# OPTIMISATION OF THE FORSTER WASTEWATER TREATMENT PLANT


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## ABSTRACT

Forster wastewater treatment plant (WWTP) is situated within the tourist belt of the Mid North Coast and can experience an increase in flow of up to 85% during holiday periods. In the past, Forster WWTP has struggled to produce quality effluent during holiday periods due to peak load exceeding the design capacity of the intermittently decanted extended aeration tanks (IDEAT's). The accumulation of cotton buds throughout the plant processes were also becoming a major concern. Due to the rapid rise in power costs and concerns for carbon footprint, MidCoast Water identified the need to address the effluent quality concerns with an emphasis on improving the plants overall efficiency. This paper aims to discuss the processes employed in meeting this challenge and highlights the fact that it can be achieved with the existing infrastructure by taking a holistic approach.

## 1.0 INTRODUCTION

Forster WWTP, operated by MidCoast Water, is situated on the lower North Coast of NSW approximately 300km north of Sydney. Forster is a coastal town and currently provides sewage services for Forster, Green Point, Pacific Palms, Smiths Lake and Tarbuck Bay. Forster WWTP is a tertiary treatment plant consisting of six IDEAT's, phosphorus removal, sand filtration and UV disinfection. The plant has an ocean release and discharges to Janie's Corner at the north of Seven Mile beach. The plant currently has a permanent equivalent population of 23,000 (5.5ML/day) though during holiday periods can experience 35,500 EP (8.5ML/day).

Approximately five years ago, MidCoast Water identified the need to improve the plant's capacity, effluent quality, and efficiency. As the plant had seen two prior infrastructure upgrades and was becoming quite congested, it was agreed the optimisation would aim to utilise the existing infrastructure with minimal costs. For this to occur, optimisation was planned to occur over a number of years so not only could individual modifications be assessed, upgrade works could be incorporated into yearly budgets.

Prior to optimisation, the 27,200 EP plant struggled to produce effluent of the required quality. During holiday season load, where inflow would increase by up to 85%, high levels of nitrogen were regularly experienced in the effluent. Peak load was found to exceed the design capacity of the biological reactors. Alongside the effluent quality concern was the number of cotton buds passing through the primary and secondary processes. Although the sand filtration system would remove them from the effluent, they would be returned back to the inlet works during backwashing, thus causing a continuous accumulation between the primary and tertiary processes.

An underlying aim for the plants optimisation was to begin a continuous process of increasing plant efficiency. With the current concerns for carbon footprint and energy prices rising fast, it was obvious that where improvement could be made, they should. In hydraulic order, this paper aims to discuss the procedures employed to optimise the Forster WWTP.

## 2.0 DISCUSSION

### 2.1 Inlet Works

To address the cotton bud issue, a 2mm M.A. Ind drum screen was installed post twin 6mm step screens and grit arrestor (figure 1). The drum screen was specified to handle 550L/s; approximately 200% peak dry weather flow rate.

**Figure 1:** ***Drum screen installed post grit arrestor.***

Not only has the screen removed the problematic cotton buds from the system, it has removed on average $1.2m^3$ of fines, in the form of paper, lint, hair, peas, corn and carrot, per day. Before and after drum screen sampling has revealed an average reduction in $BOD_5$ and Suspended Solid of 29% and 47% respectively (table 1).

**Table 1:** ***Before and After Drum Screen sampling for BOD and Suspended Solids***

| | $BOD_5$ | | Suspended Solid | |
|---|---|---|---|---|
| **Date** | **Before** | **After** | **Before** | **After** |
| 06/09/2011 | 230 | 180 | 320 | 230 |
| 06/12/2011 | 210 | 150 | 230 | 130 |
| 13/12/2011 | 160 | 140 | 400 | 310 |
| 20/12/2011 | 160 | 140 | 200 | 130 |
| 04/01/2012 | 200 | 190 | 140 | 150 |
| 10/01/2012 | 200 | 200 | 270 | 250 |
| 17/01/2012 | 510 | 180 | 1000 | 170 |
| 24/01/2012 | 200 | 150 | 270 | 120 |
| **Average** | **234** | **166** | **354** | **186** |
| **St. Deviation** | **114** | **24** | **272** | **69** |
| **% Reduction** | **29%** | | **47%** | |

Initially the drum screen ran excessively due to the incoming flow surge; the screen operates via an ultrasonic level sensor on the inlet of the screen.



Figure 1: Rotork operated penstock on outlet of balance tank.

To overcome this, a penstock operated by a Rotork actuator was installed on the outlet of the balance tank (figure 2).

**Figure 2:** ***Rotork operated penstock on outlet of balance tank***

The penstock defaults to a minimum orifice and opens marginally at set levels within the balance tank. This has not only greatly reduced the flow rate through the inlet works, allowing better solid removal from the grit arrestor and minimising the drum screen runtime, but also throughout the IDEAT's. Table 2 shows the costing for this upgrade.

**Table 2:** ***Costing for the installation of the Drum Screen***

| Component | Cost |
|---|---|
| Drum Screen/Conveyor | $93,786 |
| Penstock | $1,990 |
| Rotork | $9,958 |
| Electrical/SCADA | 17,113 |
| Crane Hire | $1,755 |
| **Total** | **$124,602** |

## 2.2 IDEAT's

To maximise the capacity of the existing tanks, the Sanitaire disc-type fine-bubble membrane diffusers were upgraded from 7 inch diameter to 9 inch; tanks 1-4 consist of 660 membranes each and tanks 5-6 consist of 1440 membranes each. For tanks 1-4, the existing blowers (two per tank) remained though the motors were upgraded from 22kW to

30kW. The blower pulleys were also replaced from a reduction ratio to a 1:1 ratio. Tanks 5-6 utilised the existing blowers and motors (three per tank), though the blower pulley ratios were also replaced to a 1:1 ratio. On all 14 blowers variable speed drives (VSD's) were installed for greater operator control and to improve efficiency. Calculations indicate that the aeration upgrade increased tanks 1-4 capacity from 3,300 EP to 5,156 EP and tanks 5-6 from 7,000 EP to 10,938 EP, thus an overall increase from 27,200 EP to 42,500 EP. As a result, nitrogen removal has greatly improved, and the number of IDEAT's operating has reduced from six all year round to three in non peak periods and four in peak periods, thus reducing power consumption and mechanical wear. Table 3 shows the costing for this upgrade.

**Table 3:** ***Costing for the IDEAT upgrade***

| Component | Cost |
|---|---|
| IDEAT 1-4 (diffusers/motors) | $220,880 |
| IDEAT 5-6 (diffusers) | $197,940 |
| 1-4 VSD's (x8) | $51,744 |
| 5-6 VSD's (x6) | $38,808 |
| Crane Hire | $10,038 |
| **Total** | **$519,410** |

## 2.3 Sand Filtration

As part of the tertiary process, four vertical gravity feed sand filters exist. Prior to the optimisation, the filters would backwash daily via a time clock; due to the original pressure differential units incorrectly installed, thus not operational. The equipment needed for the backwash process is an air scour blower (22kW), backwash pump (37kW), backwash waste pump (3.6kW) and a compressor (5.5kW) to operate the valving. Based on two, five minute backwash cycles per filter and with four filters in use, total power consumption was 56.9kWh per day. With some outside help from experts in the area resolving the pressure differential issues, the filters now backwash on average every five days instead of daily. This has not only reduced filtration power consumption by 45.5kWh per day (16,608kWh per year), it has also reduced the mechanical degradation of equipment.

Due to before and after sampling of the filtration system, it has been indicated that during normal events the filtration system can be bypassed with minimal disruption to suspended solid quality. This is made possible by utilising the three tertiary catch ponds with a total volume of 9.7ML; 2 days detention time. With the filtration system bypassed, the filter lift pumps (22kW) are also disabled. This can incorporate a further average reduction of 190kWh per day (69,350kWh per year), based on an average of 8.7hrs run time, alongside the reduction in mechanical degradation.

## 2.4 UV System

Originally five UV modules, each containing 100 low pressure lamps (total of 500 lamps) ran 24/7 within the UV system at a total power consumption of 840kWh per day (7kW per module). Whilst monitoring faecal coliform (FC), UV modules were turned off until a change was noticed. It was found that two modules would achieve the desired FC count consistently thus reducing power consumption by 504kWh per day (183,960kWh per year) and lamp costs by three-fifths for the year.

## 2.5 Future Works

The future works section of this paper discusses optimisation planned though not completed at the time of writing this paper.

Due to the potential power savings and Forster WWTP having 16ML of wet weather storage, plans are to store effluent during the day and release to the ocean during off-peak periods via a time clock. A level indicator in the storage area will override the time clock when necessary. This will reduce the power cost as off peak power is significantly cheaper than peak and shoulder tariffs, and allow flushing of the embayment prior to daylight to reduce the possibility of algal blooms.

Currently a flow control valve exists prior to the UV system. Future plans are to integrate a set flow rate to the number of UV modules operating. That is, a minimum flow rate of 80L/s may be set whilst utilising two modules of UV. When a higher flow rate is required, more modules will power accordingly.

Further scheduled is the replacement of the eight aging blowers, aerating IDEAT's 1-4, with four blowers of twice the capacity and greater efficiency. Ideally, one old unit would be replaced with a new, leaving an original as a standby or assist blower when needed. Investigations are showing a potential for between 20-30% greater efficiency with a reduction in service costs and noise output.

# 3.0 CONCLUSION

For a total cost of $644,012 Forster WWTP is now recognised as a 42,500 EP plant producing a significantly improved effluent quality. Where the plant previously struggled to produce quality effluent utilising six IDEAT's over the holiday period, licence is effortlessly met utilising four IDEAT's. Further, by employing the current efficiency processes, the plant can reduce power consumption by an average of 270,000kWh per year, equating to $54,324 based on a $0.2012/kWh charge (including all tariffs), thus a payback period of 12yrs. Coupled with the future works detailed, the saving and payback period can be further improved. Figure 4 shows the operational costs of MidCoast Water WWTP's and it can be seen that although the price per kWh has increased, Forster WWTP costs have remained constant.

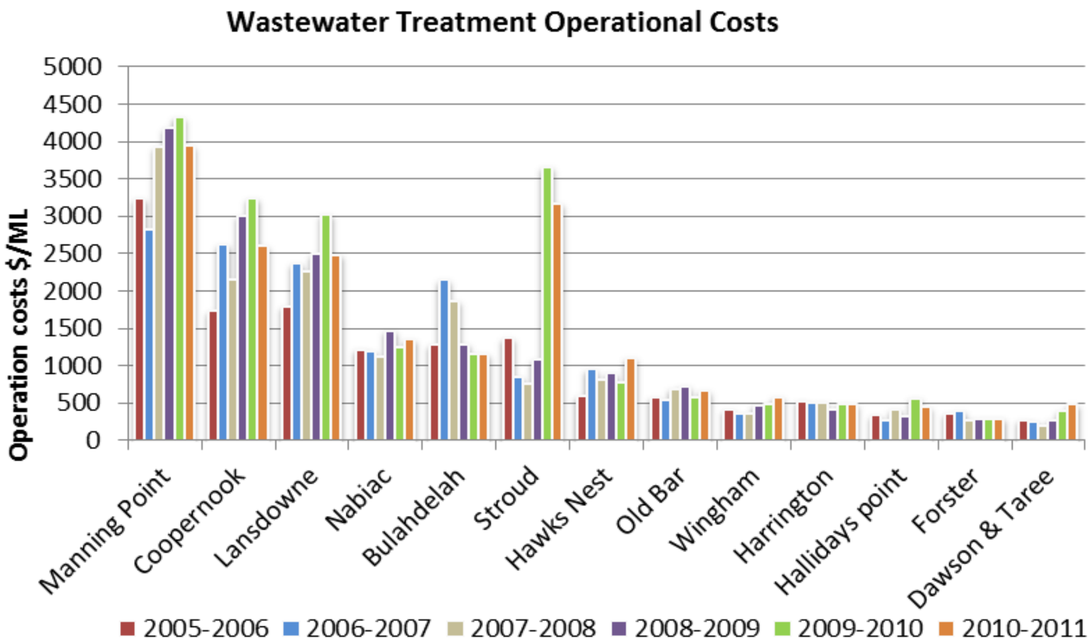


**Figure 3:** ***Operation costs per ML for MidCoast Water WWTPs.***

Forster WWTP has been a classic example of where a holistic approach to optimisation has been successful. Rather than employ the cliché response of building a new plant, MidCoast Water has identified the existing infrastructure to be adequate, thus have worked with what we had. MidCoast Water has also recognised that optimisation does not need to be revolutionary, and that a number of simple modifications can equate to a favourable outcome.

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