rainfall and flooding resulted in significant infrastructure damage across the region. Some of the major damages included:

- Several slips on Cressbrook Dam wall, similar to those that appeared in March;
- Several major water pipelines along the creek destroyed;

Downstream of Cooby Dam spillway – flows approximately 1.55m over spillway crest.

- A major wastewater pipeline along the creek broken;
- Flooding of Cressbrook pump station, requiring the baking of two 640kW motors;
- Flooding of several bore switchboards, requiring complete replacement.

Repairs to the pipeline infrastructure, in particular, have been extremely difficult due to prevailing unavailability of repair crews, and was significantly compounded by the damage to road infrastructure in the area. Following the flood damage to water pipelines, the water treatment plant lost 17ML from its reservoirs in just over 40 minutes.

This volume of water is equivalent to over 50% of daily consumption, and required the reservoirs to be isolated at the treatment plant while temporary repairs and pipeline diversions were undertaken. This resulted in loss of water supply to a large area of the city for a number of hours. While the damage bill to water and wastewater is yet to be finalised, it is expected to be in the vicinity of $3–5M, and with the funding arrangement through NDRRA yet to be finalised, the flood damage is likely to leave a significant bill for TRC to cover.

So in a period of just 12 months, Toowoomba has come from the area's worst drought in history to having dams overflowing and aquifers fully recharged. The flooding that occurred on January 10 in particular brought staff to their limit, as they experienced an event that no-one of our generation had previously seen. The lessons learnt from this have been invaluable to TRC staff and, despite the significant damage encountered, all are satisfied that our water supply is now secured for the foreseeable future.

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ICE PIGGING – THE WAY AHEAD?

Graeme Berriman
Winner of the Ecolab Prize for the Best Operator Paper at the 2011 WIOA NSW Engineers & Operators Conference

Most water system operators, especially those tasked with maintaining an ageing water system, have at one time or another been required to carry out mains cleaning. For large diameter pipes, this generally involves use of a large sponge or plastic swab or pig, excavation of the pipeline at each end to install pig launchers and catchers, weeks of interruption to supply, and a considerable burden on resources. Now a new technology developed at the University of Bristol by Professor Joe Quarini offers the potential to drastically change the way we in the water industry clean pipes.

Over the past decade water quality has become an increasing challenge for Gosford City Council (GCC). The most common complaint comes in the form of discoloured water. GCC has been addressing these and other water quality issues by implementing a program of works to improve system performance. This program has included mains cleaning activities such as flushing and air scouring the reticulation system, and pigging the larger transfer system.

While each of these water-main cleaning processes can be effective under certain circumstances, each has a number of drawbacks and limitations. Flushing a water main by initiating high velocities of water through it, removing loose particles and debris deposited along the pipe wall, is only effective on water mains up to 150mm and must be repeated at regular intervals to maintain a positive result. The other drawback of flushing is the large amount of water wasted during the process.

Air scouring, which involves blowing high pressure air mixed with small amounts of water through the main to increase sheer stress on the walls, was once considered to be the technology to move water main cleaning into the future; however, it is now known that it may cause pipe damage if not carried out correctly. Air scouring is limited to pipelines of 375mm and below.

Pigging involves forcing several coated sponge objects (pigs) of various shapes, densities and roughnesses through the pipe in order to wipe or scrape loose material and bio-films from the pipe walls.

While this method has a high degree of success in cleaning water mains, it has a number of drawbacks. Pigs are unable to cope with large changes in pipe diameter and direction. Further, pigging involves a high set-up cost, needing a launcher and catcher to be installed at each end of the water main to be cleaned.

Issues can arise in tracking the pig's location where junctions exist along the pipeline and sondes introduced to solve this problem are not always successful. Pigs will not survive intact in pipelines that have protruding service connections. Finally, pigs do get lost, leading to costly recovery efforts.

To better meet the challenges faced by GCC, numerous new technologies, such as high-pressure water cleaners that crawl through the pipeline, sound waves and smart pigging that cleans and assesses pipeline condition, have been investigated. Each method was found to have drawbacks with respect to cost and length of pipeline able to be cleaned.

After further investigation, an innovative and environmentally friendly cleaning method – ice pigging – was identified. The advantages of ice pigging over other methods used by GCC appeared to be numerous. Ice pigging in many ways mirrors conventional pigging, but without the need for installation of specialised launchers and catchers, thus reducing overall cost; ice pigging uses ice slurries as viable semi-solid pigs; ice pigs never get stuck in the pipeline; if lost in the pipeline ice pigs will eventually melt; and finally, ice pigs are able to negotiate extreme changes in pipe size and direction.

During the late 1990s and early 2000s, Professor Quarini undertook a series of experiments to prove that, when correctly controlled, ice slurries could:

- Be successfully pumped and have the ability to form a semi-solid pig;
- Produce a cleaning ability more efficient than high velocity water;
- Transport fine and heavy sediment at velocities lower than can be achieved by water;
- Maintain its cleaning ability while negotiating pipe bends and accommodating changes in pipe size.

Put simply, the major benefit seen in ice slurries is their ability to be pumpable, behaving like a liquid; and yet in pipelines they behave as a solid, thus increasing the sheer stress on the pipe wall to successfully clean the internal lining of water mains.

To maintain the qualities listed above, the ice slurry must maintain its consistency. This means that the ice must be maintained

Figure 1. The ice delivery truck on site, ready to begin pigging.

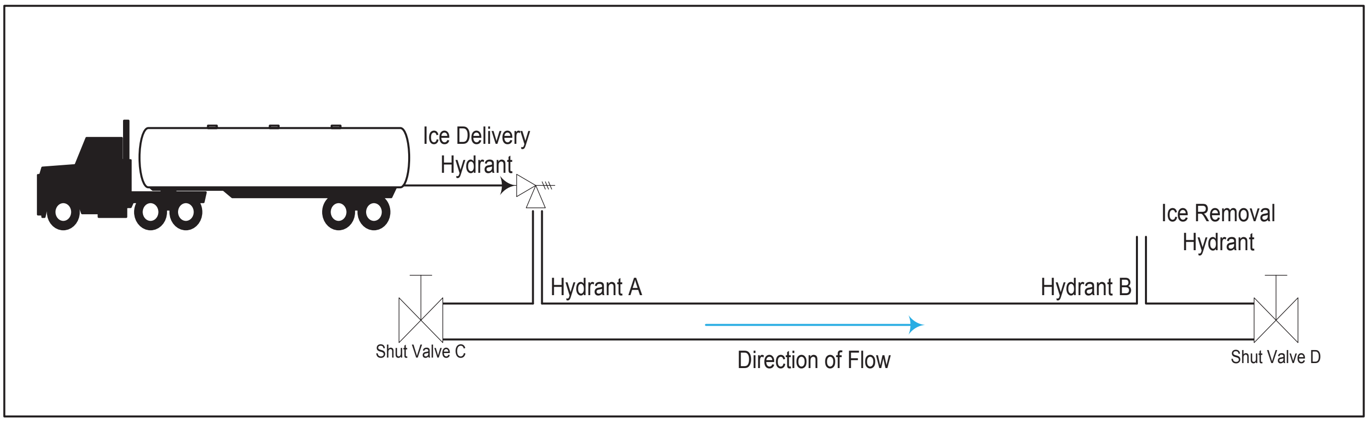

Figure 2. Schematic of the ice-pigging process.

as a series of individual ice crystals. Over a period of time, ice crystals will tend to stick together and form a solid mass as the ice ages. To maintain the ice in single crystals, a freezing point depressant and mechanical agitation is used. In ice slurries used to clean potable water mains, a uniquely designed brine solution is used.

Once the theory of ice pigging was proven in the testing facility and a number of field-based trials were successfully carried out, a vehicle was constructed in Bristol to carry out ice pigging on a larger scale (see Figure 1). The vehicle itself consists of a large articulated truck used to carry a diesel generator, ice delivery pump and a geared stirrer. The stirrer is comprised of a stainless steel cylinder with a stirring device fitted to maintain the ice at the correct consistency as it is transported to site. The ice itself is produced by specialist ice-making machines and pumped into the storage container for transport.

It is once on site that ice pigging really changes the process of mains cleaning. Pigging a water main has always included the laborious process of removing a launcher to install the pig and removing a catcher to retrieve the pig.

Ice pigging, however, uses the fittings already available, such as hydrants, air valves or even manual air bleeds. The process involves pumping the ice slurry into the pipeline via a chosen fitting. Once the ice pig is in place, water pressure is used to propel the ice through the pipe to be recovered at a pre-selected exit point (see Figure 2).

With reference to Figure 2, the section to be cleaned is isolated by shutting valves "C" and "D". At this point hydrant "A" and "B" are opened and the pump on the delivery truck is used to force ice slurry into the pipe, filling approximately one-third of the total length. Hydrant "A" is then closed and the ice delivery line is removed.

Once the correct amount of ice has been pumped into the pipe, valve "C" is opened. This allows water to push the pig along through the pipeline. Once the pig reaches the ice-removal hydrant, a tanker is connected to the hydrant and the ice, including the collected sediment, is removed from the pipeline and transferred into the tanker. The water following the ice pig becomes clean very quickly and can be flushed to a stormwater line.

During this flush, turbidity readings are taken at hydrant "B". Once the turbidity readings reach acceptable levels, hydrant "B" can be shut and valve "D" can be opened, returning the system to normal operation.

To fine-tune the ice-pigging operation, monitoring equipment is placed at the inlet and outlet hydrants to test for temperature, flow rate and conductivity (salt content). Ultimately the results of these tests are used to monitor and control the ice-pigging operation. Added to this, samples are taken from the outlet hydrant to study particulate removal rates. It is also possible to add other products to the ice, in the form of sand to increase it cleaning ability and increased chlorine to assist in removal of biological contaminants

To date, the results recorded by ice pigging show significant improvements in iron and turbidity concentration and improvements in chlorine residual.

Where To From Here?

To April 2010, ice pigging has been used to clean over 100km of DN75mm to DN450mm pipes, most of which has been carried out in the United Kingdom. Pipes tested include cast iron, ductile iron, steel, asbestos, MDPE, HDPE and PVC.

Arrangements have been made for an ice-pigging trial to be conducted in Australia. To date, discussions are underway with three water companies from Queensland, three from Victoria and one from New South Wales.

Ice pigging offers a range of benefits to the water industry in the form of reduced costs, gentle but effective cleaning, reduction in the potential for pipe damage, and reduction in down-time for the water mains being cleaned.

Further benefits of ice pigging are inherent in the process itself. Its ability to negotiate pipe size and directional changes with ease, to utilise existing fittings for the introduction and removal of the ice pig without the need for purpose-built launchers and catchers, and to achieve a reduction in iron and turbidity and an increase in chlorine residuals means that this technology appears to be a suitable and cost-effective replacement for flushing, air scouring and swabbing.

Further Reading

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IMPROVING NEW ZEALAND DRINKING WATER QUALITY

Jason Colton

There are key differences between the approach taken to managing drinking water supplies in New Zealand and Australia. In New Zealand water suppliers are required by law to comply with the NZ Drinking Water Standards, which are arguably the toughest in the world and require compliance to be demonstrated continuously by online monitoring. The regulatory timeline associated with drinking water quality in New Zealand is summarised in Table 1.

The Health (Drinking Water) Amendment Act in 2007 marked a milestone in New Zealand. For the first time, all water suppliers had a duty to ensure their water is safe to drink. They are required by law to take all practicable steps to comply with the drinking water standards – DWS2005(2008).

Grading of Public Water Supplies

The concept of grading was first introduced in New Zealand in 1995, with criteria being revised in 2003 to reflect the requirements of DWSNZ2000. The grading is carried out by a drinking water assessor (DWA). DWA are public health professionals employed by regional health authorities who have undertaken specialist training. The grading criteria cover online compliance, chemical compliance and other non-water quality related parameters such as QA/QC, staff training and supervisor qualifications.

The grades that are assigned to public water supplies are shown in Table 2. The Ministry of Health has made efforts to demonstrate a link between these grades and public health (Ball, 2007). Figure 1 shows a plot of incidences of *Cryptosporidiosis* against the grade assigned to the water supply and plant. This data clearly shows that the incidence of waterborne disease increases as the plant grade decreases, with ungraded supplies showing the highest incidence.

All grading results are available to the public via the Water Information for New Zealand (WINZ) database, managed by the Institute of Environmental Science and Research Limited (go to: drinkingwater.co.nz). Anybody can use the website to see what grade has been assigned to the water treatment plant supplying their community.

Requirements of Current Drinking Water Standards

The drinking water standards that apply in New Zealand are DWSNZ2005(2008).

The document is organised into compliance categories. The three main ones are Chemical Compliance – which is similar to the Australian Drinking Water Guidelines (ADWG); Protozoal Compliance and Bacteriological Compliance.

Table 1. Regulatory Timeline in New Zealand.

Year	Publication	Key Features
1995	Drinking Water Standards introduced. DWSNZ 1995.	Grading of public water supplies introduced.
2000	New Revision of Drinking Water Standards. DWSNZ2000.	Online instrumentation used to demonstrate compliance.
2003	Grading criteria revised.	
2005	New revision of Drinking Water Standards. DWSNZ2005.	Introduction of USEPA Log Removal concept for protozoa. Requirement for public health risk management plans.
2007	Health (Drinking Water) Amendment Act.	
2008	New revision of Drinking Water Standards. DWS2005(2008)	Minor amendments, no policy changes.

Table 2. Source and Treatment Grades.

Grade	Description
A1	Completely satisfactory, negligible level of risk, demonstrably low level of risk.
A	Completely satisfactory, extremely low level of risk.
B	Satisfactory, very low level of risk.
C	Marginally satisfactory, low level of microbiological risk when water leaves the plant, but may not be satisfactory chemically.
D	Unsatisfactory level of risk.
E	Unacceptable level of risk.
U	Ungraded.

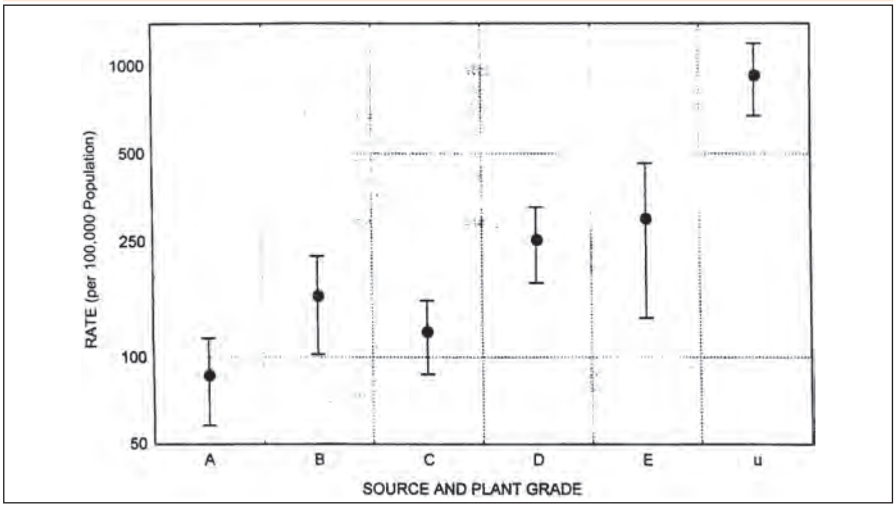

Figure 1. Incidences of *Cryptosporidiosis* (reproduced from Ball, 2007).

Figure 2. Te Marua WTP (left) and Te Aroha WTP (right).

Protozoal Compliance

The Protozoal Compliance criteria are based on the USEPA Log Removal concept, where the level of treatment required is linked to the protozoal risk in the source water. Protozoal risk is quantified by measuring *Cryptosporidium* oocyst concentration in the source water over one year or, for smaller suppliers (<5000 population), by a catchment risk survey.

The lowest level of treatment required is 3 Log (99.9%) removal and the highest is 5 Log (99.999%) removal. Treatment processes are assigned a certain Log removal value provided they meet certain criteria. Processes can be combined to achieve a cumulative Log removal value matching the source requirements.

The Protozoal Compliance criteria have to be measured continuously (every minute) using online instrumentation. The compliance reporting period is monthly.

Bacteriological Compliance

The Bacteriological Compliance criteria are based on using the Free Available Chlorine Equivalent (FACE) concept. This takes into account the effect of pH on the efficacy of chlorine, where at higher pH proportionally more chlorine is required to get the same disinfecting power.

The Bacteriological Compliance criteria have to be measured continuously (every minute) using online instrumentation. The compliance reporting period is daily.

Demonstration of Plant Performance

Two plants have been selected to demonstrate compliance with the Protozoal and Bacteriological requirements of DWSNZ2005(2008). The first is the Te Marua WTP in Wellington, which is operated by Greater Wellington Regional Council. The plant is a 140ML/d conventional clarification and filtration plant. The plant has always had an A1 grading.

The second is the Te Aroha WTP, operated by Matamata Piako District Council. The plant is a 5ML/d conventional clarification and filtration plant. The plant was an E-grade plant, but following a recent $100K refurbishment is now producing A1-grade water.

Protozoal Compliance

Both plants have to provide 4 Log of protozoal treatment. To provide this with conventional clarification and filtration, the Enhanced Individual Filter Turbidity rule must be used. The performances that must be met to achieve compliance for these criteria are as follows:

- Turbidity must be measured every minute on each filter;
- Turbidity must be <0.1NTU for not less than 95% of the month;
- Turbidity must be <0.3NTU for not less than 99% of the month;
- Turbidity must not exceed 0.5NTU for more than 3 minutes at any time in the month.

Turbidity data from Filter 3 at the Te Marua WTP for the month of February 2011 is shown in Figure 3. This is a typical line graph, similar to a SCADA trend. It shows that the turbidity was less than 0.1NTU for nearly all of the time, but it is not possible to derive percentage compliance from this type of graph. It is also difficult to compare filter performance using this type of graph.

Figure 4 shows the turbidity data for all six filters at the Te Marua WTP for the month of February 2011. This form of plot is called a cumulative frequency graph. It is possible to derive percentage compliance from this type of graph and it facilitates easy comparison of filter performance. The 95 and 100 percentile values for the US Partnership for Safe Water initiative are shown for reference.

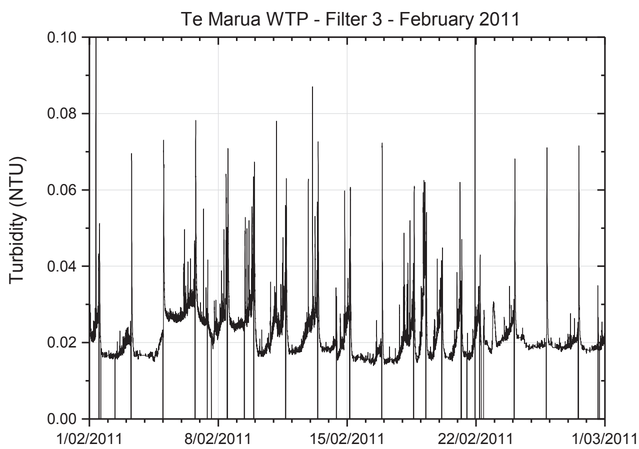

Figure 3. Te Marua WTP Filter #3 Turbidity.

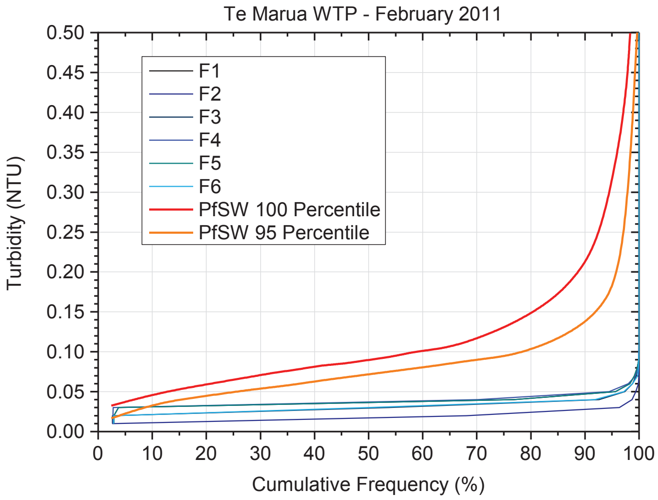

Figure 4. Te Marua WTP Filter Turbidity Cumulative Frequency Graph.

A third type of plot is shown in Figure 5. This is a box plot and shows the statistical spread of turbidity data for all the Te Marua filters. The box shows the 25 and 75 percentile values, while the bars show the 5 and 95 percentile values and the crosses show the 1 and 99 percentile values.

These three graph types show that the performance of the filters at the Te Marua WTP met the protozoal compliance requirements for the month of February.

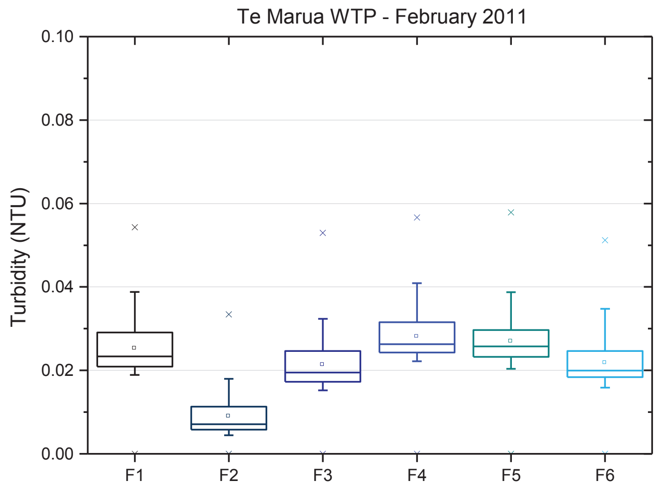

Figure 5. Te Marua WTP Filter Turbidity Box Plot Graph.

The turbidity data from the Te Aroha WTP is presented in Figure 6 to demonstrate that it is not just larger plants that can achieve this onerous turbidity targets. The data in Figure 6 shows that the Te Aroha WTP also met the Protozoal Compliance requirements for the month of February.

Bacteriological Compliance

In order to demonstrate bacteriological compliance both plants have to meet the following criteria:

- Treated water FAC, pH and turbidity must be measured every minute;
- FACE must be >0.2mg/L for not less than 98% of each day;
- Turbidity must be <1.0NTU for not less than 95% of each day;
- Turbidity must not exceed 2.0NTU for more than 3 minutes in the day;
- Chlorine T_{10} contact time must be greater than 30 minutes.

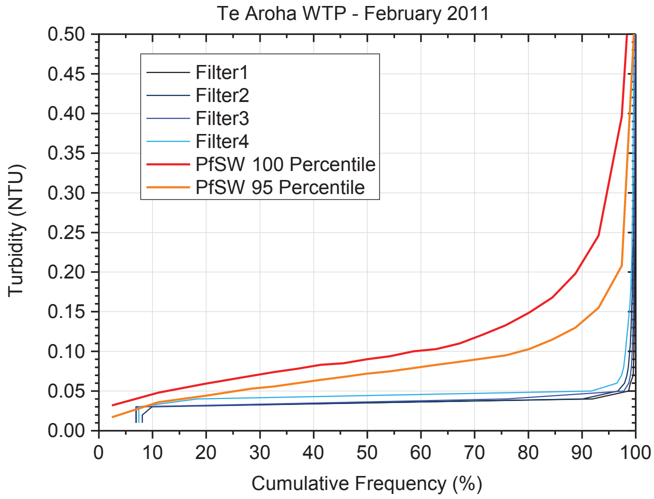

Figure 6. Te Aroha WTP Filter Turbidity Cumulative Frequency Graph.

Both the Te Marua WTP and the Te Aroha WTP meet these requirements each and every day.

Has It Worked?

So has it worked in New Zealand? Has it resulted in improved drinking water quality?

The data in Figure 7 shows that the answer is an unequivocal yes.

Furthermore, it is important to note that improvements in plant performance don't always require expensive plant upgrades to achieve compliance. For most sites it is possible to achieve compliance by optimising the existing assets. All it requires is the will, or the regulations in the New Zealand case, to want to do it and to then simply make a start.

An end goal will only be achieved by taking the first and subsequent steps. Without taking these steps, it won't happen.

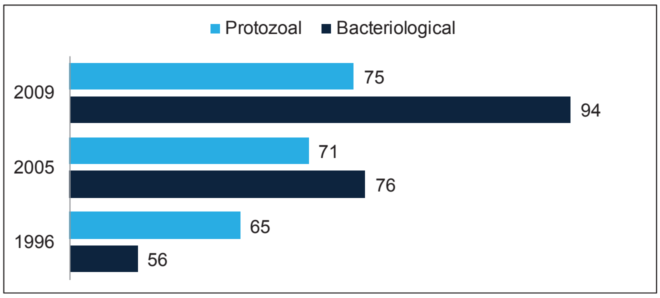

Figure 7. % NZ Population with Compliant Drinking Water.

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Ministry of Health, New Zealand. (2006): *A Summary of the Annual Review of the Microbiological and Chemical Quality of Drinking-Water in New Zealand 2005*.

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WHERE HAVE ALL MY DRYING BEDS GONE?

Ian Davis

Winner of the Iwaki Pumps Australia Prize for the Best Paper Overall at the 2011 WIOA Qld Conference

Gympie Sewerage Treatment Plant is a 45-year-old trickle bed filter plant with primary sedimentation and anaerobic sludge digestion. The growth of Gympie, combined with changes to effluent discharge regulatory requirements, has resulted in the construction of a Biological Nutrient Removal (BNR) plant. Construction of this plant commenced in mid-2009, and the plant is expected to be fully operational by December 2011. The plant is designed for a capacity of 30,000 EP. The existing plant had a series of drying beds and a drying lagoon. Up to 100,000 litres of sludge was discharged weekly from the anaerobic digestors. The drying beds and lagoons were demolished within two weeks of construction commencing.

It was, therefore, necessary to develop on short notice a system of temporary sludge removal for a period of two years.

A number of options were considered:

- Construction of new drying beds. This would be a major capital cost, involving the construction of new infrastructure that would be redundant in two years. The other issue was land availability. There was no suitable land available for the drying area required.
- Early construction of the new sludge dewatering facility, a belt press. The new belt press would be constructed a considerable distance from the sludge digestors. The project program and site made this a difficult and expensive option. Furthermore, return of supernatant back to the inlet works would have presented many difficulties.
- Remove digested sludge. This material could be transported to the nearest waste removal facility. This requires no capital costs. However, at 3% solids, transport costs would be exorbitant with most of the material water. The nearest regulated waste facility is 1.5 hours driving away.
- Allow sludge to settle in tanks. This also involved considerable capital cost, and the amount of dewatering that would occur was unknown. Once again the infrastructure would be redundant once the new plant is commissioned.
- Construct a cheap dewatering facility. This facility would need to be a low capital cost, with effective dewatering.

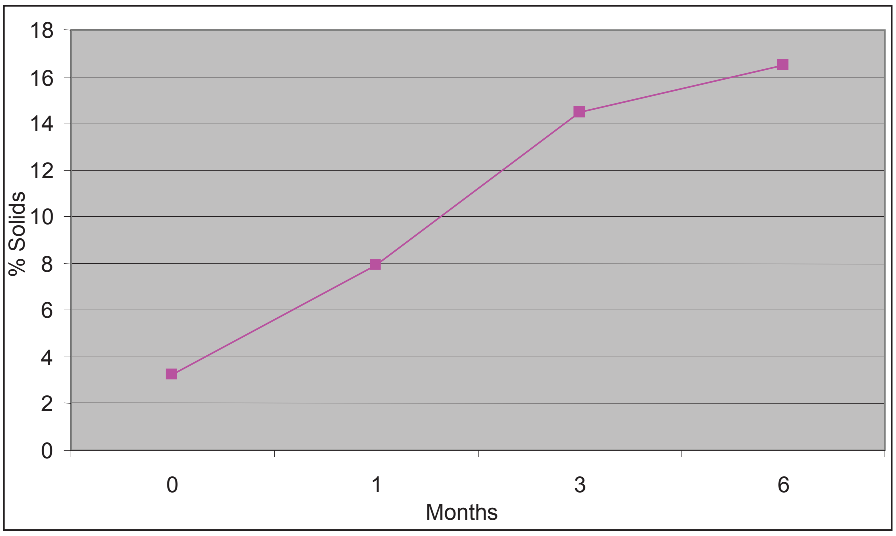

Figure 1. Percent solids obtained from the sample geotextile bag.

The preferred option was a low-cost dewatering facility that could be easily removed once the new plant was operational. Geotextile bags were considered as an effective dewatering option that did not involve a major capital outlay.

Investigations were performed on sample bags to determine if the sludge could be effectively dewatered without any filter aid. Results are shown in Figure 1. While the sample bags are not completely representative of dewatering on a large scale, it can be seen that this sludge would easily dewater through the geotextile bag in an acceptable time frame.

Construction of the Dewatering Facility

The size of the geotextile bags was 15–20m long by 3–4.5m wide. An area was found that would not interfere with any construction works of the new plant. This area was graded to ensure it was flat across the width, with a very slight slope down the length. The area was bunded and lined with polyethylene sheet. At the low point a pit was constructed, using a 1000L container. This contained a sump pump with float switches. Flexible hose was run back to the digestor supernatant pit.The geotextile bags were laid upon porous panels, which improved dewatering. In the final version there were four bags in service, with provision for a fifth. Figure 2 shows the arrangement of the


Figure 2. The geotextile bags in place.

bags. Cost of construction was minor, with temporary materials used. The largest cost was the geotextile bags themselves.

There were two possible ways to operate the bags:

- Option 1 was to keep topping the bag up until it was full, and then allow the material to dry over time. This would result in a very dry material that would have the minimum transport cost. The disadvantage of this is that the material takes many months to fully dry out, and there was not enough room to have a large number of bags at any time. It is possible to stack the bags, but this was considered to be unsafe. The amount of bags required depends on the final sludge solids. Calculations showed that a minimum of 12 bags would be required if the sludge was dewatered to 15% solids.
- Option 2 was to dewater the sludge to a level such that it is still liquid and able to be removed from the bag easily. Then this sludge can be removed and the bags can be continuously recycled. While this results in an increase in transport costs, the capital costs are significantly less than for purchasing multiple bags and the footprint is much smaller.

The key to the second option is running at the highest possible sludge solids while still producing a dewatered sludge that can be removed from the bag by a sucker truck. Digested sludge has a solids content of approximately 3%. The goal was to dewater to a minimum of 6% solids, thus halving transport costs. Table 1 shows how costs diminish with increasing solids content. The table summarises the costs at various percentage solids. It allows for the increased capital costs for additional bags for the dry solids option.

Table 1. Cost Comparison of Wet Sludge vs. Dry Sludge Removal.

Dry Sludge Solids %	Cost per Week	Wet Sludge Solids	Cost per Week
7	$3042	3	$5,308
8	$2662	4	$4,008
9	$2366	5	$3,228
10	$2130	6	$2,708
11	$1936	7	$2,336
12	$1775		
13	$1638		
14	$1521		
15	$1420		

From a straight cost comparison, drying the sludge fully is the cheapest option. However, there were a number of logistical issues that made this impractical. The primary issue was the turnover time when drying, which means a large footprint is required or, alternatively, stacking of the bags. Given the difficulties of this option, it was decided to use the second option, and remove partially dewatered sludge. The focus was then to ensure that this sludge had been dewatered to a minimum 6%.

Once the system of wet sludge removal was established, the bags were filled and emptied on a rotation system. Each bag was allowed to dewater for up to two weeks prior to being emptied.

Practical Issues

Site level is very important, particularly across the width of the bags. It was found that even with a very small slope the bags rolled, and it was necessary to stake them. The site had to be level across the width, and only have the slightest fall lengthways.

Over-drying was an issue in the hot summer months. At one stage in December 2009, the bags were unable to go more than a week before they became unpumpable; this meant that the bag then became unusable as it could not be emptied. If this occurred it was necessary to dry the bag out, remove the dry solids and put another bag in its place. Drying the bag out took time and balancing the sludge removal between the other bags then became difficult. It was important to ensure each bag was able to remain in service.

Low solids content was also an issue. The geotextile bags do tend to clog up and it is important to monitor solids levels. It was found that the use of a water blaster every second day cleaned the bag surface efficiently and dramatically improved dewatering. Maintaining the correct solids content was critical to the successful operation of this system. If the solids are too high the material cannot be pumped and the bag becomes unusable. If the solids are too low the costs blow out and sludge removal is inefficient, ultimately leading to too-high sludge levels in the digestor and sedimentation tanks.

The use of geotextile bags is an effective and low labour-intensive way to dewater sewerage sludge. It will dewater to up to 15% solids, depending on the time allowed. Once this process was established, the dewatering system worked very well and will sufficiently remove sludge until the new plant is commissioned. It requires minimal maintenance, a few hours a week water-blasting, and an hour a week for removal.

Acknowledgement

The Author wishes to Acknowledge Mr Ross Gibbs for his involvement in initiating and developing this project.

The Author

Ian Davis was a Process Engineer with Gympie Regional Council in Queensland.

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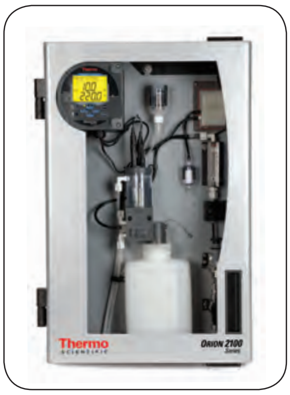

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