Each year qldwater hosts the Dial Before You Dig Water Connections Tour, a one week roadshow where government and other utility representatives have the opportunity to gain first-hand experience with regional and remote water and sewerage service providers. This article provides a brief case study of one of the activities which has arisen as a direct result of the tour.

In 2016, Townsville City Council’s Mark Vis and Steve Gray joined the North Queensland tour group and mentioned in passing a James Cook University (JCU) algal harvesting trial at Cleveland Bay Wastewater Treatment Plant (WWTP) to an interested Wayne Saldumbide from Burdekin Shire Council (BSC). Mark is the current chair of qldwater’s ERA 63 Reference Group.

While the algal system is continuing to be evaluated in Townsville, BSC’s Ayr/Brandon WWTP was facing a potential upgrade and the smaller scale had the potential to make the technology viable and cost-effective. With the arrival of Shaun Johnston as the new Manager Water and Wastewater at BSC, council agreed to a trial.

According to Mr Johnston, ageing sewage collection and treatment infrastructure, increased environmental concerns around nutrient pollution sources in reef catchment areas, high energy, capital and operating costs of conventional treatment options, and limited funding availability meant there was a strong need to look at other fit-for-purpose solutions to maximise environmental benefit while minimising costs to the community.

“As no viable answers were available, BSC decided to look outside of the box for solutions and partnered with JCU and MBD Energy Ltd to trial the use of macro algal treatment to remove nitrogen and phosphorus from wastewater streams at the Ayr/Brandon WWTP,” Mr Johnston said.

**The technology**

Low-energy High Rate Algal Ponds (HRAP) are constructed through which wastewater flows, allowing freshwater macro algae to grow and ultimately be harvested.

The Ayr/Brandon WWTP discharges 1.6 ML/day-1 with an average concentration of total
nitrogen (TN) of 11.7 mgL⁻¹ and total phosphorous (TP) of 8.8 mgL⁻¹. Should licence standards change, the treatment of this wastewater to contemporary standards would likely require discharge levels of <5 mgL⁻¹ TN and <2 mgL⁻¹ TP.

To determine the capacity to deliver these reductions using treatment with the algae technology, trials were conducted at JCU with wastewater from the Ayr/Brandon WWTP over a five week period using a seven day growth cycle. Algae was cultured directly in the wastewater from the WWTP with no added nutrients and was harvested after seven days with the changes in water quality measured. This was replicated five times with the significant reductions in nutrient concentrations presented in the Table below.

<table>
<thead>
<tr>
<th>Concentration change</th>
<th>% Reduction</th>
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</thead>
<tbody>
<tr>
<td>Total Nitrogen (TN)</td>
<td>9.7 mgL⁻¹ to 1.5 mgL⁻¹</td>
</tr>
<tr>
<td>Dissolved inorganic nitrogen (DIN)</td>
<td>8.2 mgL⁻¹ to trace levels</td>
</tr>
<tr>
<td>Total phosphorous (TP)</td>
<td>8.2 mgL⁻¹ to 2.5 mgL⁻¹</td>
</tr>
<tr>
<td>Reactive phosphorous (RP)</td>
<td>7.5 mgL⁻¹ to 1.7 mgL⁻¹</td>
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</table>

The daily growth rate of the macro algae was 18.8 g dry weight per m² over the period of the trial or the equivalent of 66 tonnes of macro algae per Ha per year.

Translating this to the full scale volume treated at the Ayr/Brandon WWTP (1.6 MLday⁻¹ discharge) results in a required treatment footprint of 3 Ha of macro algal treatment facilities which would result in a retention time of approximately six days with the removal of >99% of DIN and 85% TN, and 77% RP and 70% TP. Discharge water quality would almost meet DEHP standards (5N/2P) and this water could be reused for irrigation or discharged with significantly reduced environmental impacts.

The treatment facilities would produce more than 150 tonnes of dried macro algae per year which would recover ~ 4.5 tonnes of nitrogen and 1.5 tonnes of phosphorous. The harvested algae has the potential be used as a protein and mineral animal feed supplement.

The pilot revealed that the addition of a sand pre-filter would increase the available nitrogen and phosphorus for the process, allowing better results to be achieved in practice than were measured in the trials.

BSC estimated a capital investment of $30 million would be required for the Ayr/Brandon WWTP to meet the current standard DEHP 5N/2P licences with conventional technologies. In contrast, the indicative capital cost of a 3 Ha facility using the algae-based technology is $1.5 million. The projected annual operating cost of the plant would be $300,000 which would exceed costs for a BNR plant, however the carbon emission reductions through reduced energy consumption show particular promise, and capital costs are a fraction of the alternative.

Overcoming barriers
The technology and trial formed the basis of BSC’s submission to the Department of Environment and Heritage Protection’s (DEHP) review of flexible nutrient offset arrangements.

Director of Innovation Partnerships at qldwater, Dr Rob Fearon prepared a report published in 2016 which outlined options for managing future loads to the Reef from smaller WWTPs in Reef catchments which clearly demonstrated that the cost of upgrading these smaller plants could not be justified and that smarter alternatives to achieve the same environmental benefit needed to be considered. According to the report, nitrogen released from WWTPs represents less than 4% of total catchment loads and focusing on priority sources of the 96% of non-urban load would have greater and more rapid benefits for the health of the Reef.

“Applying this ‘smarter investment’ principle where there are still going to be requirements for plant upgrades or renewals and linking to nutrient offset approaches is critical to achieve the best possible result for the Reef and for Queensland communities,” Dr Fearon said.

Mr Johnston believes that the uptake of these sorts of innovative technologies should be incentivised – supported by both state capital investment and a link to the environmental regulator.

“This is a great example of something which is offering a low-cost, fit for purpose solution which clearly has limitations for some of the larger WWTPs but offers huge potential for the smaller ones.
BSC is sticking its hand up for the first full-scale implementation, but our council needs to be confident that our proactivity will be recognised and supported by government stakeholders willing and prepared to share the risk in order to realise the significant benefit,” Mr Johnston said.

**The DBYD Water Connections Tour**
This is one of many examples of the benefits of water industry information sharing and innovation and encapsulates the goals of the Tour. We hope that in the coming years we are arranging industry visits to the full-scale plant and more showcases of other innovative technologies.

**qldwater** works to strengthen the Water Industry, through leadership, support and representation for its Queensland members. We provide technical input into policy development, guidelines, and coordination to respond to the needs of a changing industry. www.qldwater.com.au

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