IN-HOUSE VALIDATION OF THE AURORA CLASS A RECYCLED WATER PLANT

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ABSTRACT

Yarra Valley Water (YVW) commenced operation of the Aurora Class A Recycled Water Treatment Plant (RWTP) in March 2009. The plant produces Class A recycled water fit for dual pipe recycling in accordance with the Victorian Environment Protection Authority (EPA) and the Department of Human Services (DHS) requirements. The validation assessment of the Aurora RWTP's process train was completed in-house by YVW's engineering staff. This assessment confirmed that the plant provides the required 7 Log reduction of viruses and 6 Log reduction of protozoans from the plant's feed water. This paper details YVW's experiences relating to the validation assessment including key challenges, the pros and cons of undertaking the validation assessment work in-house, the value of existing validation data and future operation within the current recycled water management regulatory frameworks.

KEY WORDS
Class A, Recycled water, Validation, Aurora, Ultrafiltration, Ultraviolet Disinfection, Dual pipe.

1.0 INTRODUCTION

The Aurora RWTP is located in the suburb of Wollert approximately 20kms north of Melbourne and commenced operation for reticulated supply of Class A recycled water in March 2009. The Class A water will be supplied throughout the Epping and Craigieburn area for use in dual pipe residential households for toilet flushing and outdoor use. It will is be also available to other non-residential users such as councils and industry for uses such as irrigation of municipal areas and within processes where the water quality provided is deemed fit for the intended purpose (dust suppression, process water etc).

The Aurora RWTP treats Class B recycled water produced by the Aurora Sewage Treatment Plant (STP), located on the same site. The key treatment steps within the Aurora RWTP's process are ultrafiltration, ultraviolet disinfection (UV) and chlorination using sodium hypochlorite.

Table 1: ***Aurora RWTP process step details and DHS endorsed log removal credits***

Treatment Step	Equipment Specification	Virus Log removal Credits	Protozoan Log removal Credits
Ultrafiltration	Element - NORIT X-Flow SXL – 225 PVC Membrane - NORIT 0.8mm UFC M5 32 modules per skid Nominal Capacity 2ML/skid/day	4	4
Ultraviolet Disinfection	Wedeco LBX 1000-EW Reactor 65.5cm diameter SS 316 chamber, Horizontally mounted, 40 x 330W low pressure high-output lamps	0	2
Chlorination	Chlorine Contact pipe (36m of 761mm) Sodium Hypochlorite dosing 5min contact time to achieve 5 mg.min/L	3	0

The process has been successfully validated to achieve DHS endorsement as having the treatment capability to achieve the required 7 log removal of viruses and 6 log removal of protozoans from the plant's feed water. The details of each process step within the RWTP and the log removal credits attributed to each step are summarised in Table 1.

2.0 DISCUSSION

2.1 The Validation Process

The term validation, when used in reference to a recycled water production process, is the process of demonstrating the treatment capability of the system. The treatment capability target for producing Class A recycled water for dual pipe recycling has been established as being a 7 log reduction of viruses and 6 log reduction of protozoans. The term log reduction is used to refer to the decrease in concentration from the feed water to the product water. A 1 log reduction equates to a 90% reduction in concentration, a 2 log reduction equates to a 99 % reduction and so forth. Therefore a 7 Log reduction equates to a 99.99999% reduction.

The validation assessment of a RWTP process is completed by using available validation data (generally provided by the equipment supplier) to demonstrate the RWTP process will be capable of achieving the required performance under the proposed operational conditions. Validation data is obtained by intentionally challenging the process equipment with known doses of micro-organisms under controlled conditions. This enables testing of a range of treatment scenarios to establish the level of treatment provided by the system under these conditions. This process generates a set of validation data for given operational conditions for which the system can be termed validated. This data can then be used in a validation assessment for a new RWTP to confirm to the regulatory stakeholders (primarily DHS) that the plant will provide the appropriate level of treatment. For the validation data to be deemed acceptable for use it must be reviewed to ensure that it has been obtained in accordance with a methodology approved by DHS. In the case of the Aurora RWTP, DHS recommended that the validation data be reviewed against the following USEPA guidelines that set out methodologies for validating water treatment processes for use in the development of drinking water plants:

- Membrane Filtration Guidance Manual, USEPA, November 2005.
- Ultraviolet Disinfection Guidance Manual, USEPA, November 2006.
- Alternative Disinfectants and Oxidants Guidance Manual, USEPA, April 1999.
- Disinfection Profiling and Benchmarking Guidance Manual, USEPA, August 1999.

The validation assessment for the Aurora RWTP was completed in-house by YVW engineering staff in consultation with equipment supplies, DHS and other network contacts within the Victorian Water Industry who have undertaken similar validation assessments or are already utilising the same process equipment in a Class A RWTP process. A summary of the overall process followed to complete the validation assessment is summarised in Figure 1.

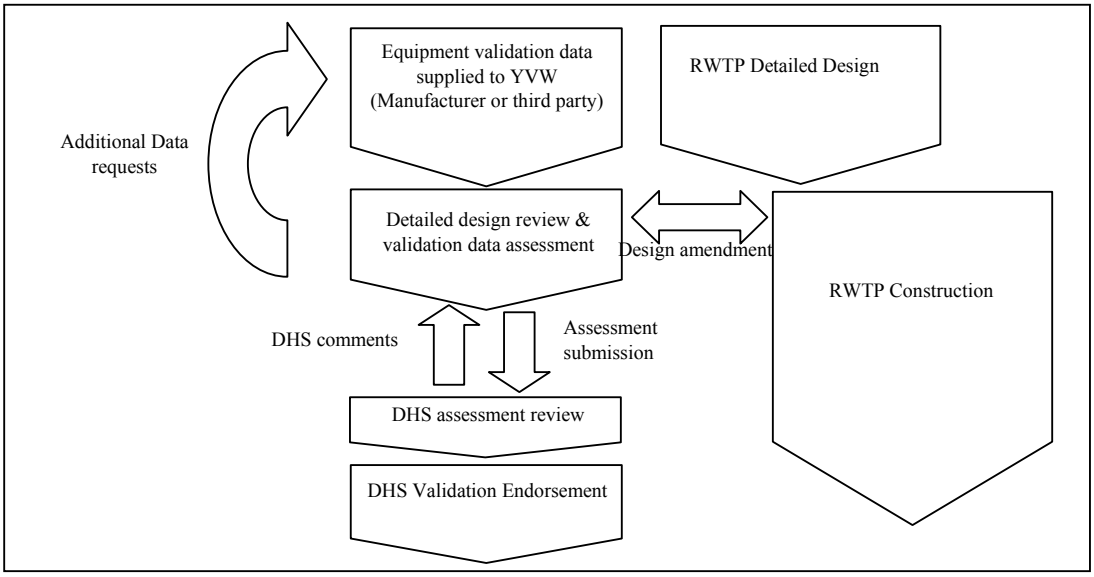

Figure 1: ***Aurora RWTP Validation Assessment Process Flow Diagram***

2.2 YVW's Experience of Validation In-House

The majority of the validation assessment of the Aurora RWTP was completed between mid 2008 and early 2009. The decision to complete the work in-house was made in light of YVW's success completing the validation of YVW's first Class A RWTP, Brushy Creek RWTP (Chirnside Park), in late 2007. It was felt that YVW had gained sufficient internal expertise during the Brushy Creek RWTP project to complete the validation assessment. This feeling was further supported by the fact that the process train for the Aurora and Brushy Creek RWTPs are essentially identical except for the use of different models of UV reactor. Despite this previous experience a number of key challenges were still encountered during the completion of the validation assessment of the Aurora RWTP and these are discussed below.

Regulatory Evolution

One of the key challenges faced by YVW during the Aurora RWTP project was the lack of regulatory guidance in existence at the commencement of the project. While dual pipe recycling was not a new concept for Australia, water recycling from sewage was a new application for the Victorian Water Industry. During the timeline of the project this regulatory void was partially filled by the creation of both the Victorian EPA's *Dual Pipe Water Recycling Schemes – Health and Environmental Risk Management, Publication 1015* which were released in October 2005 and the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*, released in 2006 and prepared as part of the National Water Quality Management Strategy commenced in 1992.

The transition from the primary guideline at the time of the preparation of the Aurora RWTPs performance specification, the EPA Victoria's *Guidelines for Environmental Management for Use of Reclaimed Water, Publication 464.2, June 2003* to the new guidelines has seen a change in the focus of treatment performance proving post construction (verification) to a greater emphasis on up front validation

Under the new framework a more conservative approach was adopted such that the operator has certainty, through manufacturer pre-sales laboratory testing, that the equipment installed onsite will meet the required treatment standards even if the equipment/plant is never operated to the level tested in the laboratory. Therefore, it is critical that validation data be requested for review at the equipment selection phase of a RWTP project. However, the new framework still provides limited guidance to explain what is actually involved in assessment of the validation data. This can lead to overestimating the simplicity of what is a very technical and theoretical process. For these reasons YVW has learnt that it is critical to have a good working relationship with DHS and to allow sufficient time to discuss the validation process with DHS upfront at the planning stage of a new RWTP project.

Which Validation Guideline?

With most process equipment being supplied from abroad, it is common for RWTP process equipment to have been validated to the relevant validation standard of the country of origin. It is therefore important to consult upfront with DHS to confirm whether this guideline can be referenced for use in the Victorian RWTP project context.

This issue was most prominent in relation to the Wedeco UV system used at Aurora RWTP. This UV system had been validated within the framework of the Tier 1 performance accreditation of the draft Ultraviolet Disinfection Guidance Manual (USEPA 2003). However, the draft guideline was superseded by the final version of this document in 2005, with the final guideline taking a more rigorous approach to validation than the draft. This meant additional time and effort was required to ensure that the validation report met the testing requirements of the new standard.

Staff Turnover

While YVW had completed the validation of the Brushy Creek RWTP a relatively short time before the Aurora RWTP validation assessment was commenced there had been a significant movement of staff within YVW during this time. This meant that the new staff undertaking the assessment were required to spend time learning the details of the validation process. With the validation methodologies and testing procedures being highly theoretical and technical this process is time consuming. This experience clearly outlined the benefits of preparing an internal validation process overview and once again the need to maintain a good working relationship with DHS.

Ultrafiltration Validation

The key challenge faced during the validation assessment of Aurora RWTP's ultrafiltration system was the requirement to obtain additional validation testing data from Norit midway through the assessment. This data was required to validate the UF systems' Direct Integrity Testing (DIT) method which is a routine test to check for breakages of the UF membranes. The validation of the DIT test is probably the most critical part of the UF system validation because resolution of the DIT test must be greater than or equal to the maximum number of log removal credits being sought for the system.

The validation data that was required to be obtained was data relating to the testing of a breached membrane. While YVW already had been provided validation data it became apparent through the validation assessment that additional data would be required for a higher test pressure than had already been provided.

While the required test data was able to be provided by the membrane supplier in the case of Aurora RWTP, this will not always be the case and some additional testing could be required specifically for the project in question. The risk of this issue occurring can be minimised by either ensuring system designs are identical to the systems already validated or by completing the validation assessment within a timeframe that allows for additional testing should it be required.

Ultraviolet Disinfection Validation

The key challenge during validation of the UV system was that the system was significantly oversized for the treatment of start-up flows and as well as that the validation report provided by Wedeco was in accordance with the draft USEPA guidelines, rather than the final guidelines (which has been discussed above).

The oversizing of the system meant that the flow to be treated by the system was below the minimum flow the unit had been validated for. As a result additional validation data was required to be sought from Wedeco primarily in the form of computation flow analysis that confirmed that the hydraulic conditions within the reactor at low flows were equivalent to the conditions within the reactor at validated flow rates. This evidence was sufficient to gain DHS endorsement that the reactor would perform.

2.3 Pros and Cons of In-House Validation

YVW's overall experience of completing the validation of the Aurora RWTP in-house has been a positive exercise that has created a very high level understanding of the fundamentals of RWTP treatment systems and provided many key learnings that will streamline the regulatory endorsement of future RWTPs. While the process was generally a positive one there were both pros and cons experienced during the project:

<u>Cons</u>

- It is difficult to make the technical knowledge gained by staff members through one validation assessment available to new staff due to the highly technical and theoretical nature of the work.
- Completing a RWTP validation assessment in-house is time consuming and may require a number of staff being committed to the project.

<u>Pros</u>

- Involvement in the validation assessment has given the YVW staff involved a detailed understanding of the fundamentals of RWTP operation. This enables strong process support provision to the operations team running the RWTP on daily basis.
- The business has gained greater insight into the finer points of RWTP regulatory approvals which can and are being applied to future projects.
- The completion of the validation assessment by the company responsible for the ongoing operation of the RWTP provides the key regulators with a level of comfort relating to the understanding and importance of validated limits.
- YVW is now positioned as a knowledgeable stakeholder able to help progress the development of the regulatory framework with the aim of further clarifying the validation assessment process.

3.0 CONCLUSIONS

In conclusion the completion of the validation assessment of the Aurora RWTP in-house has provided YVW with a detailed knowledge of the RWTP validation assessment process required under the Victorian recycled water regulatory framework. YVW has also gained a strong appreciation for the value of available validation data and the importance of reviewing this in as much detail as possible at the equipment selection phase of a new RWTP project. These learnings will be directly applied to future RWTP projects to streamline the delivery and regulatory approval process.

It is also concluded that there remains a space within the current recycled water regulatory framework for additional guidance material relating to the completion of validation assessments. This will benefit all parties involved in the development of future RWTPs including, operators, equipment suppliers and regulators.

Finally it is concluded that the value of direct and early engagement with DHS in relation to a proposed Class A RWTP to confirm the requirements of the validation assessment process are critical to the smooth progression of the RWTP approval process.

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