THE IMPLEMENTATION OF THE TWEMS EFFLUENT REUSE SCHEME

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ABSTRACT

Dawson River sewage treatment plant (STP) serves the towns of Taree, Tinonee and Cundletown on the Mid North Coast of NSW. The treated effluent from the plant is stored onsite and supplied for irrigation purposes to 7 farms on Dumaresq Island and 5 farms adjacent to Cundletown. This reuse scheme forms part of MidCoast Water's Taree and Wingham Effluent Management Scheme (TWEMS).

A mixture of hard hose irrigators, K-Line, bike shift, subsurface drip line and a centre pivot forms the basis of the TWEMS irrigation. The scheme has been operational for approximately 5 years and many lessons have been learned as the scheme matures.

The beneficial reuse of effluent does impose a significant ongoing cost on the operation of the Dawson River STP. Power consumption and operational and maintenance costs have initiated some important changes to the original scheme. End user cooperation and acceptance has also been essential to the viability of the TWEMS.

This paper will explore some of the irrigation options for the beneficial reuse of effluent, with power consumption and energy efficiency in mind. It will also consider ease of use and infrastructure requirements for each of the utilised methods of irrigation.

1.0 INTRODUCTION

MidCoast Water (MCW) is the water and wastewater authority servicing the Great Lakes, Greater Taree and Gloucester Local Government Areas, on the mid north coast of New South Wales. Dawson River sewage treatment plant (STP) is one of MCW's largest plants, currently treating an effluent load of 25,000 equivalent persons (EP), with a total capacity up to 30,000 EP. The treated effluent from Dawson River STP is stored in 2 concrete storage dams with a combined capacity of 76 ML. Any effluent exceeding this volume is released into the Manning River at a licenced EPA discharge point.

In an effort to reduce the volume of effluent discharged to the river, MCW has developed a recycled water scheme that services 12 nearby rural properties in the Cundletown and Dumaresq Island areas. This Taree and Wingham Effluent Management Scheme (TWEMS) utilises stored effluent from the Dawson River STP to irrigate pasture on both beef and dairy producing properties. MCW is responsible for the monitoring of recycled water, soils, surface and groundwater associated with this scheme. Results obtained from the annual monitoring program are compared with baseline data that has been obtained from previous investigations.

The TWEMS sees MCW provide a pressurised irrigation system, complete with pumps, pipelines and hydrant infrastructure and irrigation equipment (see Table 1). The effluent pump station is located at Dawson STP and includes:

- 2 x 30kw CR90 Grundfos pumps
- 3 x 110kw ISO WEG pumps

Three control huts are also located to service several of the farms each. These contain flow and pressure recording devices, isolation valves, electronic actuating valves for flow and pressure control, and telemetry equipment. This facilitates remote control of farm pressure and flow at Dawson STP should it be required.

The farmers are required to maintain the provided irrigation equipment (see Table 1) and adhere to MCW's safety and environmental requirements. Each irrigator also enters an agreement that will see a price for the recycled water set after 5 years to subsidise the power costs of pumping.

Table 1: ***Irrigation Area and Irrigation Equipment for Each Property***

Property	Area Irrigated (ha)	Irrigation Equipment
Blore	36.2	2 Travellers
Mathews	33.2	1 Traveller
Milligan	25.4	1 Traveller
Tate	19.7	200m Centre Pivot
Butler	16	K-Line 110 pods
Barlin	34.9	K-Line 94 pods
Hammond	29.2	2 Travellers
Crossman	48.8	2 Travellers
Eakin	12.7	1 Traveller + K-line 10 pods + 1.1ha subsurface drip irrigation + 4 bike shift
C Mills	15.5	1 Traveller Shared b/w both
R Mills	8	
Knox	10.7	1 Traveller
TOTAL	**290.3**	**11 Travellers/ 214 K-Line pods/ 4 bike shift/ 1 Centre Pivot**

2.0 DISCUSSION

2.1 Types of Irrigation

The types of irrigation employed as part of the TWEMS are displayed in Table 2. The pros and cons of each mode of irrigation are also included.

Table 2: ***Types of Irrigation Installed and their Positive and Negative Aspects***

IRRIGATION TYPE	PROS	CONS
Travelling Gun Irrigation	• Irrigates large areas • Delivers large amounts of water	• High Capital cost • High pressure (700kpa) • Require tractor for moving
Centre Pivot	• Low pressure (300kpa) • Low labour	• High Capital cost • Circle irrigation (irrigates 78% of a square paddock) • Fixed area of irrigation
K-Line Pods	• Low pressure (350kpa) • Low Capital cost • Suits all types of terrain	• Labour time in shifting pods • Storage of equipment when not in use (pipe and pods)
Bike Shift	• Low pressure (300kpa)	• Labour time in shifting

	• Low Capital cost • Suits all types or terrain	sprinklers • Slower watering time for larger areas
Subsurface drip line	• Low pressure (200kpa) • No effluent surface ponding (delivers water direct to root zone)	• High Capital cost • Can be susceptible to beetle attack (annual injection of insecticide) • Low flow rates (for effluent application we are trying to discharge large amounts of water)

The deployment of such a range of irrigation types in the TWEMS has had its challenges. It has been difficult to supply the correct pressure to each farm considering the different pressure requirements of each mode of irrigation. To complicate matters, some farms were given a combination of low and high pressure irrigation types. Pressure reducing valves and electronic actuating Biffi valves have performed an important role in ensuring the low pressure components of the system are protected. This has not come without incident though, and the resulting repairs have been costly.

2.2 Effluent Reuse and Utilisation

During periods of sufficient natural rainfall the treated effluent is not required for reuse and continues, under licence, to be discharged to the Manning River. Table 3 gives an indication of the reuse volumes and percentage of total outflow for the first 5 years of the TWEMS. The scheme was designed for 50% effluent reuse, but is yet to reach this target (see Table 3).

Table 3: ***Effluent Reuse as a Percentage of Total Effluent Outflow from Dawson***

Financial Year	Irrigation Flow (ML/yr)	Total Outflow (ML/yr)	Effluent Reuse (%)
2009/10	380.2	1522.4	25%
2010/11	292.4	1625.9	18%
2011/12	39.8	1992.2	2%
2012/13	415.5	1719.4	24%
2013/14	524.3	1307.7	40%

The farmers who utilise the irrigation equipment and are the end user of the treated effluent have been integral to both the successes and failures of the TWEMS. For some of the users the irrigation scheme provides somewhat of an insurance policy against drought. The biggest users have been the 2 dairy farms, followed by the beef and silage making properties. Unfortunately, several properties have not made a serious attempt to utilise the resource, and this has been a function of the following:

- Insufficient machinery or labour to operate the irrigation equipment
- Off farm incomes (pasture production does not form the majority of their income).

2.3 Reuse Pumping Pressure

The TWEMS pump station requires a pressure set point of 750 KPa to ensure the delivery of a minimum of 650 KPa to the extremities of the system. This is the minimum required to operate the travelling hard-hose irrigators with the attached rain gun. The properties not requiring the full pressure (i.e. those with K-Line, bike shift, subsurface, and the centre pivot) have pressure reducing valves installed at the farm gate.

When operating in normal periods of demand the pumping requirements are approximately 30 – 50 L/s. In extended dry periods this flow increases to approximately 80 – 100 L/s, with 140 L/s being the maximum flow rate achieved thus far through the system. If all users were to irrigate at the same time, there is a potential demand of over 200L/s. This does not occur and is not likely to occur for this scheme. As mentioned earlier, the following pumps make up the TWEMS effluent pump station:

- 2 x CR90 Grundfos 30kw – 35 L/s each
- 3 x ISO 110 WEG motor 110kw – 105 L/s each

The pump philosophy sees the CR90 pumps cover normal periods of demand up to 55L/s. During high demand periods from 55L/s up to the 140 L/s, one CR90 and one ISO 110 deliver the required flow and pressure. The current flow requirements, taking friction loss and head pressure into account, would suggest that the ISO 110 pump is oversized for this application. Subsequently, it was decided to purchase and install a 75kw Wilo pump to replace one of the ISO 110kw prior to spring 2014. This change (at a cost of $10,500) would see a reduction in power consumption at the pump station with a minimal reduction in flow delivery (1 x CR90 and the Wilo 75kw deliver 120L/s at the required pressure). The smaller 75kw Wilo pump has proven to be better suited to the TWEMS pumping arrangement and come with a reduction in power consumption.

2.4 Electricity Consumption

Sinclair Knight Merz (SKM – now Jacob) was engaged by the NSW Office of Environment and Heritage (OEH) under its Energy Saver program to conduct an Energy Audit for MCW at Dawson STP. The aim of the audit was to identify a number of energy efficiency opportunities at the plant. SKM examined the monthly power load profile and demand for Dawson STP for the 2 years of 2011 and 2012. It was clear from the analysis of monthly energy demand that the effluent pump station that supplies and pressurises the irrigation scheme is a large consumer of power. Dawson STP was found to have a base load demand of approximately 95MW/month. This represents treatment only activities, as the effluent irrigation pumps were not operational. During periods when the irrigation scheme is operational the base load power demand averages approximately 150MW/month.

Irrigation does not occur all year round, but tends to be prominent in the dryer summer months. The monthly electricity usage for Dawson STP during these periods tends to be $10,000 - $20,000 more than other months when the irrigation is not in use. There is a strong correlation between electricity consumption and effluent reuse pumping at Dawson STP.

2.5 Moving to a Low Pressure System

It was important to look at making changes to the TWEMS to lower the pumping pressure and subsequently reduce power consumption. One option was to convert all properties to K-Line and decommission the hard hose travelling irrigators. The cost of completing such a task was prohibitive due to the pipework changes and locations of mains and hydrant outlets. Another option was to replace the rain gun trolley on the travellers with a Briggs Boom. This boom has several fixed extensions that reach some 30 meters either side of the trolley. Low pressure sprinklers are suspended from the boom frame in a similar manner to a pivot irrigator. It could be retrofitted to the travelling irrigators and the required operating pressure is 200kpa. This would make a significant difference to the pressure demands of the TWEMS.

The decision was made to purchase and install one Briggs Boom to an existing travelling irrigator at Eakin's property. This property had a mixture of low and high pressure irrigation and so it was an obvious choice to trial the low pressure boom and eliminate the high pressure component. The Briggs Boom has been operational for the spring/summer period of 2014/15, providing some positive outcomes to date. It operates at 200kpa as opposed to 700kpa and delivers 12L/s in comparison to the rain gun's 14L/s. The delivery of effluent is far less wind affected, and the watering is uniform across each irrigation run.

3.0 CONCLUSION

The TWEMS effluent reuse scheme has reduced the volume of treated effluent discharged to the Manning River from Dawson STP (as shown in Table 3). It has provided several local dairy, beef and silage enterprises with a valuable resource that greatly enhances pasture production. However, the operation of the pressurised reuse scheme has increased the power consumption of Dawson STP considerably. Although it is only seasonal, when the scheme is running in the warmer months, it often doubles the power consumption of the STP.

The different types of irrigation employed in the TWEMS have presented many challenges in pressure control. The travelling irrigators with the rain gun attachment have required a substantial amount of pressure to operate (as shown in Table 2). This high pressure has had implications for effluent pumping and power consumption, and also been a factor in several pipeline breaks and leaks. If the pressure is not delivered within that 650-750kpa range, there are also issues of soil compaction and the effluent becoming atomised.

The decision to convert the high pressure rain gun attachment to a low pressure Briggs Boom has so far proven to be a positive change. It will lower the TWEMS operating pressure by at least half, and in turn considerably reduce power consumption. It should also reduce the number of breaks and leaks in the delivery system. It does require the investment of more money into the scheme, but the payback period of approximately 7 years is considered feasible. During periods of peak irrigation usage, the extra power cost alone would pay for one Briggs Boom each month.

After operating the TWEMS for approximately 5 years it is clear to me that low pressure reuse schemes would offer the most benefit to both the end user and the supplier of treated effluent. They are the simplest and cheapest to operate, and deliver the effluent to the pasture without soil compaction and issues of atomisation.

The K-Line and bike shift irrigation have required the least amount of attention/maintenance, and a quad bike is the only machinery necessary for shifting these low pressure modes of irrigation.

4.0 ACKNOWLEDGEMENTS

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