RECYCLED WATER – THE FOURTH WATER UTILITY

Louise Jones
MWH New Zealand Ltd

ABSTRACT

Around the world the use of recycled water, either from stormwater or from treated wastewater, is gaining in popularity. Many water utilities are utilising recycled water for non-potable uses, such as open space irrigation and industrial use, or for augmentation of drinking water supplies though aquifer and reservoir recharge. Recycled water is also being used to enhance the environment with schemes such as reduction of salt water intrusion and boosting river flows.

Water recycling is a relatively new process, for both the water utility provider and for the communities they serve, so in recent years there has been much written on the public perception of recycling schemes and, to a lesser extent, the technical aspects of building and commissioning such projects. But little consideration has been given to the day to day management of water recycling schemes which can be complex at both an operational and management level.

Drawing on experience gained from a water recycling scheme in Western Australia this paper looks at some of the challenges of establishing and managing a water recycling asset, and asks whether these assets, which can simultaneously be both a wastewater and drinking water asset, should be fitted into the existing asset management structures or should in fact be considered as a separate, fourth, water utility.

KEYWORDS

Recycled water, water re-use, asset management, water utility.

1. INTRODUCTION

Around the world the use of recycled water, either from stormwater or from treated wastewater, is gaining in popularity. Many water utilities are utilising recycled water for non-potable uses, such as open space irrigation and industrial use, or for augmentation of drinking water supplies though aquifer and reservoir recharge. Recycled water is also being used to enhance the environment with schemes such as reduction of salt water intrusion and boosting river flows.

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Drawing on experience gained from a water recycling scheme in Western Australia this paper looks at some of the challenges of establishing and managing a water recycling asset, and asks whether these assets, which can

simultaneously be both a wastewater and drinking water asset, should be fitted into the existing asset management structures or should in fact be considered as a separate, fourth, water utility.

Particular examples have been taken from the Groundwater Replenishment Trial project carried out by Water Corporation in Perth, Western Australia for which the Author was project manager. This project comprised a 5Ml/day ultra-filtration, reverse osmosis and UV plant designed to purify treated wastewater from the nearby Beenyup wastewater treatment plant. The aim of this project was to trail the injection of recycled water into the ground at 60m depth to recharge the local drinking water aquifer. If the trial is successful and there are no detrimental effects on the groundwater quality the aim is to build a full scale plant by 2015.

2. WHAT IS RECYCLED WATER?

A water recycling scheme will generally entail collecting water that has been 'used' in some way, treating it to improve quality and then re-using again for a different purpose. A recycling scheme can be as simple as the redirection of stormwater back into the groundwater system or as complex as full purification of wastewater for potable use. Other terms used for recycled water are reclaimed water or water re-use.

In nearly all water recycling schemes the source water requires some form of treatment to remove contaminants. Stormwater often requires treatment to remove pollutants from road and drainage systems. Wastewater requires treatment to at least remove pathogens, BOD and most nutrients before it can be re-used. Considerably more treatment is required if the end use is for drinking water supply.

In most cases the use of recycled water leads to rigorous testing that may not be applied to a more traditional source. This is to ensure that there are no man-made contaminants present, such as pesticides, hydrocarbons, chemicals and hormones, which are potentially harmful to users, and would not be expected to be present in a more traditional source.

For the purpose of this paper, the discussions use the example of treated wastewater as the source water and presume an end use that requires water of drinking water quality, for example aquifer recharge or market garden irrigation. This presents one of the more common uses of recycled water and perhaps one of the more complex in terms of establishment and management.

3. THE CHALLENGES OF ESTABLISHING A NEW RECYCLED WATER SCHEME

The difficulties of managing a water recycling utility commence even before the project is built. For traditional stormwater, wastewater and drinking water utilities there are existing protocols for obtaining approvals to build the scheme, and established standards by which the scheme will be monitored. For a water recycling scheme this may not be the case.

On an international level there are now many water recycling schemes in operation but this experience and expertise may not filter down to the regional or local level. Often there is no specific regulatory framework for a water recycling scheme meaning that either existing regulations must be adapted to suit or new regulation put in place. Either way this can mean lengthy delays for asset managers in obtaining consents or permits. In addition, the absence of a regulatory framework will often mean an absence of quality standards by which the scheme will

be monitored. This can create difficulties in completing the design of the new asset as the required treatment processes cannot be fully defined.

3.1. OBTAINING CONSENTS AND PERMITS

In nearly every developed nation there is some sort of consent or permit system in place to protect the environment and natural resources. These can be in the form of a permit to abstract from the environment or a permit to discharge back to the environment. For wastewater and drinking water schemes there are clear criteria for obtaining a discharge or abstraction consent. But existing criteria do not apply to water recycling schemes. Where recycled water is used for irrigation, for boosting river flows or for aquifer recharge is a consent required if the discharge to the environment is of a higher quality than that of the receiving environment? Similarly, is an abstraction permit required if the water utility is drawing water that was previously added to the aquifer by a recycling scheme? If recycled water is taken from a wastewater treatment plant and added direct to a drinking water system is a consent required at all? Of course there will need to be some sort of regulation, but what is clear is that the existing consent systems are not necessarily applicable to a recycled water scheme.

In Western Australia there are three regulators concerned with water recycling schemes. The Department of Environment and Conservation (DEC) control discharges to the environment, the Department of Water (DoW) control abstraction of water and the Department of Health (DoH) control the quality of Drinking water. For the Groundwater Replenishment Trial the initial concern was to obtain a permit from the DEC as the injection in the aquifer was considered a discharge. However, it was agreed by all parties (via an interagency agreement) that the recycled water would be of drinking water quality prior to injection. Therefore, the DoH set the recycled water quality standards and this was by far the most complex part of the consenting process. The DoW also contributed with additional measures to ensure that the integrity of the aquifer was maintained in the long term.

Obtaining the consents and permits was a long process as agreements and standards had to be written and agreed as the process progressed. Overall it took well over two years to get the consents in place and the conditions of the consents were still being developed and agreed as the recycling plant was being commissioned.

3.2. ESTABLISHING AND MEETING WATER QUALITY REQUIREMENTS

For any recycled water scheme the quality of the final treated water may end up being considerably higher than those of a more traditional water source. This is because there will be pollutants and pathogens from the urban environment present in the source water, both stormwater or wastewater, that would not normally be present if the water were coming direct from the ‘natural’ environment and so treatment is generally more rigorous.

This means that for a water recycling scheme there is a very strong focus on ensuring that these ‘unnatural’ pollutants are removed before the water can be reused. The degree to which these pollutants will need to be removed will of course depend on the actual end use of the recycled water but the specific use of ‘recycled’ water has, to date, lead to regulators to enforce quality standards that are far more onerous than schemes using a more traditional water source.

In Western Australia, the DoH set water quality standards that required the regular testing of over 100 different chemicals which included hormones, phenols, pharmaceuticals, metals, VOCs and metals. These were in addition to the usual drinking water quality tests and had to be carried out for the duration of the trial as the composition of the treated wastewater could alter at any time.

There are two issues for consideration when establishing a new water recycling scheme. Firstly, what quality standards will be need to achieved, and secondly, how can compliance with these standards be demonstrated. Assuming that regulatory authorities will determine the quality standards required, the asset managers job is to demonstrate that their new water recycling asset complies with this standard. For a traditional wastewater or drinking water plant the means of compliance has been established for many years with set sampling protocols, monitoring and reporting requirements. For a recycled water asset this may not the case. There are several issues that may need to be addressed before a recycled water asset can be brought in to service. The frequency of sampling and level of continuous monitoring required will likely be far greater than a more traditional asset. This can add significant operational costs to the scheme and may require the installation of automated systems and data logging in order to achieve compliance.

For the Groundwater Replenishment Trial the treatment plant processes were continually monitored for parameters such as pH, dissolved oxygen, conductivity and turbidity. The aim of this monitoring was to demonstrate that the treatment units were operating correctly at all times. This monitoring was verified by weekly testing of over 20 chemicals. On a quarterly basis over 100 parameters were tested. Samples were also taken from the groundwater adjacent to the injection areas to monitor the effects on the aquifer.

Another issue to consider is the ability of local laboratories to test for the parameters specified in the standards, for example the ability to test for low levels of hormones or particular pesticides. If local laboratories can not perform these tests provision will need to be made for testing for these parameters at other locations and again may add significant costs to a project.

In Western Australia the main testing laboratory, Chem Centre, had to employ additional staff and purchase new equipment to be able to carry out the level of analysis required for the groundwater Replenishment Trial. In some cases they had to establish completely new techniques for analysing for some of the chemicals required by the DoH. Fortunately, the size of the contract (testing was to cost A$4M over 3 years) meant that the Laboratory were happy to oblige but it was some time before all parties were happy that water quality analysis would comply with the required standards.

3.3. TRAINING OPERATORS

With any new asset there will be always be a need to train operational staff in the operation of the plant and equipment and establish new working procedures. It is usual to draw on the existing skilled operators to form the basis of the team and add new staff as required. With a water recycling asset it is likely that the treatment processes used will differ from those used elsewhere and monitoring and reporting requirements will differ. This can lead to a scenario where all the staff must be trained from scratch and there will be limited hands on experience and no established work routines. This can cause difficulties during the first few months of operation.

Another factor to consider is there may not be an established training syllabus for water recycling plant operators and therefore no local training schemes available. Provision may be required for training by plant and equipment manufacturers and customised or one off training packages will be required. For many regulatory authorities demonstrating that the staff operating the recycled water asset are fully trained and competent is an important factor in demonstrating compliance with standards. Therefore, establishing training requirements and training the operators is an important element in managing the recycled water asset.

Water Corporation, being a large organisation, had an in house training team and established training packages for drinking water, wastewater and stormwater operation staff which combined elements of nationally recognised qualifications and local knowledge. For the Groundwater Replenishment Trial it was initially thought that the

drinking water training packages would be suitable but as the plant was put in to operation there were several gaps in knowledge that needed to be addressed, for example, understanding the differing composition of the source water from the wastewater treatment plant. These shortfalls were easy to overcome, the hardest part was demonstrating to the regulators that the operational staff were competent and fully trained when there were no training standards to benchmark against.

4. THE CHALLENGES OF MANAGING A RECYCLED WATER ASSET

Once an asset is built the challenges of day to day management of the asset begin. Managing water utility assets is never easy but there are some complexities in managing a water recycling asset that need to be addressed if the asset is to operate successfully. There are several subtle differences in managing a water recycling asset and a clear understanding of the operational drivers and monitoring requirements is important if the scheme is to succeed. Another issue to consider is building a knowledge base around the operational and maintenance of the recycled water asset as in the early stages it is likely that few people will have experience and expertise in this area. In the longer term there are also issues around duplication of knowledge across the asset groups as recycled water assets span across traditional asset groups.

4.1. SETTING OPERATIONAL TARGETS

A water recycling asset may require very different operational targets to a wastewater or drinking water asset. Water Recycling schemes are often 'non critical' assets in that they are not directly serving the public but instead are supplying water for irrigation or for industry. These assets may be turned off from time to time without reductions to levels of service and therefore do not require an immediate response to shutdowns or failures. Full emergency response plans are not required with problems being dealt with the next working day.

Operation of a non-critical asset can also result in some very different maintenance strategies. Maintenance can be reactive rather than preventive as shutdowns are acceptable. There can be cost savings from adopting a reactive maintenance strategy as equipment does not need to be replaced before failure.

Overall these factors can lead to a different operational philosophy from a traditional wastewater or drinking water asset and this should be reflected in any operational targets. There may be a tendency to rollover existing operational targets from similar wastewater or drinking water schemes which may not suit a water recycling scheme. The significance of this should not be underestimated as operators and managers who have worked on more traditional schemes will need to understand the different operational drivers and have appropriate targets if they are to operate the scheme successfully.

On the Groundwater Replenishment Trial this was not appreciated until after the scheme had commenced operation. The biggest issue came from setting the wrong key performance indicators (KPIs). The KPIs did not take in to account the non-criticality of the plant forcing call-outs and repairs out of standard hours to meet volume targets that were not critical whilst not capturing lapses in recycled water quality that were critical to regulatory compliance.

4.2. ESTABLISHING REPORTING SYSTEMS

The reporting systems used in an organisation are a key aspect in managing a recycled water asset as some of the day to day operational tasks will revolve around ensuring that the correct data is collected and recorded. The

reporting system will also demonstrate that the asset is achieving regulatory compliance and so it is vital that this is done effectively.

In most cases the reporting system is shaped by external reporting requirements and will differ for wastewater and drinking water assets. Wastewater requires periodic sampling of the treated effluent to check for pathogens, BOD and nutrient levels, drinking water requires ongoing, sometimes continuous monitoring for a range of chemicals and pathogens. In addition, these monitoring results will be reported to a different regulatory authority: usually an environment agency for wastewater and a health agency for drinking water.

For a water recycling asset the reporting requirements will invariably be far more onerous than those from a more traditional source and will ultimately be determined by the the end use of the recycled water. Where treated wastewater is used as the source water is it likely that there will be requirements to sample and monitor the wastewater quality as it enters the recycled water plant. Water will require monitoring as it passes though the recycled water plant to demonstrate that the treatment process is operating correctly at all times and the final treated water will require frequent sampling to test for a wide range of parameters as set by the regulatory authority. All of this data will need to be collected, collated and presented and, given both the number of samples and the increased frequency of samples, there will need to be a resource made available to do this work.

Many organisations rely on automated and computerised collection of data and population of databases to enable fast and efficient reporting. Whilst these systems can save on time and resources the cost of setting up such a system can be prohibitive. Propriety systems for data collection will likely be tailored to wastewater or drinking water schemes and modification may be required to meet the reporting requirements of a recycled water scheme.

Water Corporation used an automated system to schedule the time and location of the sampling, print sample bottle labels and then collate and present that data once analysis was complete. The system was initially set up for wastewater treatment plants and when the decision was made to use this system for the Groundwater Replenishment Trail the sheer volume of samples and number of parameters that had to be tested for was not known. The existing system had to undergo a major upgrade in order to meet the needs of the Trail increasing the number of different parameters that could be stored in the system, the number of samples that could be processed and the requirements for identifying reporting of discrepancies and violations. This was time consuming and expensive and, with hindsight, not the best system for the task.

4.3. BUILDING A KNOWLEDGE BASE

An issue arising from the operation of a water recycling plant is building a knowledge base around the recycled water asset and then the possible duplication of the knowledge base within the organisation. When a recycled water plant is first commissioned it is likely there will be limited operational knowledge. It is also likely that due to the nature of a recycling plant there will be some crossover in the processes and procedures used. For example, stormwater operators need pressurised distribution system knowledge to enable distribution for irrigation and wastewater operators need drinking water sampling knowledge. This crossover does not just occur at the operational level but also at a management and strategic level.

Once the knowledge base it established there is a dilemma as to whether to keep the expertise in one area and share experience as needed, or to allow the expertise to sit in each asset group. Sharing expertise and experience will require a very high level of co-operation between assets groups, which although is possible, is not something that is likely to have been required previously. However, duplication of knowledge by having expertise in each group would seem to be least efficient long term.

In Water Corporation there was already an existing knowledge base for water recycling schemes gained from the operation of a recycling scheme for the supply of industrial water. This plant was operated by the wastewater asset group as the asset sat at a wastewater plant and the water was not intended for drinking water supply. Whilst the wastewater group had knowledge of the recycling plant and equipment used they did not have knowledge of the requirements for drinking water supply such as sampling procedures. In addition, the knowledge regarding the large reverse osmosis plants used for the new desalination plants in Perth, sat with the Drinking Water asset group. In order to overcome this Water Corporation chose to second expertise in to the wastewater group in the short term and made the decision to hold the expertise in both groups longer term.

5. RECYCLING WITHIN WATER UTILITY ASSET MANAGEMENT STRUCTURES

In all but the smallest organisations the management of the three water utility assets; stormwater, wastewater and drinking water, is carried out separately.

Wastewater and drinking water assets are managed separately for several reasons:

1. At an operational level the management of wastewater and drinking water assets are separated to minimize cross contamination during day to day operation and maintenance. The treatment processes are generally different and operational staff are often only trained in one asset type.

2. At a management level the quality monitoring and reporting requirements for wastewater or drinking water are very different. In addition, the size of the asset base may require that more than one manager is required. More often than not the split occurs on an asset basis rather than a geographic one.

3. At a strategic level the planning of new infrastructure is generally carried out on an asset by asset basis and the technical expertise tends to specialise in one asset type.

Stormwater management has a different set of issues again. Stormwater is not collected or distributed to individual households and is not monitored in the same way as wastewater and drinking water. The extent to which stormwater assets are required is dependent upon the geography of the area and the magnitude of rainfall events.

So where does a recycled water asset fit in to the structure?

For some recycled water schemes there is an obvious choice of asset group. For example, where stormwater is collected, stored, and then recycled for public space irrigation, stormwater may be the obvious asset group. However, if a pressurised distribution system is required this may lie outside the expertise of the stormwater asset team and so expertise from the drinking water asset team may be required.

Where wastewater is the source water the choice becomes even more complex. It may be logical to locate the additional treatment processes required for water recycling at the existing wastewater treatment plant to minimize transfer costs and make use of the operational staff all ready on site. On this basis the asset could be considered a wastewater asset?

However, the treatment processes used to further treat the wastewater will be different to traditional wastewater treatment processes meaning that staff may not be correctly trained. In addition, the monitoring standards required are more likely to be similar to those used for drinking water. On this basis the asset could be considered a drinking water asset?

The answer will, of course, be different for each organisation depending on the internal management and operational structure. In some organisations the size and split of the existing asset base may be a major factor in deciding which asset group to manage a recycled water asset. Where there is an imbalance in the size of the asset base between the three water utilities, the recycled water asset may be allocated to the smallest asset base to distribute work load evenly across resources. Geography and asset location may also influence the decision. These are the simplest solutions but may create issues and higher operational costs in the longer term as personnel may need to be up-skilled and management systems upgraded to cater for the different operational requirements of a recycled water asset.

Other factors that may affect the decision are the internal and external monitoring and reporting requirements, the operational philosophy and the levels of operator skill and knowledge, all of which have been discussed earlier in the paper. Whatever the decision it should be made based on consideration of all the issues discussed in this paper as a poor choice at an early stage may mean extensive up-skilling of personnel and upgrades of existing management and reporting systems adding to project costs and creating delays.

For Water Corporation whether to make the Groundwater Replenishment Trial assets drinking water or wastewater assets was a complex problem. Similar plants set up for recycling wastewater for industrial use all sat in the wastewater asset group and the new Groundwater Replenishment Trial assets sat adjacent to the existing Beenyup Wastewater Treatment Plant. On that basis the decision was made early in the project that it was to be a wastewater asset. However, as the project developed it became apparent that this may have not been the correct decision.

The first problems arose in the design stages of the project as the wastewater asset group did not have the correct expertise to review the design and advise designers on Water Corporation standard requirements for drinking water standards compliance. In addition, the critical regulator was the DoH, a group with which the wastewater asset group had no established links.

During commissioning and early operation there were some minor issues with the operational staff who had all come from a wastewater background. These staff continued with the same operational philosophy as a wastewater treatment plant and some failed to understand the importance of reporting deviations from quality standards.

Other issues encountered were an inadequacy of the automated reporting system which had to undergo a major upgrade and the difficulty in establishing KPIs that were outside of those normally reported in the wastewater asset group. With an organisation the size of Water Corporation the need to alter the established reporting routines was a time consuming and surprisingly complex process.

6. CONCLUSIONS

This paper has highlighted the many subtle, and not so subtle, differences in managing a recycled water asset compared to a stormwater, wastewater or drinking water asset. It has discussed the issues that may be encountered when establishing a new recycled water asset and also the issues that may be encountered in the day to day operation of such an asset. It is hoped that this paper, whilst not providing solutions to these many issues, will at least alert asset managers to the challenges they may face so that they may give them better consideration during the conception and planning of a water recycling project.

Although it may seem like the most efficient solution to try and fit a recycled water asset in to one of the existing asset groups the efficiencies will be short lived as adapting existing systems to fit the differing requirements of a

water recycling scheme and meeting targets which are governed by a different operational philosophy will make the day to day management of the asset difficult and time consuming.

Just as stormwater has become a separate asset group to wastewater, it is likely that in the future recycled water will become a separate, fourth, water utility.

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