Desire Gralton, Communications Manager qldwater, explains how two regional towns overcame high Manganese levels to produce award-winning water.

Two regional Queensland towns with seemingly similar raw water issues found two very different treatment processes to deliver award-winning water solutions for their regions.

Georgetown is a small town situated in the Gulf Savannah on the banks of the Etheridge River. Water for the town is drawn from beneath the sands of the Etheridge River bed which provides some degree of natural sand filtration. In the dry season iron and manganese are prevalent and in the wet season the fast flows of water stir up sediments resulting in dirty water.

Richmond, one of Australia’s richest fossil grounds, sources its water from the Great Artesian Basin via two bores which contain high metal concentrations of iron and manganese causing staining and a notable odour not appreciated by residents or visitors.

Through regional collaboration, Etheridge and Richmond Shire Councils engaged water and wastewater treatment specialists Aeramix to undertake extensive field based laboratory and pilot trials to assess process configurations and identify the minimum process requirements for the Georgetown and Richmond water treatment plants.

Although the primary objectives at the two sites were similar in that both raw water supplies contained iron and manganese which led to staining throughout the reticulation system, the investigations identified quite different treatment needs for the two water supplies.

At Richmond it was found that iron could be precipitated to below ADWG limits via aeration alone, however the removal of manganese required small additions of chlorine in the form of sodium hypochlorite.

According to Aeramix Manager Technical Services and Innovation, Mark Samblebe, the aeration phase utilised at Richmond also served to assist with the gassing off of sulphide odours, and when combined with the addition of small amounts of chlorine, Manganese was also dramatically reduced.

“Our research demonstrated that the addition of chlorine dramatically improved iron precipitation and this observation was also made with respect to manganese,” Mark said.

In comparison to Richmond, the Georgetown water supply proved far more difficult to treat. Although iron was readily removed with chemical oxidation using chlorine, the elevated Manganese was far more difficult to remove.

Numerous combinations of oxidants were tested, and
additional process steps to improve oxidation such as pH manipulation were also trialled without success. Despite achieving significant manganese removal rates (60-70%) final treated water was still above the ADWG aesthetic limit and well above the 0.05mg/L threshold for preventing staining.

The initial Manganese concentration at Georgetown was significantly higher than that of Richmond, hovering around the 1-1.1mg/L mark for much of the trial period with historical records indicating levels as high as 1.5mg/L. Removal rates using all forms of oxidation and combinations of oxidation and pH manipulation could not consistently remove manganese to below 0.2mg/L, still above the ADWG aesthetic guideline.

Results of a range of oxidation-flocculation and filtration methods for the Georgetown raw water showed mixed success leading the Aeramix TSI team to investigate the use of catalytic filter media. As can be seen in Figure 1, the catalytic media was superior to any other method of removal for manganese from the Georgetown water supply.

![Image 1. Manganese residual in a pipe from the Georgetown pipework (left) and a sample of town water during a dirty water event caused by manganese staining (right).](image)

**Figure 1:** Treated water manganese concentration under various oxidation and filtration methods at Georgetown.
Mark says the challenges and results of the two investigations highlight the importance of performing on site assessment of process options and chemical configurations.

“In theory one would expect that traditional oxidation, coagulation and filtration would be sufficient for both supplies however the test work clearly showed this was not the case and that the Georgetown supply required a different process configuration to achieve the required outcomes.”

“The value of on-site testing and assessment was proven in both cases where significant savings in capital cost were gained in Richmond where a relatively simple process was identified, while for Georgetown, it identified that the composition of the raw water was prohibitive to the oxidation process and an alternative was required.”

“The on site assessment is even more important when working with oxidation processes, where if samples are collected and transported to an off-site laboratory, significant oxidation can occur prior to the assessments being made. Up to 90% of the iron in the Richmond supply was oxidised by aeration alone, a phenomenon which would occur in the transport and handling of bulk samples for analysis at an off-site laboratory resulting in misleading process performance results.

Table 1 identifies the key process steps developed and implemented for the two supplies:

<table>
<thead>
<tr>
<th>Process Step and Description - Richmond</th>
<th>Process step and description - Georgetown</th>
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</thead>
<tbody>
<tr>
<td>Mechanical oxidation/aeration for removal of sulphides and aid iron precipitation</td>
<td>Coagulation/flocculation - combining turbidity into large particles for removal via filtration</td>
</tr>
<tr>
<td>Chemical oxidation via chlorine - Manganese precipitation</td>
<td>Primary filtration - Dual media Granular activated carbon and sand - Solids and organics removal to reduce chlorine demand for metals precipitation.</td>
</tr>
<tr>
<td>Oxidation tanks- precipitation of iron and manganese</td>
<td>Chemical oxidation via chlorine</td>
</tr>
<tr>
<td>Coagulation/flocculation - combining precipitated metals into large particles for removal via filtration</td>
<td>Secondary catalytic media filtration for precipitation and removal of iron and manganese</td>
</tr>
<tr>
<td>Direct filtration - Dual media granular activated carbon and sand, solids, iron, manganese, taste and odour removal</td>
<td>Post filtration chlorine top up for disinfection (optional - usually sufficient chlorine added in oxidation step to provide residual for distribution)</td>
</tr>
<tr>
<td>Disinfection - Sodium Hypochlorite</td>
<td>Water storage - chlorine contact and sterilisation</td>
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<tr>
<td>Water storage - Chlorine contact</td>
<td>Distribution</td>
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Richmond Shire Council Mayor John Warton says the project has delivered exceptional outcomes, with the previously odorous supply being awarded best tasting water in the qldwater Best of the Best Queensland Water Taste Test 2014 followed by winning the WIOA Water of Origin Taste Test against NSW winner Orange in 2015.

“Now people living in Richmond can drink straight from the tap, and good water means a very positive future for Richmond.”

According to Etheridge Shire Council CEO Michael Kitzelmann, the provision of pure water from highly degraded water sources is a challenge for many small and remote Councils.

“While the initial concept was to develop an emergent response to a critical failure in the town’s water supply through a temporary stop-gap system, the project has instead delivered a high quality permanent system. With the assistance of Richmond Shire Council and Aeramix, Etheridge has been positioned to provide a water treatment system that is not merely achieving, but exceeding the anticipated quality of outcomes.”

Through the re-use of excess equipment at the new Richmond Shire water treatment plant the team from Aeramix designed and implemented a permanent solution to the water treatment issues for a total budget of $387,000.”

Both Councils have observed positive flow-on effects of these projects including

- compliments instead of complaints from the community,
- reduced costs in infrastructure replacements,
- reduced water consumption as Council no longer needs to regularly flush the water mains, and
- reduced use of chemicals to remove rust stains.

The projects have also highlighted the effectiveness of regional collaboration and private-public partnerships. Aeramix key personnel continue to provide remote access and support to upskill Council staff to ensure that the plant can operate without external support in future.

Richmond Mayor John Wharton says the project has provided many learnings for his team and water services operations staff who now have a much improved understanding and respect for the complexities involved in managing and maintaining the water supply and treatment system.

“Council has identified and approved the need for a more specialized skill set within the team to provide an ongoing and improved level of service in this area.”

Both projects were 2015 IPWEAQ Award winners, with the Georgetown and Richmond projects taking out the Water Projects under $1 million and the Water Projects $1 million to $5 million categories respectively.

qldwater is the central advisory and advocacy body within Queensland’s urban water industry.

qldwater represents members from Local Government and other water and sewerage service providers across Queensland.

qldwater works to strengthen the water industry through leadership, support, development and representation of our members and to position and promote the achievements of the industry.

Our aim is to support our members to deliver safer, healthy and sustainable urban water services to their communities.