ENERGY EFFICIENT WASTEWATER LAGOON MIXING / AERATION

Paper Presented by:

Bree Wiggins

Author:

Bree Wiggins, *Environment & Wastewater Manager***,**

South Gippsland Water

78th Annual WIOA Victorian Water Industry Operations Conference and Exhibition
Bendigo Exhibition Centre
1 to 3 September, 2015

ENERGY EFFICIENT WASTEWATER LAGOON MIXING / AERATION

Bree Wiggins, *Environment & Wastewater Manager,* South Gippsland Water

ABSTRACT

In 2009 South Gippsland Water developed a Sustainability Strategy which has been driving the Corporation to reduce energy consumption, and investigate energy efficient options for many aspects of its operations. A significant contributor to power use at lagoon-based wastewater treatment plants are traditional surface aerators. Many of South Gippsland Water's lagoon sites have aerators ranging in size from 12 to 37 kW which are maintenance and energy intensive.

The Inverloch wastewater treatment plant primary lagoon has a 12 kW diffuser aeration system, and two surface aerators which are 18 and 22 kW respectively. In July 2014, a Wind Mixer was installed in the primary lagoon with the aim of reducing the amount of time the 22 kW aerator would be required to operate. Since the installation of the wind mixer, South Gippsland Water has been able to switch the 22 kW aerator off for 5.5 months. A saving of $4500 (16% of energy costs) has been made for the nine month period July 2014 to March 2015 when compared to the same period the previous year. A payback period of approximately six years is anticipated as a result of these savings. Dissolved oxygen is closely monitored, and average dissolved oxygen concentrations have increased since the mixer was installed. This was the first Wind Mixer to be trialled in Victoria, and has proven to decrease energy consumption while having low maintenance costs.

1.0 INTRODUCTION

South Gippsland Water is committed to providing water and wastewater services to the region in a sustainable manner. In 2008, South Gippsland Water undertook an energy audit of the entire Corporation's activities which included water and wastewater operations, vehicle fleet, and offices and depots. One of the goals of the audit was to determine the largest energy using processes and act on these to reduce operating times, reduce energy loads, and increase process efficiencies. During the audit, the key energy consumption processes were then examined to determine the opportunities available for improvements. The priorities identified for energy management were 1) wastewater treatment plants, 2) water treatment plants, 3) water pumping from reservoirs and rivers, and 4) depots and offices. Examination of secondary wastewater treatment plants showed that the largest energy consumer was the aerator at each plant. One of the actions identified in the energy management action plan was to consider the replacement of electrical aerators with low energy aerators.

2.0 DISCUSSION

The Inverloch wastewater treatment plant treats domestic wastewater from the township of Inverloch. The plant treats around 400 ML of wastewater per year in a series of five lagoons, before discharging via the Baxter's Beach ocean outfall. A small portion of the treated effluent is used for agricultural irrigation by a neighbouring landholder.

2.1 Drivers for the Project

In 2012, South Gippsland Water updated its Long Term Wastewater Strategy identifying that the Inverloch wastewater plant required additonal aeration in the short term.

The Strategy proposed an additional 37 kW surface aerator required to be installed in the primary lagoon by 2015.

As part of the Corporation's sustainability program, options were investigated to improve treatment with low to no additional energy, and delay the need for additional surface aeration which is energy intensive.

2.2 Existing Operation

Before the installation of the Wind Mixer, the primary lagoon at the Inverloch wastewater treatment plant contained a 12 kW diffused aeration system, along with two surface aerators which are 18 and 22 kW respectively (see Figure 1 below).

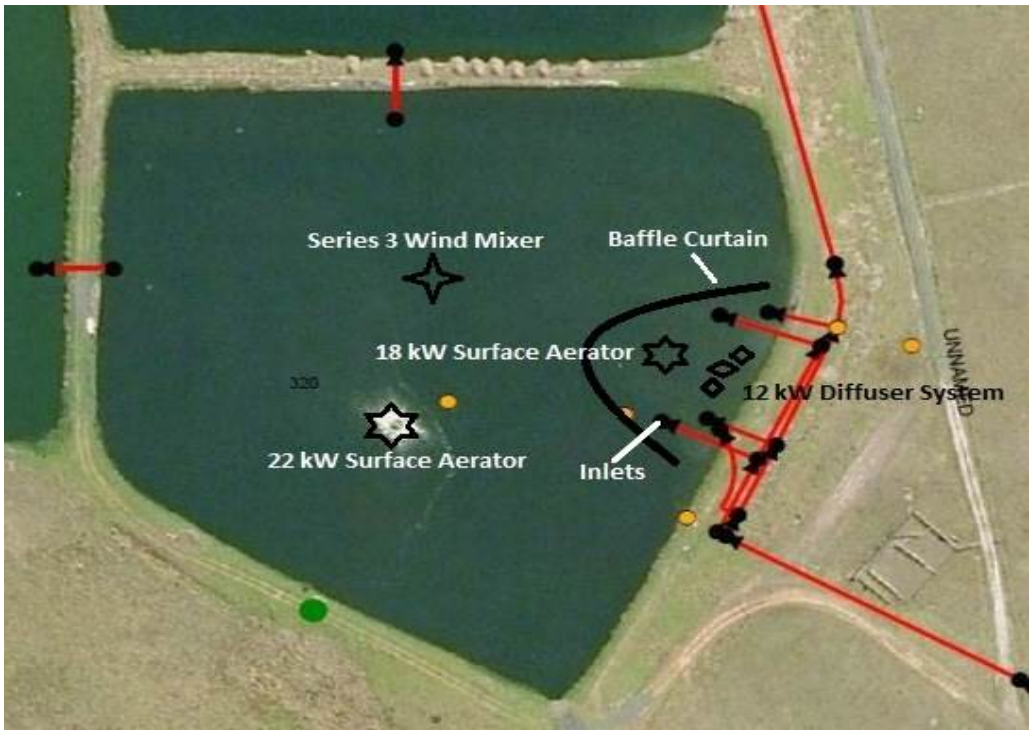

Figure 1: ***Inverloch WWTP Primary Lagoon Aeration***

The diffuser aeration system operates 24 hours per day, and the two surface aerators are controlled with dissolved oxygen set points. The annual electricity costs associated with aeration for the site was around $28,000 per year. In addition to being energy intensive, the surface aerators also have considerable maintenance costs and issues to address operationally.

The existing surface aerators pose significant maintenance challenges for operations staff. Servicing and maintenance is required regularly to refill oil, and to de-rag the aerators. De-ragging the aerators involves three staff on a boat in the lagoon pulling wipes and rags from the propellors which has significant safety concerns.

2.3 Preferred Option – Wind Mixer

In 2010, South Gippsland Water installed a solar powered mixer at its Cape Paterson wastewater treatment plant, which treats around 90 ML/year. This was the first trial with energy efficient aeration / mixing in a wastewater lagoon, and proved to be successful.

The solar powered mixer operates on it's own for nine months of the year, with the surface aerator operated via dissolved oxygen control for only three months over the warmer summer period.

Whilst the solar powered mixer proved to be successful in reducing energy requirements, the capital cost would be significantly high for the Inverloch wastewater treatment plant. Further investigations were undertaken to reduce energy with a cost efficient aeration system, and it was identified to use wind energy.

It was decided to install a SERIES 3 Wind Mixer, by Gurney Environmental Ltd, at the Inverloch wastewater treatment plant. This technology was chosen as it was a very energy efficient option (just uses the wind), and it is simple in design in that it doesn't require batteries, if there's wind it operates.

Figure 2: ***Series 3 Wind Mixer Installed in Wastewater Lagoon***

The intent of the Wind Mixer is to provide mixing whilst supporting the facultative treatment process of the lagoon. It takes the oxygenated water from the surface deeper into the lagoon, whilst not disturbing the sludge layer at the bottom of the lagoon, enabling it to process anaerobically.

2.4 Choice of Location

The Inverloch wastewater treatment plant had been identified as requiring an upgrade in terms of additional aeration. It is located in an elevated location on the coast and receives good winds throughout the year which allowed the installation of the Wind Mixer without the optional 0.55 kW backup motor. The mixer only requires wind speeds of 6-8 kph to operate, however it can withstand strong winds, which are often experienced at this site.

2.5 Results of Trial

The Wind Mixer was installed in the primary lagoon in July 2014. For the nine month period between July 2014 and March 2015, the 22 kW aerator (the second surface aerator outside of the baffle curtain) was able to be switched off for five and a half months.

During this period, South Gippsland Water saved 16% of its energy costs for the site, which is a $4500 saving when compared to the same period the previous year. The second aerator previously operated all year round controlled by dissolved oxygen level set points.

Dissolved oxygen levels are monitored continuously through SCADA. As shown below in Figure 3, average dissolved oxygen concentrations have increased since the Wind Mixer was installed. Prior to the installation of the mixer, dissolved oxygen levels usually decreased during the peak summer holiday period, with the previous aeration configuration of two surface aerators and the diffuser system which was not sufficient to keep up with the peak load. Since the installation of the Wind Mixer, average dissolved oxygen levels have increased during the peak summer load period. This likely to be attributed to the additional aeration provided by the Wind Mixer during this time.

Figure 3 shows the 2013/14 average dissolved oxygen data prior to the Wind Mixer being installed (dotted line), and the 2014/15 data after the Wind Mixer was installed and operating (dashed line).

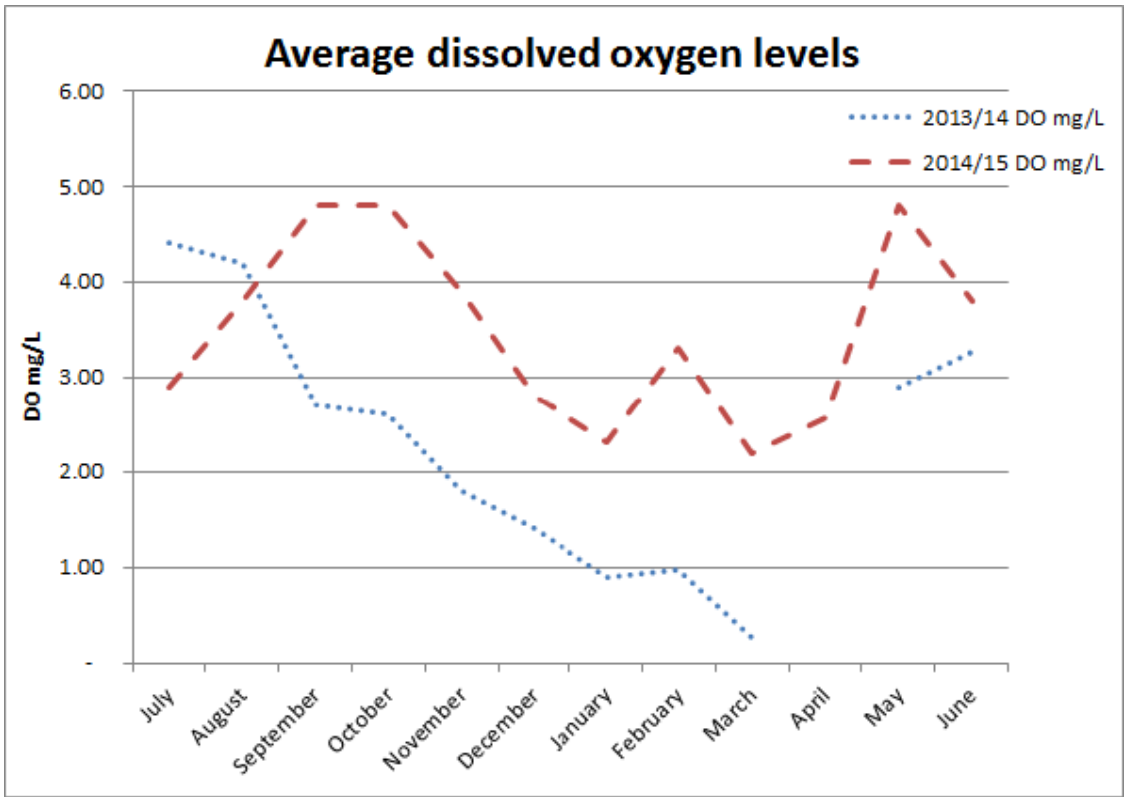

Figure 3: ***Dissolved Oxygen Levels in Inverloch WWTP Primary Lagoon***

The Inverloch wastewater treatment plant discharges to a combined ocean outfall pipeline, along with treated wastewater from Wonthaggi and Cape Paterson wastewater treatment plants. Final treated wastewater is sampled from a point downstream of the junction which combines the three discharges, and this sample point is used to monitor compliance with South Gippsland Water's Environment Protection Authority (EPA) licence. Since the installation of the Wind Mixer, and the reduction in usage of the second surface aerator at the Inverloch wastewater treatment plant, the combined Baxter's Beach wastewater system has remained compliant with EPA discharge licence limits. Figure 4 below shows a schematic of the Baxter's Beach wastewater system.

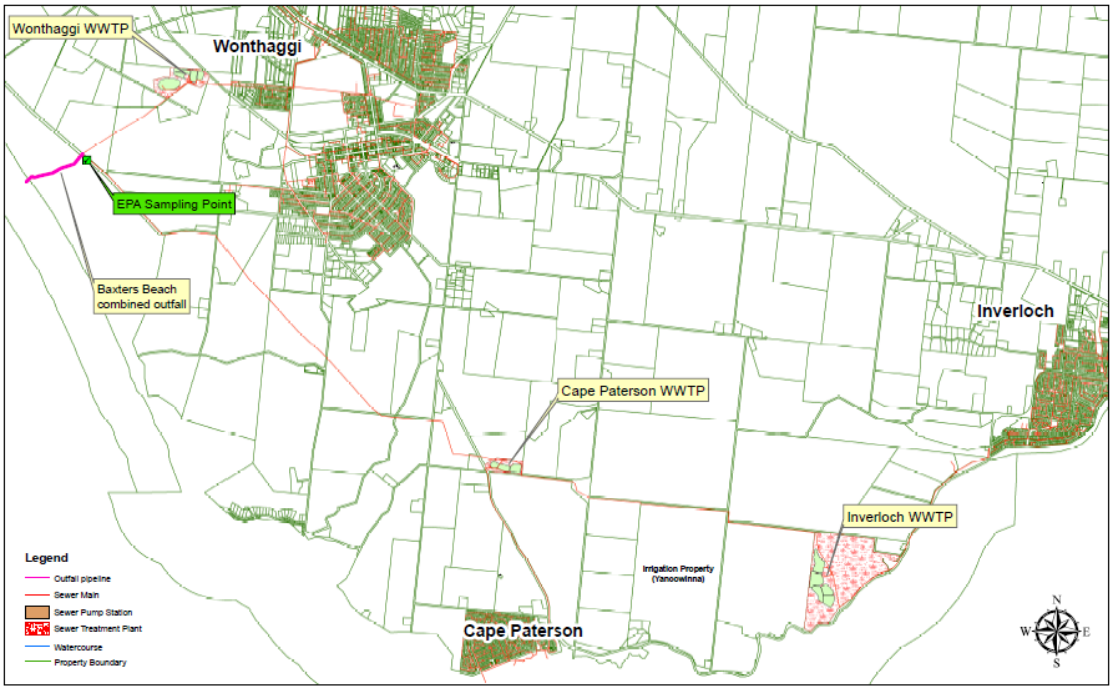

Figure 4: ***Baxter's Beach Wastewater System***

Quality of treated wastewater is also monitored individually for the Wonthaggi, Inverloch and Cape Paterson wastewater treatment plants for individual analysis of their operation. Figure 5 below indicates that the quality of the licence parameters from the final lagoon at the Inverloch wastewater treatment plant has improved since the Wind Mixer was installed. This may be due to the additional aeration provided during peak summer loads, and the increase in average dissolved oxygen concentrations.

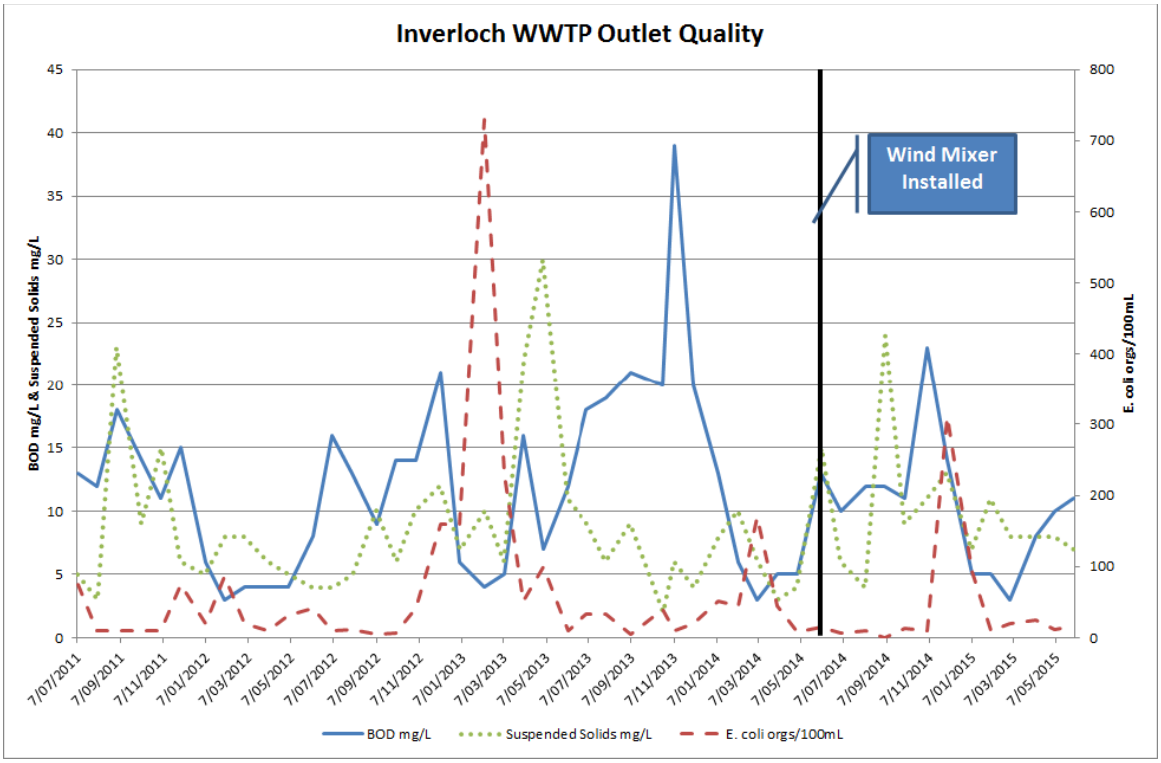

Figure 5: ***Inverloch WWTP Final Effluent Quality***

2.6 Advantages and Disadvantages

South Gippsland Water believes there are many advantages of the Wind Mixer. The key advantage is that it has provided additional aeration / mixing in the primary lagoon whilst decreasing power consumption for the site. The other important advantage operationally is that it has low maintenance requirements, less noise, easy to service, and doesn't get clogged up with rags like the traditional surface aerators. Only two inspections are recommended per year. The Wind Mixer is installed on a stainless steel anchor cable with a winch kit that enables the mixer to be pulled to the shore to carry out maintenance. This is much safer than having to go out on a boat, and saves the expense of getting a crane to pull it out.

The obvious disadvantage is that if there is no wind, there is no mixing, however there is an optional 0.55 kW backup motor kit that can be installed to negate this. South Gippsland Water has not found this to be an issue as the Inverloch wastewater treatment plant is a fairly exposed windy site, and as there is existing backup aeration in the form of surface and diffused aeration, the optional motor kit has not been purchased.

3.0 CONCLUSION

The installation of the wind mixer has been considered successful for South Gippsland Water. It has allowed a reduction in power costs for the site, whilst maintaining (and improving) treated effluent quality. Operationally the wind mixer has been easy to maintain, and there has been no ragging of the mixer which was experienced with the surface aerators.

4.0 ACKNOWLEDGEMENTS

Thanks to Ravi Raveendran and Brett Vurlow from South Gippsland Water who assisted with providing data and reviewing this paper.