WaterWorks

OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION

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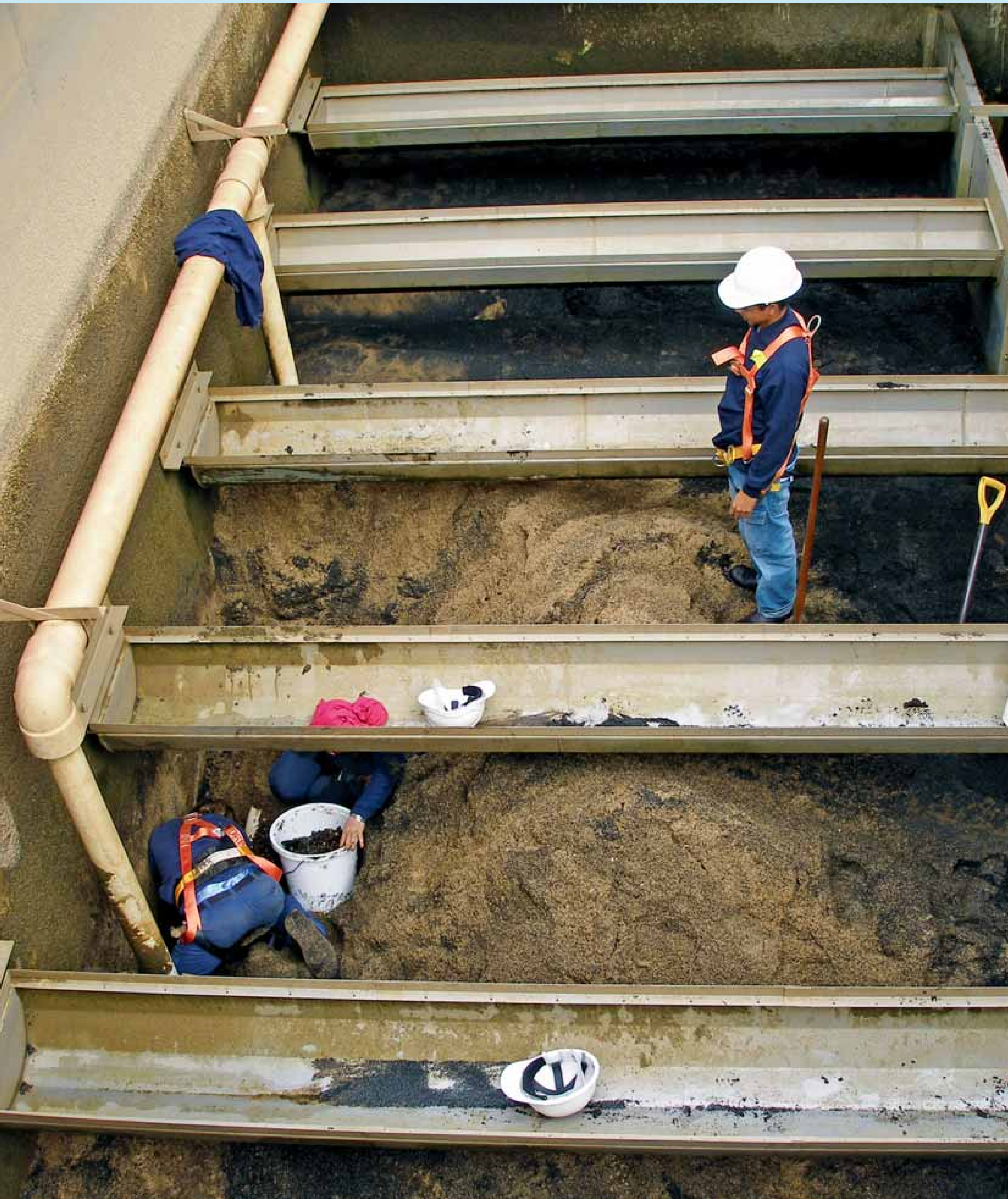

WATERWORKS
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Contributions Wanted

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 the above address in handwritten, typed or printed form.

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ALARMING PROBLEMS

Peter Mosse

The latest Health Stream (September 2009) includes reports on the Brisbane fluoride incident and pathogen related water quality incidents at Jindabyne and the ski resort of Smiggin Holes. In the Brisbane fluoride event, fluoride continued to be dosed into treated water despite the plant being offline. At Smiggin Holes up to 400 people became ill in a number of different ski lodges. At Jindabyne, sewage overflowed into lake Jindabyne due to a failure of a sewerage pump. In both the latter events a boiled water notice was put in place.

In analysing these events, a common theme emerges - the reliability of alarm systems and of the follow up systems that are in place to respond to an alarm condition.

I have spent time in many WTPs and carried out a significant number of WTP operational reviews across the country. A recurring theme is the poor state of the alarm systems. Common problems identified include:

- Inactivated alarms. Often done by operators simply because the alarms were being repeatedly triggered when no alarm state existed. This was "driving them mad" and the utility had failed to correct the problem.
- Alarm limits set deliberately high to avoid false alarms.
- Alarm limits that bear no relationship to the Risk Management Plan critical limits or HACCP limits.
- Poor, or no, calibration of instrumentation controlling alarms.
- Inadequate checks of alarms. An electronic instrument output check does not constitute an alarm check.
- No provision for automatic shutdown of the plant when critical parameters are exceeded. Also, confusion as to which, if any, alarms shut a plant down.
- Failure of critical alarms that are supposed to shut a down a plant as defined in a RMP.
- Poor logic behind the alarms available. For example, turbidity meters on treated water but none on the raw water or clarified water. This means there is no provision for an early warning and when the treated water exceeds the limit, to some extent it is all too late, particularly if those alarms are unreliable or fail.
- No escalation system in the event that there is no response to an activated alarm.
- Failure to identify alternative notifications for the situation where the nominated officer is on leave.
- Inappropriate prove times - both too long and too short. Short prove times are likely to lead to false alarms that lead to operators possibly ignoring alarms or inactivating them or raising the limits.
- Alarm limits changed by on call staff to avoid being called out during their on call period can either be because they don't want to be called out or because they lack confidence and training in the operation of the plant to feel confident they know what to do if the alarm is activated.
- Alarms and alarm limits not clearly displayed on plant control systems.
- Alarm limits that have been changed and no one really remembers when and by whom.
- Many alarm set points are not appropriately protected and there are suspicions that alarm limits are changed by staff without the necessary knowledge or appreciation of what the alarms are for. Once changed, they appear to stay changed.
- Assumptions by senior management that all alarms are in place.

Alarms are an integral part of process monitoring. They should be established to support the achievement of the target objectives and critical limits identified at each control point and thereby help to protect the consumer from exposure to unsafe drinking water. The limits and actions should be based on a risk management assessment and a control point approach to water quality management as recommended in the ADWG Framework for the Management of Drinking Water Quality.

A number of brief general suggestions are offered here.

1. Critical alarm limits should be set to help protect public health. The definition of a critical alarm is simple - critical alarms are those that should the parameter being

OUR COVER

Our cover shot shows a deep bed excavation being carried out in a filter to expose a few nozzles for inspection.

CONTROL SYSTEMS ENGINEERS

AIT

Has your site experienced downtime or compliance issues from:

- Chattering or nuisance alarms?
- Alarm floods when power is lost or isolated?
- Operators complaining about or ignoring the alarm system?
- Unreliable alarm paging systems due to calibration issues?
- Too many alarms occurring?

How much time is spent manually checking alarm issues?

When did your plant last review critical alarm set points in the PLC?

Do your operators get frustrated with the number of alarms?

Are critical alarms sometimes missed due to the total number of alarms?

Can you rely on your alarm system 100%?

Does any of this sound familiar?

You need Automation IT to perform an Alarm Rationalisation at your plant!

Automation IT are licensed system integrators for Matrikon and use the extensive Alarm Manager software tools to provide a complete rationalisation of plant alarm systems. Common problems are identified and a detailed report is provided along with the necessary updates to the plant's control system to rectify the issues. The software tools allow not only alarm system analysis, but also feedback on how your operators are interacting with the alarm system and how many alarms are being ignored as well as how long it takes to react to alarms. This data can then be benchmarked to ensure that the operator loading observed falls in line with "Best Practice" operator loading objectives as outlined in EEMUA #191 guidelines. It is not uncommon for unaudited modern plants to exceed the recommended guidelines for alarm loading by an order of magnitude!

Automation IT has extensive experience in the design and implementation of alarm management systems as well as full system integration and MES capabilities. For more information please contact our office on the number below.

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monitored exceed the limit, it will result in the production of unsafe drinking water. Clearly, critical alarms necessitate plant shutdown. When critical alarms are activated the plant should shut down automatically. What is required is a clear definition of what parameters are to be alarmed and which ones should shut the plant down. For a WTP, consideration should be given to the following conditions automatically shutting the plant down:

a. Significantly elevated raw water turbidity

b. Alum dosing failure

c. Elevated clarified water turbidity

d. Elevated turbidity in water from individual filters

e. Elevated turbidity in combined filter flow

f. Failure of the disinfection system.

2. Alarm limits should be set as part of the process of implementing the control point philosophy of the ADWG Framework.

3. The alarm limits should be linked to the target objectives and critical limits determined for the control points.

4. Appropriate delay (prove) periods should be established to ensure that alarms are not activated inappropriately.

5. Alarms should be tested. This includes a full test where the alarm is activated by altering the conditions at the sensor and allowing the "system" to run right up to checking paging systems and implementation of incident management plans. In particular, the timely and appropriate shut down of the plant should be assessed.

Have You Identified All The Hazards??

Most operational management systems incorporate an assessment of hazards and associated risks. See if you can work out an unusual hazard for a WTP from the photograph above taken at a WTP recently (answer on page 11). What preventive measures should be put in place?

The concept of an alarm in the water industry is often poorly understood. The alarm is often simply regarded as being analogous to a wake up alarm. A time is reached and a noise is emitted and someone wakes up. However an alarm is actually an alarm system - a complex set of interconnected actions and responses.

An alarm is triggered in response to some deviation in a measured parameter. The objective of the alarm is to bring about a change in an operational process that results in a change in the measured parameter back into the target range. As such it involves many steps using different modalities:

1. Physical, chemical, electrochemical measurement
2. Electrical/electronic
3. Telecommunications
4. Human recognition and reaction
5. Process modification
6. Change in measured parameter

The need for alarm checks is obvious. The check should be a full check, not just a 4-20 mA or other electronic check. The alarm condition should be triggered by modifying the water quality near the sensor. For example:

1. Remove the on line pH probe and place it into a beaker of the same water that it was in. Add a drop of acid or alkali to the water to take the pH outside the alarm limit.

2. Add some turbid water to the turbidity analyser or alternatively add some formazan standard to the turbidity analyser.

In each case watch, wait and see what happens. Check the whole alarm response. This includes the initial triggering of the alarm, notification of the operator and activation of the escalation process if the operator link fails.

Each alarm should have a time period for the measured parameter to exceed before the alarm is triggered. This period should be adjustable, however to prevent general access to this adjustment, it should be password protected and only be available to the main plant operator, supervisor and manager. This is necessary to avoid "fiddling" with the delay period just to avoid "inconvenient" activation of alarms.

There is an urgent need for the industry to be aware of these limitations relating to alarms. All too often there is an assumption that alarms are in place but there is no effective checking mechanism. Operators often know the alarms are inactivated but have chosen for one reason or another not to report them. Sadly, in some cases they have simply given up because of the lack of response to their notifications or requests. In other cases, training of operators at a specific site fails to identify these critical controls to the point that they just don't know.

If the industry needs a reminder beyond the three incidents reported in Health Stream then reading Steve Hrudey's book *(Safe Drinking Water. Lessons from Recent Outbreaks in Affluent Nations)* is recommended as it contains case studies on amongst many others, the Milwaukee, Gideon, Galway, and Walkerton incidents. The threat from pathogens is real. Unfortunately the response to the need for alarms is all too often one of complacency, a word used at least once at the Walkerton inquiry and one that Steve Hrudey uses throughout his book. The two events in the Australian Alps are a reminder of what can and does happen. The event in Brisbane was too close for comfort.

There is a need to get the alarms right, get the number of alarms right, get the priority level correct and use them to the advantage of the operators, the utility and the consumer.

LETTER TO THE EDITOR

I recently had the opportunity to consider the paper 'Water Industry Operations, A Need for Reform' prepared by George Wall, Peter Mosse and Peter Bernich for the Water Industry Skills Task Force.

In recent times I have read a number of papers and letters in Water Industry publications which would leave the reader thinking that there are few opportunities for training in our industry and those that are available are ineffective.

I would like to point out that the Water Industry Training Centre and its predecessor, the Water Training Centre, has been engaged in providing quality training for operators of water and wastewater treatment plants for 31 years. I have been proud to have been part of this for 29 of those years and privileged to see the motivation of our water industry operators to accept the challenge of training and personally develop their work and leadership skills over that time.

It therefore depresses me when I see comments that highlight the lack of quality training in the industry, the dissatisfaction of operational managers regarding training quality, training courses not in keeping with regulatory and technological changes and the lack of trainers with acceptable water industry expertise. Nothing positive in all of that.

The Water Industry Training Centre prides itself on the standards set in its courses and assessment of operators. Feedback from trainees indicates that these standards are meeting their needs in most cases and where constructive comments are made, we always use them to improve our techniques.

Our experience with operational managers would suggest that in most cases they do have a good understanding of the training needs of their staff and it is where these managers have a role in recommending and arranging training, trainees not only attend but are in a more beneficial position to qualify for a Certificate. This is achieved in part by our provision of Training Plans to operations managers providing a clear training path to qualification. Many operational managers partner with us in the collection of workplace evidence which we are very grateful for and it also provides an opportunity for these managers to play a more active and informed role in the training of their staff.

It disappoints me to hear comments regarding training courses not keeping up with changes in the industry. The Centre's courses do cover traditional treatment processes as these are still the most common and conventional in our industry. It is vitally important that trainees develop underpinning knowledge of the basic concepts of treatment approaches if they are to optimise plant performance. This requirement is reinforced in the content of units of competency in the Water Training Package. Our courses are reviewed regularly and augmented with newer process variations as they are implemented. Additionally, courses have been developed and incorporated into our range of options as they are required. For example, Dissolved Air Flotation in the early 1990's and, more recently membrane and RO courses.

Where we develop training courses, considerable attention is applied to ensuring that the content adequately meets the performance criteria, skills and knowledge of the relevant Units of Competency in the Water Training Package.

Finally, we pride ourselves on having a high level of training expertise in our organisation. Our staff all have significant experience in the Australian water industry. Our trainers have post graduate qualifications in engineering and chemistry together with assessment and training qualifications. Having worked widely with clients throughout Australia, often on-site at treatment plants, has given us a high level of knowledge regarding the roles and responsibilities of treatment plant operators. Our significant voluntary involvement with the Water Industry Operators Association and the Australian Water Association over many years has also been excellent personal development for our staff.

We aim to continue to provide quality vocational training services to the water industry and it would be nice to see some of these publications identifying where there are positive opportunities for operators to obtain training.

John Park
September 2009

Editor's Note

Thanks John. We are certainly aware that quality training is available and we would love to publish a list of organisations that we feel are quality providers. Unfortunately, in this day and age, we cannot. Keep up the good work.

THE FIVE DAY CHALLENGE

Greg Comer

Greg was awarded the Hepburn & Iwaki Prizes for the Best Paper Overall as well as the Actizyme Prize for Best Operator Paper at WIOA's 2009 Victorian Conference.

On the 7th of February 2009, wildfire ravaged towns throughout the state of Victoria, damaging the environment and local infrastructure. The Kilmore Water Treatment Plant (WTP) sustained substantial damage to its electrical and control room system and it was quickly assessed as being beyond salvage.

The WTP services a combined population of approximately 7000 people with an average daily consumption of 3 ML/day. The high summer temperatures meant that it was extremely likely that the communities would be without potable water. The task of rebuilding the plant at first seemed near impossible but with some clear thinking, in-house expertise and sound management, the task was completed within the necessary time period.

Figure 1. The burnt out dosing and control room.

Following a more detailed investigation on the Sunday afternoon, it was found that while the control room and chemical dosing system were completely destroyed (see Figure 1). Fortunately the Dissolved Air Filtration (DAF) filters, motors, backwash pumps, dispersion system, raw water supply and most pipe work was still intact and serviceable.

All field wiring (415Vac, 240Vac, low voltage and instrumentation) cables were in good condition. Although the cabling was burnt at the cable entry point to the building, it had suitable length on it to be serviceable which later would become a very important aspect to the solution to this incident.

To save water, Stage 4 restrictions had been immediately introduced after the fire. A limited supply from Yarra Valley Water's Wallan system had been reconnected. With these steps in place it was estimated that the water in storage would sustain the system's water supply for approximately five days. Within five days the 7000 people could be without drinking water. This was not an option and could not be allowed to happen. A solution to the problem had to be provided within five days. It also had to be sustainable and possibly last 6-12 months. Not an easy task.

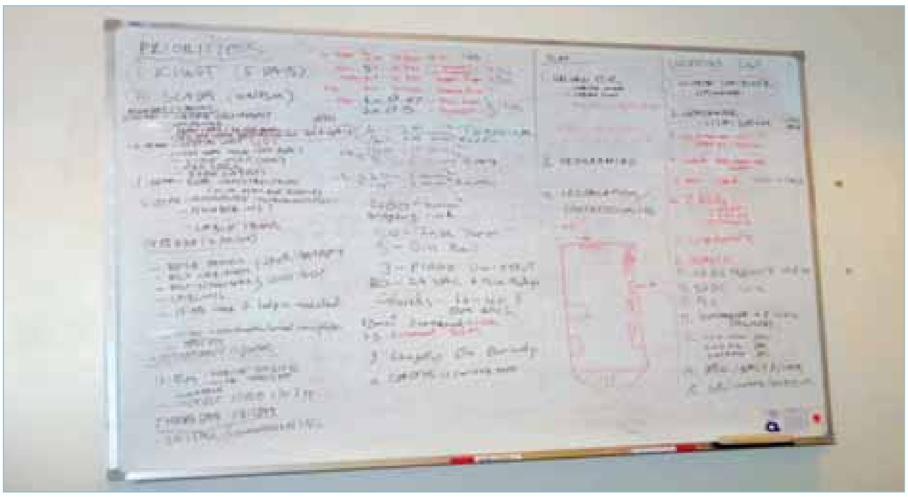

Figure 2. The container "concept" summarised on a whiteboard.

The Plan

A number of ideas were considered, from portable water systems to carting in water by truck, but none were thought to be viable or sustainable for any length of time. Considering that the DAF system itself was largely intact, the only solution was to try to use it, rebuild the control room and start producing water in the shortest time possible.

As the Operations IT department members had detailed knowledge of the plant PLC code, SCADA systems and electrical infrastructure, it was decided that the quickest option was to manage and resource the project from within Goulburn Valley Water (GVW).

Work on the concept plan was started immediately on Sunday night. It was hoped that this effort would dramatically increase the chances of success and enable the procurement of the necessary equipment to be well on the way at the start of business Monday morning. Over an eight hour period, various scenarios were discussed and alternatives considered. The Sunday night session was seen as the key to the success of the overall project. "There was a job to be done: So let's do it and do it well".

The basic plan consisted of:

- Use a shipping container to house the temporary control room containing the motor starters, PLC, interface cubicles, human machine interface (HMI CitectSCADA), telemetry, UPS.

- The timing of restoration of power to the site was unknown. Therefore a 300KVA diesel generator would be required.
- Local electrical contractors would be employed to investigate, test, label and get the existing field cabling ready to be connected to the new control room.
- The Corporation's South West Operations team, in conjunction with GVW treatment specialists, would arrange for the replacement of the chemical dosing systems.

A conceptual design for the layout of the shipping container (see Figure 2) was drawn up outlining where it would be located onsite and where various cabinets (including junction boxes for the power and control cables from the field) and motor starters would be installed.

An important concept in the layout of the container was the ability to work on more than one item at a time. This enabled simultaneous construction phases to be completed while others were put on hold if parts were unavailable. As the week progressed this decision was instrumental in achieving success.

Figure 3. Team members working side by side in the shipping container.

The other important and equally valuable decision was to use the existing PLC code and CitectSCADA project that was operating before the fire. The PLC code and CitectSCADA projects were proven to work. It was thought that re-writing the code to a modified version would add extra time and produce errors. The Corporation's change management systems contained the latest backups of these projects and were easily obtained.

The next stage was to develop a detailed parts and equipment list. This covered cabinets, cables, motor starters, PLC equipment, computer equipment, timber and a suitably sized generator. This information was placed in a spreadsheet and periodically e-mailed to vendors throughout the night/morning. This ensured all the required parts would be sourced and received as early as possible. In addition to this, the major vendors were contacted Sunday evening to inform them of the situation so they would be fully prepared for an immediate order early Monday morning.

With the design and procurement aspects completed, the attention turned to developing a time line for the construction, installation and commissioning phases of the project. Construction would begin first thing Monday morning. Milestones were set for various stages to be completed with regular update meetings to monitor progress and assess whether extra resources were needed. A list of items for the critical path (show stoppers) were itemised with contingencies put in place so that objectives could be achieved even when experiencing long delays. The core team consisted of five members of the Operations IT team and a maintenance officer from the Central water group to assist with general construction duties.

Day 1

The first task Monday morning was to brief the other team members of the situation and the task ahead. The container arrived approximately 10.00am, ahead of schedule, and was found to be already lined and insulated. This saved an enormous amount of time and allowed the real construction phase to begin. Initial construction tasks (measurements and layout) were carried out in conjunction with finalising procurement of the materials ordered in the late night planning session. There were two local electrical wholesalers involved who greatly assisted in this area. Lighting was installed in the container as a priority so that work could continue into the night. The remainder of Monday saw the mounting of the cabinets, cable tray and some initial wiring. A scheduled progress meeting was held to check on progress late that afternoon. It was agreed that the project was on target and that some items that had not arrived would be on site first thing Tuesday morning. For the project to succeed it was realised that long hours were going to be needed. Fatigue management issues were discussed to reduce the risk of mistakes and accidents. Team members were required to get at least 6 hours sleep a night.

Day 2

Tuesday saw the bulk of the construction take place. The main tasks carried out included continuing to mount the cabinets and motor starters, cabling, setting up the laptop for the HMI, air conditioning installation and cutting holes for the field wiring to enter the control room. The team followed the layout drawn on the white board at Sunday's planning meeting, improvising where required to appropriately install the cabinets, motor starters and cable tray for the large task of interfacing the field cabling.

The main item on the critical path for the construction phase in Shepparton was to adequately prepare the power and control junction cabinets ready for the field equipment to be wired. Connections between the motor starters, power junction box and the power distribution board were also carried out. The layout of the container continued to be very important with up to five team members working independently side by side (see Figure 3). After a second planned progress meeting it was decided to gain the assistance of two extra electricians to aid in wiring duties. By the end of day 2, progress was still on track but the enormity of the task was becoming apparent.

Figure 4. The finished control room.

Day 3

Construction continued on Wednesday morning. Work was progressing well which led to the decision to relocate the container to Kilmore WTP on Wednesday afternoon and begin the next stage of wiring in the field devices and a 300KVA generator.

Day 4

The wiring of the external field cables into the interface cubicles continued on Thursday along with the PLC cubicle. The PLC input/output (I/O) wiring was a huge task and the time needed was underestimated. This could have had the potential to delay progress considerably. A subset of the Operations IT team concentrated on this and made the important decision to test each I/O point from the PLC code through to the CitectSCADA HMI as it was connected. While this was painfully slow the effort was well worth it when it came to commissioning the finished product. The pre-built dosing system arrived and was installed then interfaced to the control system. Thursday proved to be the longest day with some 20 hours worked but the end was in sight and we had renewed belief the deadline could actually be met.

Day 5

The PLC wiring continued Friday morning and was still the main task to be completed. All of the 415 and 240 Volt supplies were connected enabling motor direction testing to begin and valve operation to be tested. Some online water quality instruments were interfaced to the HMI as a "nice to have" but not essential to the overall task. Control signal cables were all terminated and by mid afternoon, motors and valves were starting to operate in automatic mode. Figure 4 shows the finished control room.

Late Friday afternoon, water was being treated in one filter. This water was then used to backwash the second filter. At approximately 7.00pm Friday night the plant had two filters online producing reasonable quality water in automatic mode. At around 9:00pm on the Friday night, the inlet valve at the Kilmore township 16ML tank was opened and the tank commenced filling.

It was then time for a well earned beer and some sleep!! For all the team members it had been a very rewarding experience but one that hopefully would not have to be repeated.

The Author

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OPERATOR EXCHANGES IN GERMANY

Jörg Krampe

The exchange of experiences and the qualification of wastewater treatment plant operators in Germany is organised by the DWA (German Association for Water, Wastewater and Waste). The role of the DWA is to support the water and wastewater industries and to bring together specialists active in these fields. The Association is a not for profit organisation. A major function of the DWA is the provision of training and competencies for operators and professionals working in water and wastewater. This paper will describe the exchange of knowledge and experiences of operators of WWTPs in the state of Baden-Wuerttemberg in the south of Germany.

WW Treatment in Baden-Wuerttemberg, Germany

In 2004 there were 9,994 WWTPs operated in Germany, and 96% of the inhabitants of Germany are connected to the sewer network. In Baden-Wuerttemberg, there are 1,026 operational WWTPs with 99% of the inhabitants connected to a centralised WWTP. Baden-Wuerttemberg has a population of 10.7 million, but due to the large amount of industry the total design capacity of all WWTPs in Baden-Wuerttemberg is 21.5 million EP.

The WWTPs are divided into groups based on their BOD_5 influent load, in accordance with the effluent requirements of the German government. Using the specific load of 60 g BOD_5/person, the total load of the WWTP is calculated as an EP. Larger plants have to achieve better effluent results than the smaller plants.

Table 1 gives an overview of the size and type of wastewater treatment processes in Baden-Wuerttemberg in Germany. Some 83% of the WWTPs are activated sludge systems. Most of the smaller activated sludge plants are operated with extended aeration to achieve a simultaneous aerobic sludge stabilisation, whereas the plants larger than 10,000 EP mainly use anaerobic digestion for the stabilisation of the sludge.

In Germany WWTPs are mainly owned by the cities and townships, and therefore in many small communities there is only one person responsible for the operation of the WWTP. This makes it very difficult for the operators to have an exchange with other professionals; hence the need for the DWA.

Based on geographical areas, the WWTPs are grouped in WWTP neighbourhoods. If there are more than 30 WWTPs in a neighbourhood, it will be divided into two neighbourhoods to keep the groups small and effective. Due to the wide range of size of the WWTPs (50 to 1.2 m EP) and the different treatment requirements for the larger WWTPs, the plants larger than 100,000 EP are connected into larger groups, to be able to consider the special needs of both the smaller and the larger plants.

Figure 1 shows the groupings of neighbourhoods in Baden-Wuerttemberg.

Every neighbourhood has a facilitator and an operator spokesperson. The facilitator is provided by the DWA to organise the meetings and prepare and present new topics for the operators. The operator spokesperson represents the operators in liaison with the DWA.

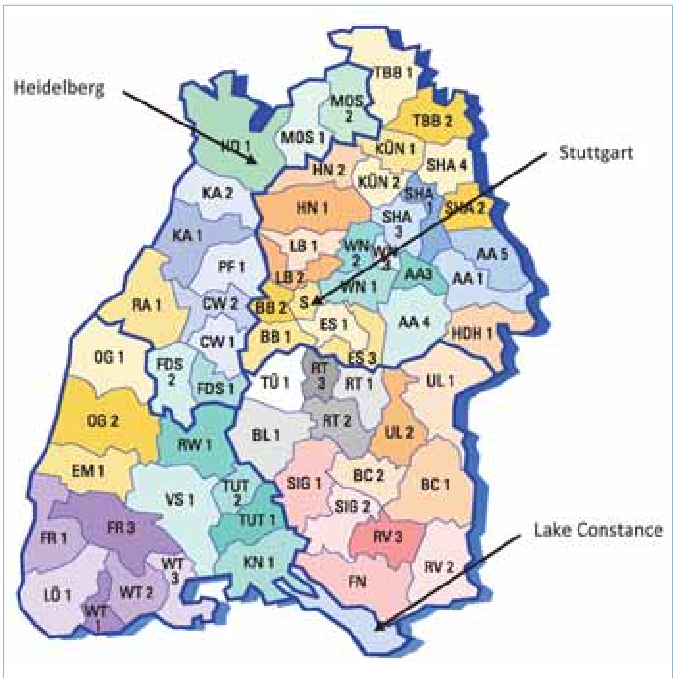

Figure 1. Allocation of the WWTP neighbourhoods in Baden-Wuerttemberg (DWA, 2008).

Some of the WWTPs are also connected in specialised neighbourhoods to take into account particular needs relevant to these plants. Specialised neighbourhoods are available for:

- Expert chemical staff
- Sludge treatment
- Trickling Filters
- SBR systems
- International Lake Constance neighbourhoods

There are three main events involving the WWTP neighbourhoods held each year.

1. Annual data evaluation

Early in the year there is a meeting of the whole neighbourhood and the local water authority. The main focus of this meeting is the evaluation of the previous year's operating data, as well as discussion of technical and other problems of the operators. This day is organised by one of the operators at their WWTP. Typically this day starts with the inspection of the WWTP where the meeting is taking place. This allows time for discussion about the installed technology, effluent results and specific problems. After a short break the data evaluation starts for all the plants. The facilitator compiles the data in software that allows direct comparison of the results of the last 2 years and between the different plants (Figure 2).

Frequently the discussion is focused on a specific topic which the facilitator will introduce. Specific topics have been:

Table 1. Size and type of WWTPs in Baden-Wuerttemberg (DWA, 2008).

Size (EP)	No	AS with separate stabilisation	AS with extended aeration	TF	RBC	Multi-stage	Mechanical	Lagoons	not specified
< 1,000	234	13	138	8	24	12	2	30	7
1,001 – 5,000	313	48	222	14	6	5		12	6
5,001 – 10,000	146	45	91	2		6			2
10,001 – 100,000	294	221	42	5	1	24			1
> 100,000	39	34		2		2			1
Total:	1,026	361	493	31	31	49	2	42	17

AS Activated sludge, TF Trickling Filter, RBC Rotating Biological Contactor.

- Nitrogen removal efficiency
- Amount of infiltration water
- Energy consumption.

At this meeting, all of the reporting requirements of the water authority are determined, and relationships between the operators and the water authority are generally friendly and cooperative. At the end of the day, the representative of the water authority gives a short overview of changes in legislation since the last meeting, and forthcoming initiatives. The facilitator gives an overview of changed guidelines and specialised courses available for operators in the coming year. Finally the operator who will organise the next meeting is chosen and the next date is fixed.

2. Qualification day and excursions

This day is quite different because there are no reporting issues to fulfil. This gathering takes place in the summer time and therefore this day can also be used for excursions. In recent years, the excursions have included:

- Visiting the production facilities of a belt filter manufacturer
- Visiting the rainwater and de-icing water treatment at Stuttgart airport
- Visiting the WWTP sludge incineration facility at a local power station.

Apart from such excursions, the facilitator delivers courses in topics the operators have selected or that are suggested by the DWA. Topics in recent years have included:

- Operational problems with fine pore diffusers – how to recognise and how to fix
- Enhancing the treatment process for phosphorus removal even if it is not forced by the water authority
- WWTP data evaluation and easy cross checks against design parameters
- Checking and calibration of flow meters

Sometimes manufacturers are invited to talk about their latest developments, such as flow meters, automatic samplers or operational methods of analysis. There is also the chance to talk about occupational health and safety issues. This is one of the topics championed by the DWA, who provide instructors and information focusing on this topic. Examples are shown in Figure 3 including safe sewer access equipment.

Another recent example was a focus on water quality in the receiving water body. A special bus equipped with microscopes and visual aids was organised for this day. Under the guidance of a biologist, the group examined the water quality of the river Nagold before and after receiving the effluent of the Wildberg WWTP (Figure 4). Another important feature of the day was a barbecue lunch for the group.

Such experiences give operators renewed motivation and demonstrate what can be

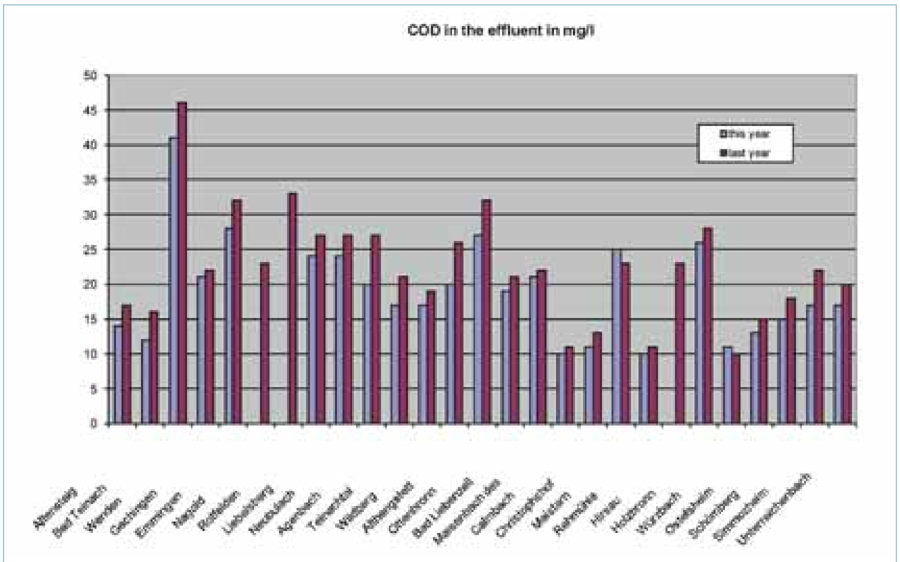

Figure 2. Example graph for direct comparison of the operational results of the WWTPs

Figure 3. OHS courses for operators.

achieved by well-operated wastewater treatment plants.

3. Review by facilitators and operator spokespersons

After the results of the data evaluation of the neighbourhood days are evaluated centrally for all the neighbourhoods, the results are discussed at a meeting of facilitators and operator spokespersons. There are also presentations of actual developments in operations, legislation and research to ensure that everyone is well informed about all important topics in wastewater treatment. All the presentations at this day are available electronically, so that these can subsequently be used at neighbourhood days.

The concept of wastewater treatment plant neighbourhoods is well received by all participations. It ensures the continuing development of plant operators, and encourages questions and mutual assistance. For the operators it is also very helpful to know that there is a WWTP not far away with special tools in the workshop or stand by pumps or blowers. Possibly neighbouring operators are qualified in different topics (eg electrical, metal working or chemistry).

There is a significant benefit for those towns and cities whose operators have access to this exchange platform between the various WWTPs, and where operators can discuss problems with each other, without having to pay a consultant for every small problem. And last but not least, most of the facilitators gain benefit from networking with the operators and seeing their problems first hand.

Forty years of neighbourhood work in Baden-Wuerttemberg (Figure 5) shows that this idea is a success story and can be an example for other regions.

The Author

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Editor's Note

The implementation of similar groups in Australia to facilitate formal and informal interaction between water and wastewater treatment plant operators would certainly benefit operations in this country.

Figure 4. Photos of the receiving water training course.

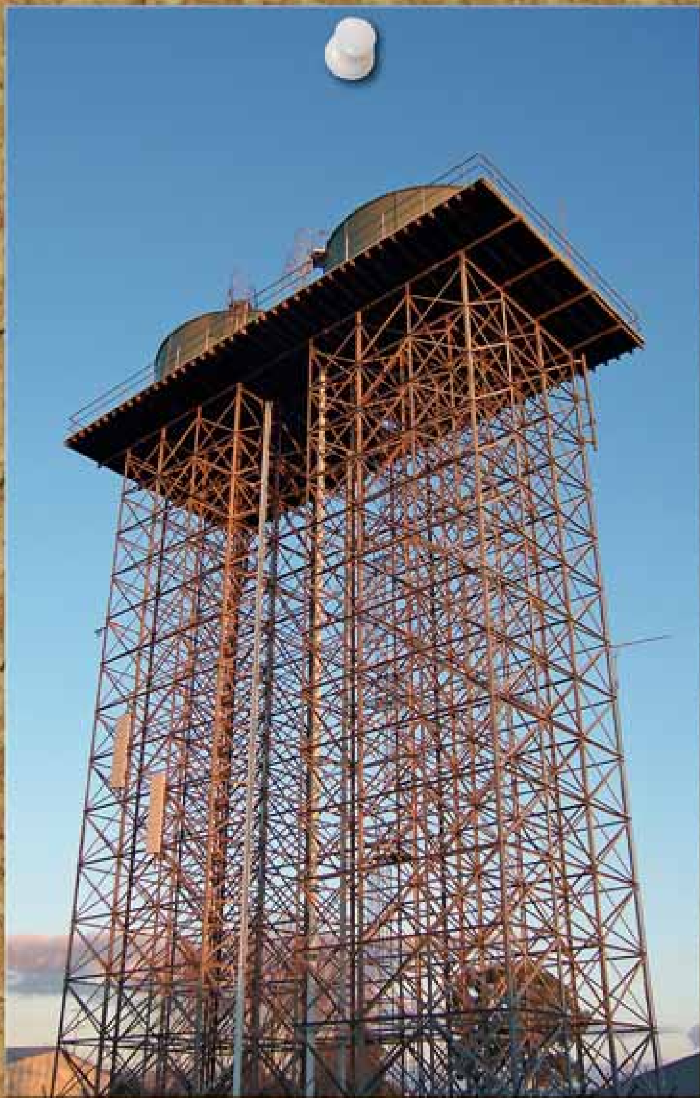
Figure 5. Gathering of Mentors on the occasion of the 40th anniversary of the WWTP neighbourhoods.

Have You Identified All The Hazards??

(From page 4) The answer: Golf balls from a neighboring golf course!

TopOpShot

There are many potentially spectacular photographs waiting to be taken in water industry operations. Some may already have been taken. WaterWorks would like to offer a prize for the TopOpShot submitted to WIOA in 2010. The best photos will be displayed just as these are here in the December 2010 Edition. So send us photos you already have, or be on the look out for a "good opportunity" during the year.



VERMIN PROOFING POTABLE WATER STORAGES

Jai Josey and Peter Duzevich

At the time of their construction, a fine wire mesh was used to cover the ventilation holes in many of the concrete reservoirs used to store treated water in South East Queensland. Due to the light weight nature of the material and its constant exposure to the elements, the mesh had completely deteriorated in the vast majority of cases (Figure 1). With this mesh no longer in place, the reservoirs become exposed to potential water quality contamination issues from both wind born debris and more seriously, bird entry.

Inspection reports had been provided to Sunshine Coast Water identifying three reservoirs with these very issues. Sunshine Coast Water and their contractor Aqualift Potable Diving decided to approach the renovation process from a different angle.

Figure 1. An unsealed ventilation hole in the upper wall of a reservoir.

Stainless steel security mesh (Figure 2) was selected for the replacement material, as it was rigid enough to cover the original vent holes with minimal fixing and it was also fine enough to keep out insects, birds and most wind born contaminants.

This stainless material is usually quite expensive, but many security door manufacturers have off-cuts available and they were happy to supply the smaller pieces at a fraction of the original price.

Large stainless steel washers were used on each corner of the mesh panel (Figure 2b) and 8mm aluminium ‘knock in’ plugs with stainless steel drive pins were used to secure the panels.

One of the problems in replacing the screens was gaining access to the ventilation holes that were often high above the ground. Rather than work from the ground up, it was determined that it would be more effective to do the work from the “top down” using technical rope access equipment and trained operators who could carry out this work safely and cost effectively. This eliminated the need for expensive personnel lifting equipment and overcame the limited space around some of the tanks.

The operators used an SRT Oz Pod rescue frame (Figure 3) to lower themselves over the edge and carry out the drilling and pinning. This type of equipment is often used in cliff rescue scenarios and for high-rise window cleaning, as it can be easily moved around when fully assembled and it only requires minimal back stay anchoring to maintain stability.

A six to one rescue pulley system was used to allow the operator to lower himself over the edge, adjust his height and then lock off (Figure 4). A secondary safety rope was employed as a back up in case of a pulley system failure. This was operated by one of the topside support personnel each time the operator was moving up or down.

By using a side rope (Figure 4) the operator could be swung left and right by the top side assistants to enable two mesh panels to be fixed on each drop over the side. After the first day and the usual ‘process improvements’, the team were fixing up to thirty panels per day. Considering this was in fairly hot weather conditions (mid January in Qld), it was a

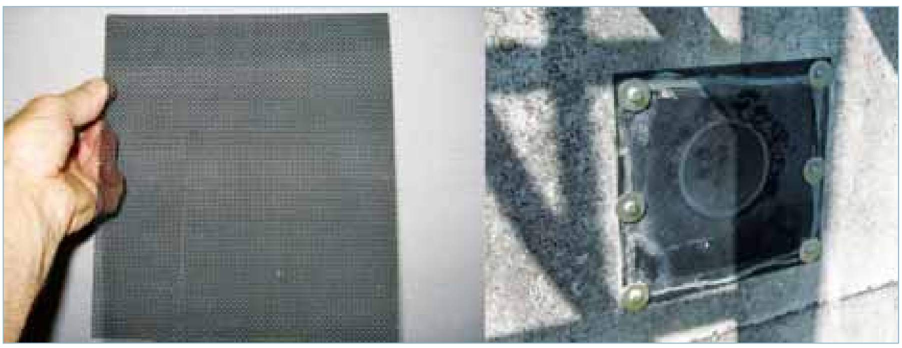


Figure 2. (a) A piece of Stainless Steel security mesh and (b) the finished product.

Figure 3. Utilising the Oz Pod and advanced roping techniques to assess the upper walls of a reservoir.

Figure 4. The operator is held in position by a side rope from his harness (on right near hammer) leaving his hands free to complete his works effectively.

Figure 5. The Finished Product; mesh screens secured externally over the ventilation holes.

pretty good effort. The Oz Pod was picked up by all three team members each time, shifted sideways and re-anchored as the team moved around the reservoir wall.

Temporary anchors were drilled into the upper concrete walls on each reservoir, and these were used to secure a back stay rope onto the Oz Pod as it was moved around the edge of the roof.

Ensuring water storage reservoirs are appropriately sealed (Figure 5) to prevent contamination by debris and vermin is essential to preserve the quality of the water produced by our water treatment facilities while on its way to the consumer. In most cases a relatively simple and inexpensive solution can be found to fix these all too common problems.

The Authors

Jai Josey (Jai.Josey@sunshinecoast.qld.gov.au) is a supervisor with Sunshine Coast Water and **Peter Duzevich** is a project manager with Aqualift Potable Diving.

COVERING CLARIFIER LAUNDERS CONTROLS ALGAE

Adrian Harper

Figure 1. Typical algal growth two weeks after cleaning.

Figure 2. Covers on the north side of the clarifier.

Figure 3. Difference between covered and uncovered sections.

The Warragul WWTP is a 4 ML/d BNR plant that has a single 30 m diameter clarifier. Being out in the open, the clarifier launder suffers from a lot of algal growth which peaks in summer and is less extreme in winter (Figure 1). Gippsland Water has tried different cleaning strategies over the years from a fixed brush arrangement attached to the revolving bridge, to a weekly clean with a pressure sprayer, to the fall back mode of manual cleaning by the operators (generally fortnightly). Each method has its pros and cons – the fixed brush arrangement doesn't allow the algae to really take hold but the brushes wear down over time; the weekly pressure sprayer clean never got rid of all the algae and in the interim if the algae builds up enough it can slough off and contribute to suspended solids in the effluent. The same issue is relevant for the fortnightly manual clean. There are also the OH&S hazards involved with working in the slippery clarifier launder. As algae need access to the sun to photosynthesise and grow, we decided to try blocking the sunlight from the clarifier launder.

In November 2008, some crude covers were installed in two sections on the clarifier to determine their effectiveness in limiting algal growth (Figure 2). The impact of the covers was noticeable within a week and the difference between the shaded and unshaded sections was significant (Figure 3). During the regular fortnightly manual cleans, the shaded areas could be cleaned right back to the concrete whereas the exposed areas still had a slimy film attached. There also appeared to be little if any algal growth under the covers. The residue that did collect there seemed to be a thin film of pin floc carryover from the clarifier.

The covers have been in place for nearly a year now and have continued to provide a barrier to algal growth. Gippsland Water now plans to provide a more robust and permanent cover around the entire clarifier in the future. It is envisaged that the frequency of manual cleaning by the operators will decrease to every one or two months.

The Author

Adrain Harper (adrian.harper@gippswater.com.au) is a waste water technologist with Gippsland Water.

REVVING UP A RECYCLED WATER PLANT

Charlie Suggate

Charlie was awarded the WITA Prize for the Best Paper Overall at WIOA's 2009 Qld Conference.

As the keystone in Gold Coast City Council's Pimpama Coomera Waterfuture Master Plan, the Pimpama Treatment Plant has been designed to provide Class A+ recycled water through a separate network for toilet flushing and external use via purple taps and fittings (Figure 1).

Figure 1. Purple water fittings designated for recycled water use.

The Pimpama Treatment Plant is located in a rapidly developing area between Brisbane and the Gold Coast. The plant combines a wastewater treatment process based around a 5-stage Bardenpho bioreactor, with a recycled water treatment plant incorporating ultra-filtration and ultra-violet disinfection (Figure 2).

Stage 1 of the wastewater treatment plant was commissioned in late 2008 with a nominal design capacity of 17 ML/d. The plant currently receives approximately 4.2 ML/d ADWF – one quarter of the design flow.

A variety of operational challenges, some foreseen and others unforeseen, have occurred during the commissioning of the Pimpama Wastewater and Recycled Water Treatment Plant. These challenges have been overcome using both technical knowledge and effective and consistent communication. As a result, the operations team has benefited by gaining expanded knowledge and experience in addressing various issues that would otherwise rarely be encountered during typical daily plant operation.

Figure 2. Pimpama treatment plant layout.

Challenge 1. Seeding the Bioreactor

The process of inoculating the bioreactor at start-up was the subject of much discussion with a number of methods considered, each requiring pre-filling of the bioreactor with water to approximately 30% of tank depth. These included the following:

- Addition of MLSS from local source followed by feeding of biomass with manufactured food substrate before introducing raw sewage.
  - Pro: Saving on cost of transporting entire required biomass.
  - Con: Risk developing biomass unaccustomed to raw sewage characteristic.
- Introduction of raw sewage then allowing biomass to develop naturally.
  - Pro: Cheapest option, with added benefit of developing a well adapted biomass.
  - Con: Time required to develop biomass. Also likelihood of odour, foaming and sludge bulking.
- Addition of MLSS from local source followed by introduction of raw sewage.
  - Pro: Fastest method to achieve BNR.
  - Con: Logistically impractical to transport approx 200 tanker loads.
- Addition of dewatered sludge from local source before introduction of raw sewage.
  - Pro: Saving over cost of transporting MLSS.
  - Con: Less viable biomass compared to MLSS due to extensive endogenous decay.

Given that the plant was a greenfield construction site, bioreactor seed sludge would have to be sourced from another plant. The Coombabah and Merrimac WWTPs were the two most logical choices, producing significant quantities of dewatered sludge daily with the added advantage that Merrimac would also provide sludge containing extra phosphorus accumulating bacteria.

The bioreactor was first filled with Class B effluent pumped from the Coombabah WWTP effluent lagoons to a level sufficiently above all submersible mixers, A-recycle pumps and OKI aerators. To avoid the possibility of creating a septic environment and the associated odour issues, raw sewage was introduced one day after seeding had taken place.

A temporary concrete bund was constructed beside the bioreactor swing zone where seed sludge could be delivered by the bio-solids transporting contractor before being applied directly to the aerated swing zone by front-end loader.

To ensure even distribution of sludge was occurring throughout the bioreactor, MLSS concentrations were tested regularly at various locations until 1200mg/L was achieved. This took 5 days. During the seeding process and the following 2 weeks, the Specific Oxygen Uptake Rate (SOUR) was monitored closely to assess microbial activity. Initially, SOUR results were very low even into the second day of introducing seed sludge. Before the seeding process started, SOUR trials had shown that biomass within the dewatered sludge had a significantly reduced viability in comparison to that of a healthy mixed liquor and further mortality was expected to occur during handling and transport. As the SOUR results began to increase, so did the rates of nitrification, so rapidly in fact that complete nitrification was being achieved within 3 weeks from the day raw sewage was introduced to the bioreactor and focus was directed to improving denitrification earlier than expected. At this stage, the rates of enhanced biological phosphorus removal were still not of primary concern.

Figure 3. Aeration blow-off.

Challenge 2. Excessive Aeration Capacity

While the plant is receiving such low loading rates, the use of an air relief blow-off valve (Figure 3) has been employed to avoid over pressurisation of the aeration header piping and over aeration within the bioreactor. Rather than exhausting direct to atmosphere, possibly causing noise pollution, a section of 300mm header pipe has been submerged below the bioreactor surface at aerobic zone 3 where excess air is released through perforations.

Although the oxygen transfer efficiency of this excess air is relatively low compared to what would be delivered to this zone via the OKI aerator, the DO concentration does still increase as a result, so the aeration control valve for this zone is left manually closed for typical ADWF. The blow-off valve's automatic actuator modulates to maintain the aeration header pressure set-point.

The current low oxygen demands in the bioreactor combined with the relatively large sizing of the aeration control butterfly valves to each zone makes operating at ranges near the closed position very finicky. Considerable effort was spent during commissioning to tune out the resulting sporadic DO fluctuations from the PID control loops and through continued experimentation a much smoother DO profile across all zones has been developed.

Challenge 3. Managing the Sludge Age

Maintaining a solids inventory in a 16.85 ML bioreactor to suit an average daily domestic sewage inflow of 4.2 ML and BOD of 250 mg/L would seem quite easy, however, regular interruptions to the sludge dewatering process due to various commissioning events saw the sludge age reach up to 60 days at times, double the target. Aside from being able to test the belt filter presses at a higher solids loading rate and seeing the improved dewatering performance offered by a sludge with very low volatile suspended solids, the general result of running up the solids inventory was negative and became a high priority to rectify.

As the MLSS concentration increased up to 3000-4000 mg/L from a typical 2400 mg/L, sludge settling characteristics would change and often a pin-floc would develop. The resulting increase in clarifier effluent turbidity would then threaten to jeopardise commissioning plans further downstream at the media filters.

The dewatering process incorporates two gravity drainage deck (GDD) belt filter presses that each have a feed capacity of $80m^3/hr$, which when operated without interruption are able to reduce the solids inventory very quickly, however, experience to date has shown that the sludge settling characteristics will normally take approximately 1 sludge age to recover back to optimum. These events are expected to become less frequent now that commissioning of the WWTP has been finalised.

Challenge 4. Chemical Dosing

Turn down capacity of methanol, alum and hypochlorite dosing systems continues to be a limitation. Methanol is dosed into the post anoxic zone of the bioreactor as a carbon supplement for denitrifying bacteria. Although further improvements to denitrification are expected to be achieved via continued fine tuning of aeration patterns, methanol dosing will still be required. Current dosing set points already have the pumps operating at minimum speeds with low flow failures a regular occurrence. Other options that will allow further turn down of the process are being explored.

Alum and hypochlorite dosing issues are related to the media filtration section of the RWTP. Alum is dosed at a flash mixer upstream of a series of four single media filters but the raw water quality coming from the secondary clarifier is such that very little alum is required, currently up to 6.5mg/L, causing low flow failures similar to that of the methanol dosing system.

The media filtration section of the plant has provision for three different hypo dosing points. First being at a flash mixer for manganese oxidation upstream of the filters, second for ultra filtration feed water post media filters and third at the entry to chlorine contact tanks (CCTs) also post media filters. The easiest solution to this problem was to increase the dose rate upstream of the media filters so that an adequate chlorine residual would be maintained throughout and allow both downstream pumps to be switched off. Recent alterations to HACCP parameter values however, have since rendered this operational method inadequate and alternative approaches are now being trialled.

Challenge 5. Control system

During the wastewater plant startup process, SCADA software programmers were required to continually change and add new sections to the control system as other parts of the plant became available. This made it imperative to establish a high level of communication between the operations team and commissioning staff associated with SCADA system development. Each series of developments would mean losing SCADA control of some or all of the plant for the time it took to download the upgraded software. With cooperation between both parties, any unwanted software glitches that arose from these upgrades, which happened almost every time, were dealt with promptly and systematically by the programmers.

A Profibus digital network has been installed throughout both the wastewater and recycled water treatment plants rather than a typical 4-20mA communication system to provide easy access to device alarming and equipment diagnostics information. Given that most electrical staff and contractors have had limited experience using Profibus, familiarisation with the system is ongoing.

Due to the demands of meeting commissioning milestones during plant startup, much of the Profibus network was installed without earthing to structures such as cable trunking and hand-railing with VSD and Profibus cables also unshielded. Not only was the entire system vulnerable without earthing but most instruments on the network became affected by signal interference due to the absence of cable shielding, causing loss of plant control during worst cases. Much time and effort has since been directed to eliminating interference with only intermittent events still occurring in isolated sections of the plant.

Although the ultimate goal with any new treatment plant is to construct a perfect example of the latest technology that operates flawlessly from the day it is started, it is important to realise that this has probably never happened. By appreciating that defects are inevitable, and cannot always be rectified overnight, and adopting a positive approach towards cooperating with commissioning staff, GCW's operations and maintenance personnel have shown that startup problems can still be corrected to the desired standard at the end of the day.

The Author

Charlie Suggate

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Editor's Note

The scale and complexity of the Pimpana Plant is impressive. I'm sure Charlie would be happy to show other operators around the site.

SEQ IN TRANSITION THEN AND NOW

John Granzien
John was awarded the Actizyme Prize for Best Operator Paper at WIOA's 2009 Queensland Conference.

This article is being presented not as a highly technical one, but it is what it is, a straight forward description of what has happened in the South East Queensland water industry during the last 12 months or so. The reformation processes that have occurred, and also the new vision for the future of the water supply industry in this area, can, and no doubt will be beneficial in the long term. It is not the be all or end all of happiness and/or frustrations, but if we keep focused on what is required of us as individuals, together we will make it work. As the old saying says:

You have to be serious about what you are required to do, but you do not have to be serious in how you do it.
Keep smiling.

I would just like to make it clear that the content of this article is derived from my experience in water treatment operations as a "hands-on" worker from the coalface. There is no intended malice towards any individual, or "finger-pointing" towards any level of government.

Most readers would by now be aware of the recent Queensland State Government takeover of raw water storages and Water Treatment Plants throughout South East Queensland. Many of the operational staff involved would share my opinion that it has been a very bumpy ride to date.

Some of the staff of this new entity, Seqwater, started the same day as the Queensland council amalgamations took place, and others moved over on the 30th June 2009. The transition has been dubbed by many in the industry as a hard and rapid transition.

To make good decisions you need good information, and in retrospect of what has happened, there would perhaps have been better or different recommendations if more time was allocated to research and planning, prior to implementation. This may well have led to a smoother transition for staff.

Local Government amalgamations that were happening at the same time also had a huge impact on the whole show. The changes people had to make, and still are dealing with is huge, and has had an effect on the overall structure in the entire Local and State Government scene.

Seqwater is now a large organisation that is seeing rapid change. The following points are all impacting on the reform process:

- The operation and management of some 24 referable dams and 47 WTPs
- WTPs that range from plain chlorination to advanced treatment
- Internal water quality targets that cannot be achieved at some sites without significant financial input for upgrades to infrastructure. Some existing plants are not even able to always meet all ADWG aesthetic parameters.
- The "bringing together" of many varied cultures from within the industry
- Changes to legislation that dictate stringent water quality guidelines
- Accountability and transparency to a degree that has not been seen previously

THEN

Chlorine Dosing Site - We got a new loo, but made good use of the outhouse!!!

Pit Cover - Always wondered how long the timber would last?

Chemical Dosing Site - Innovative bunding. Had to go, we lost a wheel!!

NOW

Somebody mentioned health and safety so the outhouse had to go!!!!

Firewood yet to be collected!

Much more appropriate. The operator loves his plant now!!

THEN	NOW

Chemical Dosing Site - Don't ever say we weren't inventive!

Still don't like the green colour as much as the red and blue milk crate

Pump Facility - Made to last!

Much more nicerer

Valve Pit - Not sure what is supporting what?

Nice, with the new barbie plates. Handles too!

- Strict health and safety requirements
- Training and re-training of staff to ensure competency levels are maintained
- Production of water that is not "only safe", but also aesthetically pleasing
- New technology such as Ultra-filtration and Desalination
- The introduction of "water-grid" systems.

The ADWG encompasses a catchment to tap approach and Seqwater has to encompass a beach to bush approach, and ensure that it caters for everything in between. Never mind we are where we are, we have to deal with the future based on experience from the past.

Our Inheritance

In our area we have inherited a few treatment plants that have not been kept up to date. It is no-one's fault, but in a small Council, management can only do what seems best, with what funds are available. The operators have often done more than what was asked of them, and tried to improve and implement what changes that seemed necessary, to remedy any given situation.

In particular, one WTP had received little or no upgrades or improvements to help its performances in its 40-year plus lifetime. Small things were done over time to meet demand, but water quality was left by the wayside. This was the way small country towns have done things for a long time, and more focus had been put on infrastructure of roads and bridges along with waste management (to a degree), than water and sewerage infrastructure. Water is the basis of life, and safe drinking water should be the right of every Australian that is connected to a reticulated supply in any town or city.

And Now

With what has been happening across South East Queensland over the last 12 months or so, in the water reform process, all involved have had to put in extra effort to cope with the increase in workload.

But, fruits of the changes, to meet the requirement set before us all, are starting to be seen. With the extra support and help that has been offered by our new peers, process/quality control staff, catchment staff and management, but also not forgetting the most important ones, the maintenance staff, we are progressing reasonably well.

To date the amount of improvements in our area (Somerset) has been fantastic. Not sure if we were a particularly bad area to start with, but I can recall a high-level staff member in the organization saying at the start, that Somerset has a number of risks for us. That may have been the case, and it sure has been the focus of numerable upgrades and rectifications.

Work Place Safety and Health issues have also been progressively addressed, with great progress in rectification of work that has been a blessing to the operators. Stairs have replaced ladders, aluminium lids replaced rotten timber covers and gas chlorine installations have been upgraded to meet the standards. There is a long way to go yet, but we also have come a long way.

Water quality improvements, the main priority of Seqwater, well what can I say but this, things are happening big time and it can only be for the better. The introduction of HACCP also will be beneficial over time, to ensure we can achieve the water quality results that are now mandatory. Remember these plants were managed mainly to meet demand, but still not forgetting water quality parameters being reached, with what information and support that was given to the operators. Again this new venture, comes with the help of our fellow water industry personnel, and we can only further progress to the organization's goal of the assurance of continuity of supply of a safe, aesthetically pleasing water-supply for all.

In closing I would like you all to perhaps just spend a few seconds to ponder over a quote from Leonardo da Vinci: *"Water is the driving force of all nature".*

The Author

John Granzien (jgranzien@seqwater.com.au) is Operations Supervisor (Somerset Regional Area) for the Seqwater.

Editor's Note

What a fantastic change. I am sure the road has been bumpy but Seqwater can be proud of achieving this in such a short time. As a specialist in operations and production of safe drinking water all I can say is the "Then" pictures are all too common across our country. Perhaps this story can act as a prompt to other councils and authorities to make the changes. But of course the physical changes need to be supported with training and effective monitoring.

AQUIFER STORAGE AND RECOVERY TRIALS AT BARWON

Gwyn Hatton

Barwon Water provides a water supply system to the city of Geelong and surrounding region with a population of over 250,000. Up to 80% of the Geelong region's supply is traditionally derived from the Barwon River catchment with the remainder from the Moorabool River catchment. In recent times, due to prolonged dry periods, up to 40% of Geelong's potable water supply has come from the Barwon Downs aquifer. With climate change continually having an impact on the amount of water able to be harvested from surface water storages and ultimately groundwater resources, new ways of utilising resources have had to be considered. This is where Aquifer Storage and Recovery (ASR) is being investigated to see what benefits we may be able to achieve utilising this as a "new resource".

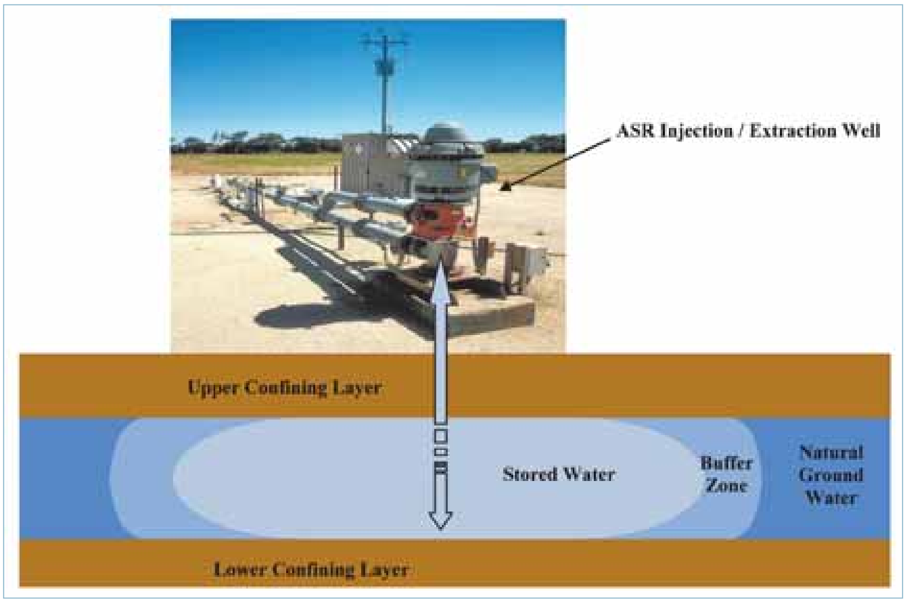

Figure 1. Typical ASR Well Arrangement.

What is ASR?

Aquifer Storage and Recovery (ASR) is a type of managed aquifer recharge whereby water is injected into the ground and recovered from the same bore at a later time when required. The aquifer is used as a large underground storage facility in times when surface water storages may be full and additional water is required to be stored for prolonged dry periods.

Depending on the end-use, the injected water may be sourced from stormwater, recycled water or excess surface water. Typically the water is stored in the aquifer for a period of time which in-turn provides additional treatment of the stored water by way of pathogen die-off.

How does ASR work?

ASR works by the injection of water into the ground by a series of injection bores. These injection bores are much like normal groundwater extraction bores and look much the same on the surface as a typical bore.

The most suitable type of ground for successful ASR requires a coarsely graded material, typically gravel or sandy in nature, confined between harder, more impervious material such as clay or bedrock. This allows the injected water to be contained within a confining layer of suitable material and not allowed to escape or flow away. The injected water forms a reservoir "bubble" around the injection well with some blending of water with natural groundwater at the extremities of the bubble (Figure 1).

Depending on the type of ground conditions, a number of injection wells may be required to allow a sufficient injection rate and achieve the required storage volume. In such cases injection bubbles may overlap with each other to form a single large reservoir of injected water around the wells. Injected water will need to be of sufficient quality so as to meet environmental requirements associated with mixing of groundwater, prevent degradation of the aquifer and potential "leaking" of the aquifer to surface water systems.

When the injected water is required, the injection wells become extraction wells to extract the stored water out of the ground for its intended use. Groundwater observation bores would be used to monitor the effect of water injected into the ground and again when the water is extracted.

What are the benefits of ASR?

ASR has a number of benefits over traditional surface water type storages. These benefits include:

- Potentially large storage volumes with minimal surface footprints and no evaporation losses
- Ability to provide an additional level of treatment through pathogen die-off over a period
- Generally lower infrastructure cost to construct in relation to similar sized surface storage
- Minimal environmental impact compared to large surface water storages

ASR provides an alternative storage for water that may have traditionally been "wasted" through lack of storage opportunities. Recycled water is a potentially continuous supply of water that currently has limited options to store large volumes for bulk use. Whilst most of it may have a market for use during the drier months for irrigation and watering, during winter this market subsides and excess recycled water would not normally be stored and subsequently wasted. Stormwater similarly would normally be available during wetter months when not required, as well as typically falling in short, heavy bursts during summer where most would run off to waste. Stormwater retarding basins in combination with ASR would provide an opportunity to harvest this previously unutilised resource.

Barwon Water ASR Research

With the realisation of stormwater and recycled water as a valuable resource, Barwon Water has begun investigations into how the technology could be utilised to provide a "new" water source and integrated into its supply system. Barwon Water recognises that to combat climate change, a diverse range of water supply options is required to meet demand.

A number of sites have been identified as potential ASR sites in the Geelong region with various end-use options being considered. These sites include the new Armstrong Creek growth corridor to the south of Geelong, the Batesford quarry area and adjoining Fyansford development area to the West of Geelong and the Jan Juc aquifer system to the south west of Geelong.

Initial investigations centre on the Jan Juc aquifer system, just to the north of Anglesea. This area was chosen as significant information about the ground conditions already exist in the area and is known to contain suitable aquifer material. The area has two aquifers, an upper aquifer, which is the target aquifer for the investigations, and a lower aquifer, which will be accessed by the soon to be completed Anglesea bore field. The Anglesea bore field will provide up to 7,000 ML/a of water to the Geelong supply system from the end of 2009. The upper and lower aquifers in this area are separated by an almost impermeable layer, known as an aquitard.

The aim of the investigations in the Jan Juc aquifer is to determine the ability and suitability of the aquifer to store sufficient quantities of water to be considered for further development. The studies will determine any potential environmental impacts and provide an analysis on the potential for full-scale implementation.

The ASR research project is jointly funded and supported by the Department of Sustainability and Environment and comprises a four-staged approach to determining the suitability of the aquifer:

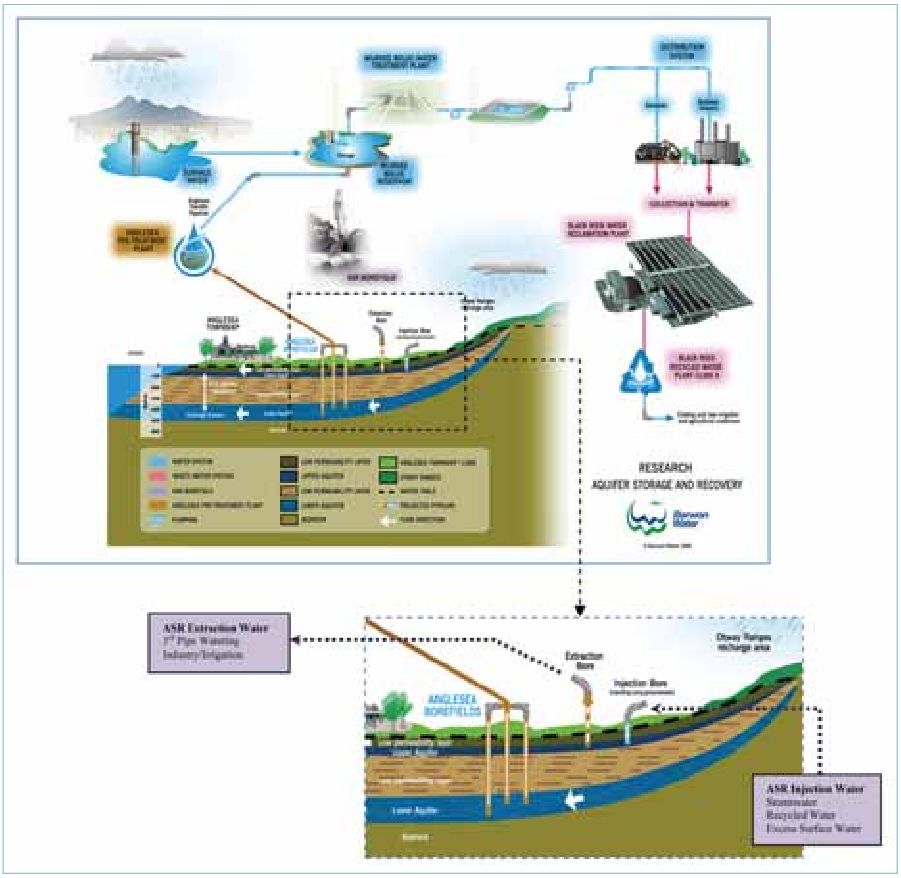

Figure 2. Hypothetical ASR Concept.

- **Stage 1 – Preliminary Aquifer Characterisation** whereby six observation bores are drilled to a depth of approximately 120m and a short-term pump test is conducted at each bore to determine aquifer transmissivity and initial water quality.
- **Stage 2 – Detailed Hydraulic Assessment**. A production bore is drilled to a depth of approximately 120m and a seven day pump test conducted to determine aquifer performance. A further three observation bores drilled to monitor aquifer behaviour during pump test.
- **Stage 3 – Aquifer Modelling & Conceptual Design**. A computer model is generated from information gained from Stages 1 & 2 to allow aquifer behaviour to be modelled under various operating scenarios.
- **Stage 4 – Injection Trial and Feasibility Analysis**. A 7-28 day injection trial whereby water is injected into the aquifer to test the behaviour of the aquifer and the injected water. From the injection trial data, prepare a design and costing of a preliminary injection bore field and assess the feasibility of the project.

Future Directions

A number of possibilities exist for the use of ASR as a new water source for Geelong. For each of the three sites identified for research into ASR, potential injection source water may be derived from:

- Class A recycled water
- Stormwater
- Excess surface water

With potential end-use of extracted water being:

- 3rd pipe use for garden watering, toilet flushing
- Industry or irrigation (sports grounds, golf courses)

Pending the outcome of the research trials and upgrade of the Black Rock Water Reclamation Plant, ASR has the potential to provide a significant resource. With up to 16,000 ML/a of recycled water potentially available, ASR could provide the means to utilise this precious resource in the future.

The Author

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