SEWAGE DISTRIBUTION MANIFOLDS IN AN INTERMITTANT WASTE WATER TREATMENT PLANT

Paper Presented by :

Paul Keating

Author:

Paul Keating, *Wastewater Treatment Plant Operator,*

Gippsland Water Authority

65th Annual Water Industry Engineers and Operators' Conference
Kardinia Heights Centre - Geelong
4 and 5 September, 2002

SEWAGE DISTRIBUTION MANIFOLDS IN AN INTERMITTANT WASTE WATER TREATMENT PLANT

Paul Keating, *Wastewater Treatment Plant Operator,* Gippsland Water.

ABSTRACT

Modifications to the Moe Waste Water Treatment Plant (WWTP) are discussed. The installation of an influent sewage distribution manifold system prevented ammonia (NH4) breakthrough into the final effluent, and improved phosphorus (P) removal. An additional selector balanced organic and hydraulic loading to individual cells and simplified the operation of the plant.

KEY WORDS

IDEA plant, upgrade, influent manifold, ammonia removal, phosphorus removal.

1.0 INTRODUCTION

The Moe WWTP, an IDEA plant, is located 135kl east of Melbourne, in the Latrobe Valley Victoria. This plant treats domestic and minor trade wastes, collected from the towns of Moe, Newborough, Trafalgar, & Yarragon. It has an EP of ≈22,000 people. Treats an Average Dry Weather Flow of 5-6 ML/day, Average Wet Weather Flow of 10-11 ML/day with a peak capacity of 18ML/day, with excess flows diverted to storage lagoons.

In an IDEA treatment plant all parts of the treatment process occur in a single tank. Moe has three treatment cells, each 50m x 20m x 5m and holding an average four million litres each. The screened sewage is continuously fed into the treatment cells where it passes through treatment cycles of four hour duration. Each cycle consists of the following phases, Aeration (85 min), Denitrification (or mixing, 30 min), Settling (40 min), and Decant (85 min). Return Activated Sludge (RAS) is returned to the selectors at the front of the cells. Waste Activated Sludge (WAS) is thickened through a Dissolved Air Flotation plant and stored in a sludge lagoon.

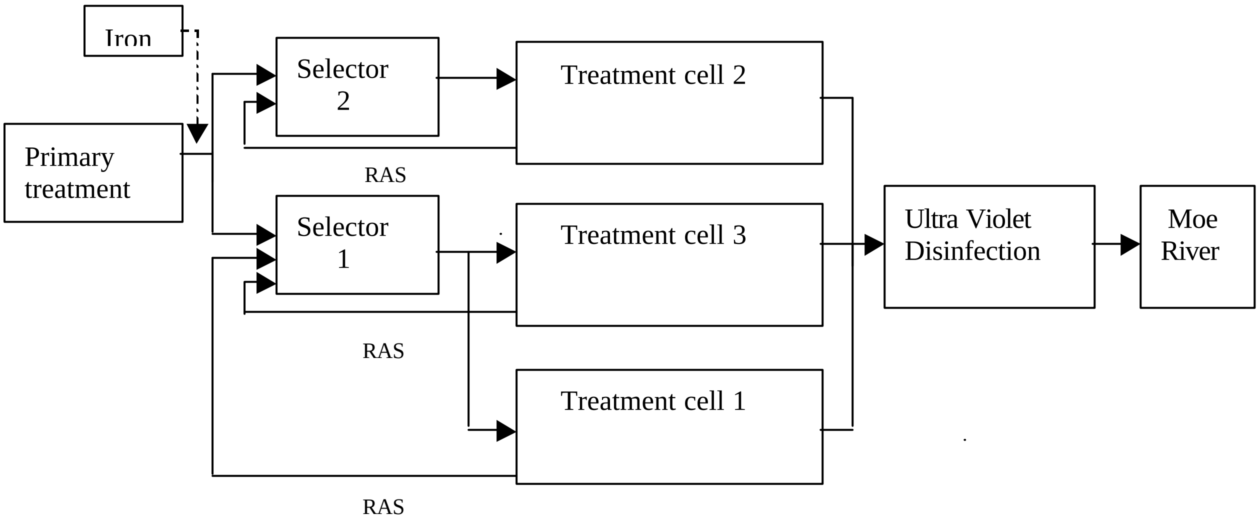
The plant was originally designed for Biological Ammonia & Nitrogen removal, with chemical Phosphorus removal.

2.0 BEFORE MODIFICATIONS

2.1 Process Flow In The Original Plant

Figure 1 shows a process schematic of the plant prior to the modifications described here. Sewage passed through the primary treatment zone, through two selectors then onto the three treatment cells. Returned activated sludge from each cell was returned to the inlet of the selectors. After treatment the decanted effluent passed through Ultra Violet disinfection and then into the river. Iron salts were not being used at this stage of operation.

Figure 1: ***Process flow before modifications***



2.2 Problems

The problems experienced in trying to operate the plant in its original configuration were;

- Ammonia breakthrough in the decanted effluent;
- Average P removal;
- Unequal split of inflows;
- Unequal organic loads;
- Poor mixing and distribution of RAS solids back into the treatment cells;
- Greatly different wasting rates to compensate for RAS problems.
- Loss of Alkalinity and pH when dosing iron salts.

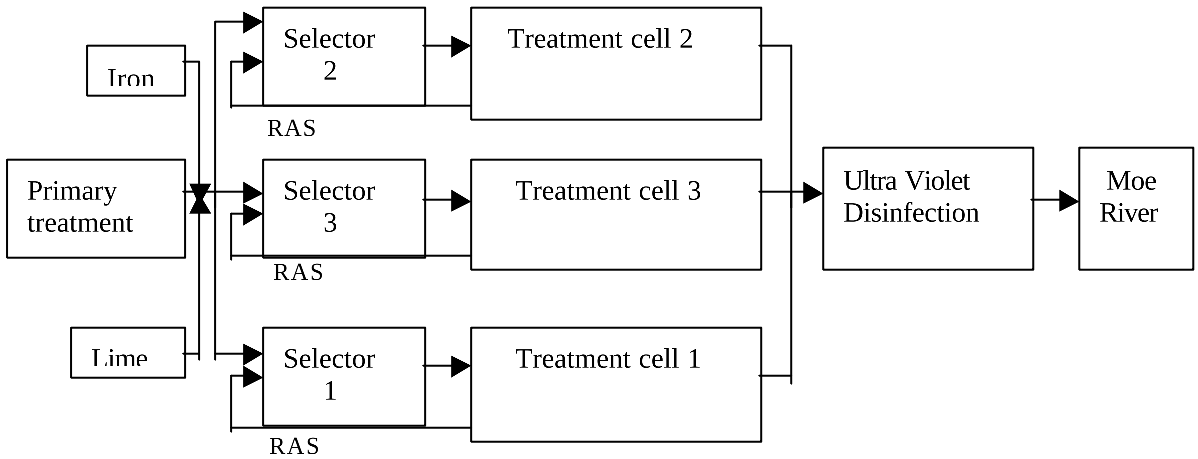
3.0 AFTER MODIFICATIONS

3.1 New Process Flow

Figure 2 shows the process flow after the modifications described here.

Sewage passed through a new and more efficient primary treatment zone, through three selectors then onto the three treatment cells. Sewage distribution manifolds were installed in each treatment cell. The ability to dose lime, after primary treatment, was installed. Returned activated sludge from each cell was returned to the inlet of each associated selector. After treatment the decanted effluent passed through Ultra Violet disinfection and then into the river.

Figure 2: ***Process flow after modifications***



3.2 The Distribution Manifolds

From discussions between Gippsland Water management and Dr Jurg Keller, University of Queensland & CRC WMPC, it was decided to use submerged sewage distribution manifolds to enhance the contact between the influent and the biomass, which would improve biological phosphorus removal in the IDEA treatment process.

Before modification, a mixture of screened sewage and mixed liquor entered each treatment cell by means of a primary manifold which was 1800mm above the cell floor. From this four short drop pipes, pointing downward at an angle of 20° to the vertical, distributed the mixture into the sludge blanket at one end of the cell.

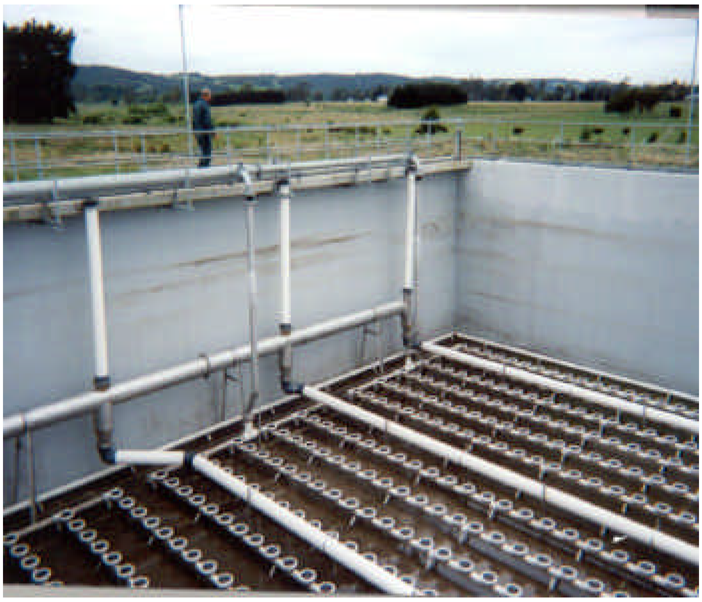
The influent delivery system was modified to form a system of distribution manifolds on the floor of each cell. The distribution manifolds were constructed from 200mm PVC, and run the full length of each treatment cell. At the start and end of each manifold, pipes rise up the cell wall. These pipes were installed to allow access to clean the manifolds and for venting when draining the cells for maintenance. In the bottom of each manifold 35mm holes were drilled every 1500mm along their full length.

Not being aware of any computer program to model flows, in this situation, led to a lot of discussion with regard to how to set up these manifolds. The size of the pipe, how long they should be, what hole size, where to place the holes and at what spacing, etc.

The delivery system before and after the modification is shown in Figures 3 & 4.

Figure 3: ***Primary manifold before Modification***

Figure 4: ***Primary manifold after modification showing distribution manifolds***



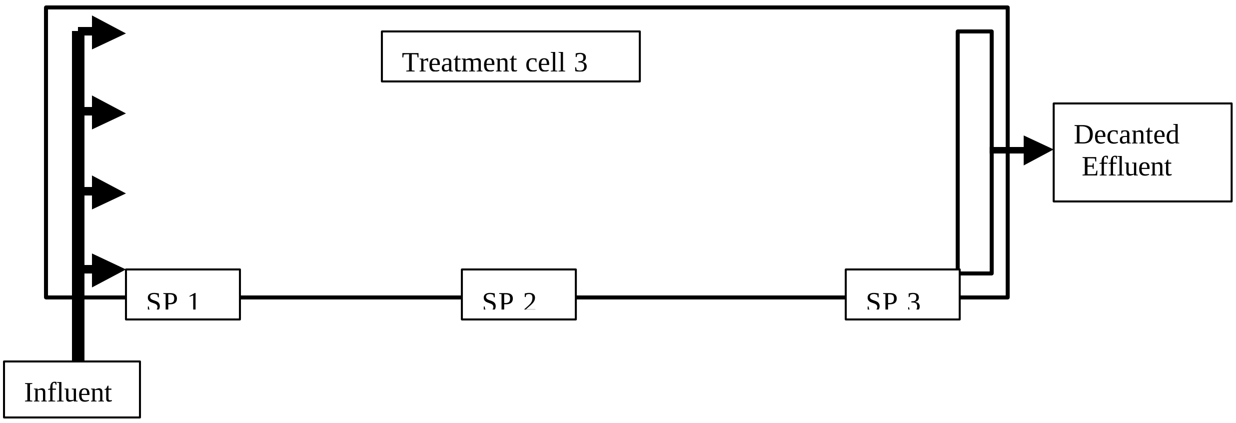
4.0 SOLUTIONS TO THE PROBLEMS

4.1 Ammonia Breakthrough

Ammonia breakthrough was experienced, to varying degrees, during each treatment cycle . During the majority of cell decants, the NH4 levels in the effluent was inside the EPA license requirements of a median of 2.0mg/l and a 90 percentile of 5 mg/l. However when the treatment cells were trying to cope with the morning peak, the NH4 levels would regularly breach the license limits.

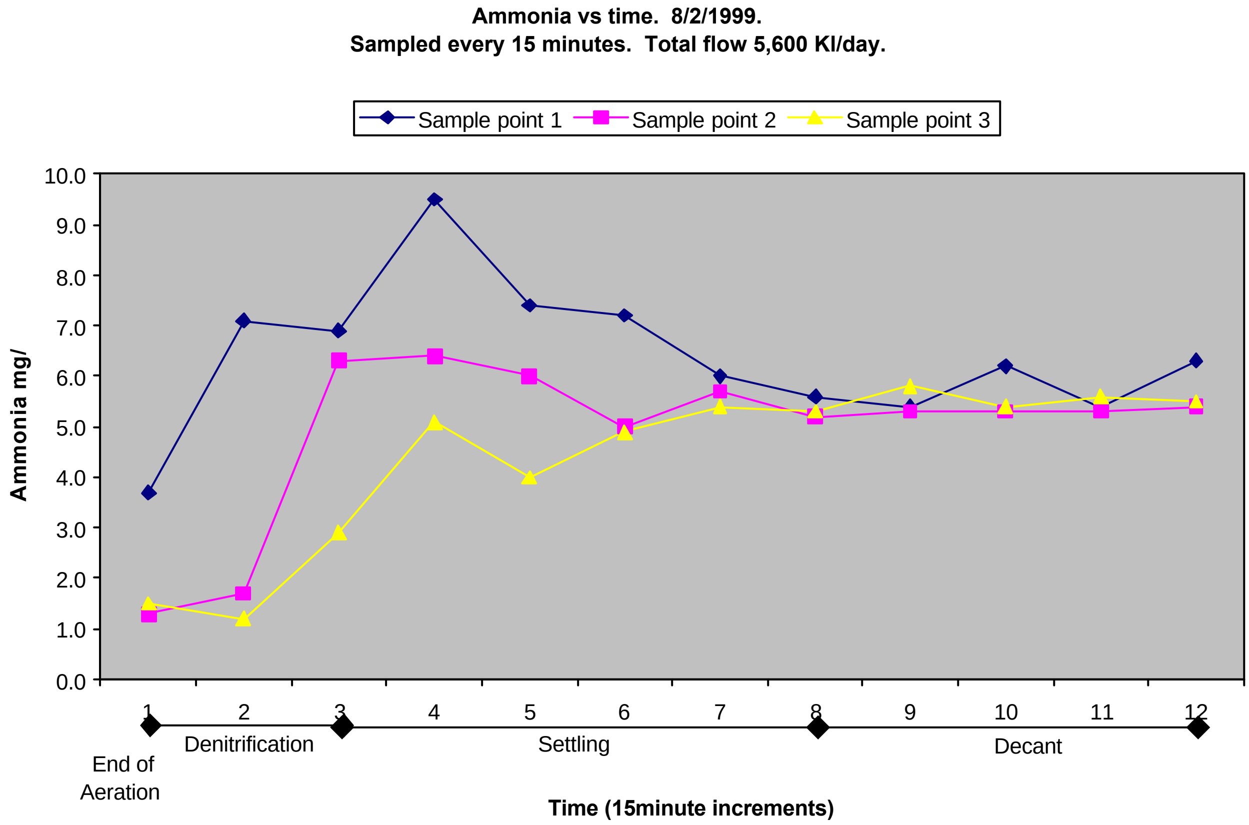
Extensive monitoring of Ammonia levels across the treatment cell 3,was carried out on a number of occasions, using the sample points shown in Figure 5.

Figure 5: ***Sample points along cell 3, for monitoring ammonia levels.***



Data collected from cell 3 on the 8/2/1999 is displayed in Figure 6. This graph shows the progressive increasing levels of NH4 across the treatment cell, during the morning peak period. These results are typical of the information collected.

Figure 6: ***Graph showing the progressive breakthrough of ammonia in the treatment cell and then into the final effluent.***



This graph displays data collected on the 8/2/1999. Samples were collected every 15 minutes starting at 10:30 am. This graph is typical of the data collected on five separate occasions over a period of four weeks.

To support our findings, on NH4 breakthrough, the treatment cell was run as an SBR. On the numerous occasions when run as an SBR, the low ammonia levels attained at end of aeration (EOA) were maintained for the rest of the treatment cycle.

4.2 Phosphorus Removal

Total P enters the Moe WWTP at typical levels of between 8.0 – 9.0 mg/l. Prior to the installation of the distribution manifolds, a lot of work went into utilizing existing infrastructure to maximize Biological P removal, with no improvement gained. Typical levels of P in the plant effluent, before the installation of the manifolds, was 4.8 mg/l. Levels of P in the effluent , post manifold installation, was between 3.9 & 4.1 mg/l. Reduction in P levels, attributed solely to the installation of the manifolds, was between 0.7 & 1.1 mg/l.

Further significant reductions in P levels, in the plant effluent, to 3.4mg/l were made by the use of online nutrient monitors and enhancing the plant PLC control program.

Levels were further reduced to 0.6 mg/l when dosing with Acetic Acid as a supplementary carbon food source, and further supplementary PLC program changes.

A representative summary of data collected at Moe, for the effect of each modification on P removal is shown in Table 1.

Table 1: ***Summary of the data collected at the Moe WWTP using Merck Spectroquant cell test kits.***

PHOSPHORUS LEVELS mg/L			
	CELL 1	CELL 2	CELL 3
Before manifolds	4.8	4.7	4.7
After manifolds	3.9	4.1	4.1
Improved cycle control	N/A	3.4	N/A
Acid dosing	N/A	0.6	NIA
Raw sewage	8.0 – 9.0		

This table shows the progressive reduction in P levels after each stage of modification. Analysis of samples was carried out three times per week over an 18 month period. Results displayed are typical values, of the data collected.

4.3 Unequal Flows, Unequal Organic Loads, & Poor Distribution Of RAS

To combat the problems of unbalanced hydraulic flows and organic loads, a third selector was constructed. The selectors inlet plumbing was altered to accommodate the new selector. Adjustable weirs were added to each of the selector outlets, enabling all of the outlets to be set at exactly the same level. The new weirs also resulted in a rise in height which contributed to an increase in driving head for the flows through the distribution manifolds.

Previously RAS entered selector 1 in an equal ratio, but due to design flaws which created mixing problems and hydraulic issues, the RAS did not exit in the same ratio. The addition of the third selector created three independent RAS – selector – cell control loops, and allowed wasting of solids to be carried out in a more reliable and stable manner.

4.4 Alkalinity And pH

Moe WWTP influent sewage generally has low alkalinity levels, which are just sufficient to sustain the treatment process but would not support the addition of chemicals for P removal.

Trials in dosing at the water treatment plant to increase alkalinity levels entering the WWTP were unsuccessful.

Through bench tests it was determined that lime was best material for addition and the expected dose rates required. Even though the plant pH is important, monitoring of the residual alkalinity levels in the plant effluent is the controlling influence on the lime addition.

5.0 PROBLEMS EXPERIENCED POST MODIFICATIONS

The vertical vent / access pipes on the primary manifold, at the head of the distribution manifolds, work as very efficient fat separators. Attempts to keep these clean has been abandoned and they have been left to fill with fat. Once the point of equilibrium is reached, any fat entering the system passes into the treatment cell for use in the treatment process. No odors have been noticed coming from these pipes. We now only worry about cleaning them when the treatment cell is taken offline and drained.

The 35mm holes, in the distribution manifolds, do block up with material. The operator monitors the water level in the vent / access pipes on the end of each manifold, for head loss. This triggers when the manifolds need to be cleaned. They are cleaned, by a local contractor, with a high pressure water hose with a special jetting nozzle attached. We have experienced a more efficient clean when the hose is pulled back through the manifold under pressure, using their easement reel. The pressure hose is run up and down each manifold three to four times. Cleaning, over the last twelve months, has occurred every five to six weeks. The cost, over the last year, for this maintenance task is approx $10,000.

There are no other maintenance issues associated with the sewage distribution manifolds.

6.0 CONCLUSION

The modifications mentioned have contributed greatly towards making the Moe WWTP a very stable and reliable treatment plant across a wide range of flow and load conditions. The sewage distribution manifolds have eliminated NH4 breakthrough in 99% of the operational conditions experienced by the plant.

Even though the installation of distribution manifolds at Moe did not achieve significant gains in P removal, any gain in minimizing the use of chemicals must be of a financial and environmental advantage. Greater reductions in P, using the manifold method, have been made at other treatment sites located around the country.

The manifold system maybe more suitable to your installation. Blockage problems experienced at Moe may be overcome by supplying a greater delivery head (700mm at Moe), or reduction in pipe diameter to keep flow velocities higher.

7.0 ACKNOWLEDGEMENTS

I would like to thank Dr Peter Mosse for encouraging me to be actively involved in the trials at the Moe WWTP and Mr Ian Soutar for allowing me to be actively involved in the distribution manifolds from their conception to completion. Also acknowledgement to Gippsland Water employees who have added their comments to the further improvement and optimisation of the Moe WWTP.