YARRA VALLEY WATER'S NITROGEN MANAGEMENT STRATEGY

Paper Presented by:

Maarten De Beurs

Authors:

Maarten De Beurs, *Environmental Scientist,*
Sabina Fahrner, *Planning Engineer,*

Yarra Valley Water

73rd Annual Water Industry Engineers and Operators' Conference
Bendigo Exhibition Centre
31 August to 2 September, 2010

YARRA VALLEY WATER'S NITROGEN MANAGEMENT STRATEGY

Maarten De Beurs, *Environmental Scientist,* Yarra Valley Water
Sabina Fahrner, *Planning Engineer*, Yarra Valley Water

ABSTRACT

Nitrogen in Port Phillip Bay needs to be managed in the long term to ensure the environmental sustainability of the bay (Port Phillip Bay Environmental Study, CSIRO, 1996). To address this issue Yarra Valley Water (YVW) has developed a self imposed cap of 87t of TN (Total Nitrogen) for discharges that contribute to the load received by the bay. To ensure continued compliance with the cap a number of nitrogen reduction projects have been identified and assessed on a $Net Present Cost ($NPC) per kilogram of nitrogen removed basis. Comparing these projects against other stakeholder's potential nitrogen reduction projects indicates that YVW's projects are financially competitive and will remove more nitrogen. YVW therefore sees the potential for surplus projects to be made available to other stakeholders to assist with Lowest Community Cost management of nitrogen loads to the Bay. In order to achieve this YVW has been consulting with both EPA and Melbourne Water on the potential development of an environmental offsetting framework. This paper focuses on the nitrogen reduction projects identified and how they may be implemented in the context of either an internal or external offsetting framework with stakeholders such as the EPA and Melbourne Water. It is currently proposed to develop a pilot study to investigate this further.

KEYWORDS

Nitrogen, offset, effluent, environment, strategy, Sewage Treatment Plant

1.0 INTRODUCTION

Yarra Valley Water's Strategic Intent is to *"Lead the global water industry in serving the Customer and the Environment"*. In order to achieve this we are aiming to provide our services within the carrying capacity of nature by 2013. Through a process involving Multi Criteria Analysis and Life Cycle Assessment, YVW identified that the total annual load of nitrogen that is discharged into Port Phillip Bay as a result of our operations is a key impact requiring ongoing management to ensure we achieve these objectives. This has lead to the development and implementation of a cap on our nitrogen discharges to Port Phillip Bay.

The Nitrogen Cap includes consideration of discharges from Sewage Treatment Plant (STP) effluent, irrigation with recycled water, sewage spills and nitrogen escaping from poorly maintained septic tanks. The measure of nitrogen used is Total Nitrogen (TN).

YVW also applies a "Lowest Community Cost" framework to all key business decisions. This means that YVW will work to achieve the most cost-efficient nitrogen management solution for the community, rather than simply the most cost-efficient solution for YVW.

2.0 DISCUSSION

2.1 Nitrogen Cap Establishment Process

Yarra Valley Water has used the 1996 study by CSIRO (Harris et al 1996) to understand the carrying capacity of Port Phillip Bay for nitrogen and other nutrients. We then defined our share of this carrying capacity, based on YVW's contribution to the total nitrogen load on Port Phillip Bay at the time of the study.

According to Harris et al (1996) the total nitrogen load on Port Phillip Bay is 7,600t per year. The study found that a long term sustainable nitrogen load would be 6,600t per year meaning that a reduction of 1000 tonnes was required. This reduction was split among the following nitrogen sources:

- Western Treatment Plant (Melbourne Water)
- Yarra and Maribyrnong Rivers
- Other rivers and streams.

The required reduction from the Yarra and Maribyrnong Rivers was allocated in the study as 350 tonnes. YVW's nitrogen discharges occur within this catchment.

Over 95% of nitrogen discharged to Port Phillip Bay by YVW is from STP effluent. Runoff from recycled water irrigation was insignificant during the period of the CSIRO study but is growing with increased usage of Class A water. The discharges from sewage spills and septic tanks are minor and poorly characterised but are expected to have decreased since the period of the study, given a significant reduction in the volume of sewage spilled and an active backlog program to replace underperforming septic tanks.

YVW's average nitrogen discharge from STPs was 107.7 t/yr over the period of the study, which represented approximately 6% of the calculated nitrogen load from the Yarra and Maribyrnong River systems (see Table1).

Table 1: ***Nitrogen load to Port Phillip Bay (1991-1996)***

Source	Load from Yarra & Maribyrnong Rivers (CSIRO Study, 1991-1996)	YVW STP discharges into Yarra & Maribyrnong Rivers (1991-1996)	YVW as percentage of total
N load (t/yr)	1,800	107.7	5.98%

Yarra Valley Water has therefore assumed responsibility for a 6% share of the 350 tonne nitrogen load reduction from the Yarra and Maribyrnong Rivers.

YVW share of reduction target:
350t per year x 6% = 20.9t per year

YVW "Nitrogen Cap":
107.7t per year - 20.9t per year = **86.8t per year**

YVW has had our nitrogen cap methodology independently verified and we are satisfied that the cap calculation is very conservative resulting in a low nitrogen cap. We would welcome any additional comment on this approach that external parties wish to provide.

2.2 Current Nitrogen Discharges

Yarra Valley Water is currently operating well under its nitrogen cap, with only 48.5t

discharged in 2009/10.

This is a result of significant improvements in our treatment standards since the completion of the CSIRO study. Our largest plant (Brushy Creek STP) had a capacity upgrade and aeration system upgrade between 1994 and 1997, and we replaced our second largest plant (Lilydale STP) in 1998. Both of these upgrades significantly reduced effluent nitrogen concentrations. However, as Figure 1 shows, YVW are likely to exceed the cap again in the future as growth in Melbourne's northern suburbs is expected to increase the amount of sewage treated by YVW. It is assumed in this graph that all major new growth areas have 100% recycling (to Class A standard) of their sewage flows.

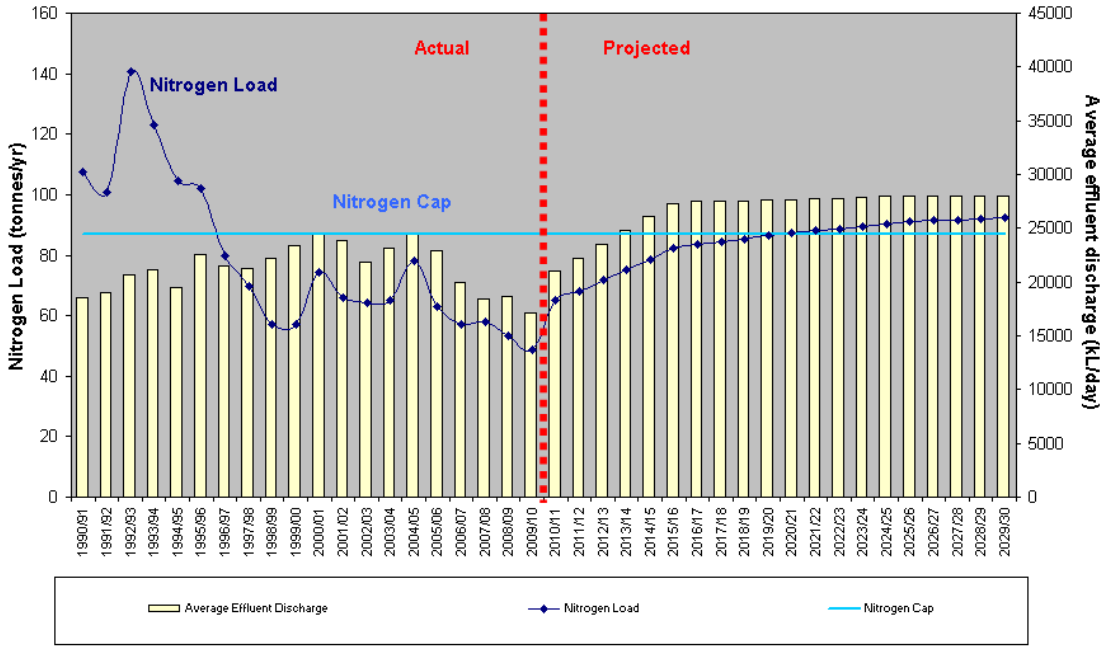

Figure 1: ***Expected growth in Yarra Valley Water's nitrogen discharges and nitrogen cap***

2.3 Nitrogen Reduction Investigations

Yarra Valley Water has undertaken a number of investigations to quantify the nitrogen reduction opportunities available. The most recent piece of work was completed in June 2010 (AWT 2010) to understand the opportunities available within our operations. The technically feasible nitrogen reduction options identified in the recent work are shown in Table 2.

Table 2: ***Nitrogen reduction options for Yarra Valley Water (AWT 2010)***

Source Control	Treatment Options	Nutrient Recovery
Trade Waste Agreements	Carbon Source Addition Conversion to the Bardenpho Process Barrier Filtration Options (MF, UF and RO) Filtration (with optional carbon source addition) • Sand Filters • Cloth Media Filters • Biological Aerated Filter (BAF)	Increased recycling Struvite recovery

	• Activated Carbon (AC) Filters Lentikats Porous Matrix Wet Air Oxidation (Zimpro process) Cannibal Activated Sludge Carbon Beds	

Notable exclusions from this table include treatment wetlands, which were excluded on a reliability basis and ozonation (excluded due to high upfront costs and scale).

These options were assessed for each of YVW's STPs. A Net Present Cost (NPC) analysis was carried out on the lowest cost options and each was assessed for its capacity to reduce nitrogen discharges. The results are shown in Table 3.

Table 3: ***Top 10 nitrogen reduction processes (treatment options) (AWT 2010)***

Location	Option	N Load Reduction (tonnes/yr) *	$NPC 20 years ($k)	$NPC/kg TN removed	% of YVW TN load
Brushy Creek	Carbon dosing at reactor	32.7	$4,013	$6	33%
Lilydale	5 Stage Bardenpho + carbon dosing	13.4	$2,062	$8	14%
Craigieburn	5 Stage Bardenpho + carbon dosing	9.5	$2,518	$13	10%
Brushy Creek	Carbon dosing at tertiary sand filter	32.7	$8,979	$14	33%
Brushy Creek	4 Stage Bardenpho + carbon dosing	37.0	$10,944	$15	38%
Craigieburn	Carbon dosing at tertiary sand filter	8.5	$3,129	$18	9%
Craigieburn	Lentikats Porous Matrix	5.9	$2,495	$21	6%
Brushy Creek	Lentikats Porous Matrix	23.1	$10,192	$22	24%
Upper Yarra	5 Stage Bardenpho + carbon dosing	4.2	$2,000	$24	4%
Monbulk	Carbon dosing at tertiary sand filter	0.14	$70	$25	0%

** N Load reduction is averaged over the next 20 years (until 2030). Significant population growth is forecast in YVW's business area which will generate higher sewage flows and greater nitrogen discharges (This means N load reduction figures are also higher).*

Plant optimisation was not costed in this table as it is difficult to identify costs and benefits available through this option. It is estimated that a nitrogen discharge reduction of up to 25% could be achieved by plant optimisation, at a low cost.

Water re-use options have been found to be cost prohibitive from a nitrogen reduction perspective. The costs are $300 to $600 per kg of nitrogen removed, which is much higher than the options presented above. There are also limitations on demand, meaning not all the available recycled water may be used under these scenarios. Recycling will continue to be implemented by YVW in response to customer demand or where dual pipe recycling is mandated.

Melbourne Water has established internal nitrogen targets similar to YVW's and has also been working to reduce nitrogen discharges in the Port Phillip Bay catchment. In order to achieve the Lowest Community Cost solution to reducing nitrogen discharge to Port Phillip Bay, YVW has benchmarked its nitrogen reduction projects against projects proposed by Melbourne Water.

Costs provided by Melbourne Water for these projects are shown in Table below. The costs include full construction and maintenance costs for these wetlands and therefore do not take any of the co-benefits (such as phosphorous reduction, flood peak attenuation, biodiversity benefits etc) into account. The figures contained in Table are also estimates and therefore should only be considered as indicative ball park figures.

Table 4: ***Melbourne Water nitrogen reduction projects***

Project Name	Location (Melways)	N Load Reduction (T/yr)	$NPV/kg TN removed
Hallam Valley Wetland	Hallam (91 D4)	2.1	$83
Olinda Creek Wetland	Yering (274 G9)	3.3	$84
Eley Rd Bioretention System	Burwood East (61 G5)	0.6	$113
Chandler Rd Wetland	Keysborough (89 F11)	0.8	$187
Banksia St Wetland	Eaglemont (32 C6)	0.4	$226
Banyule Swamp Wetland	Heidelberg (32 E2)	0.4	$332

2.4 Our Strategy

Yarra Valley Water intends to remain under the Nitrogen Cap at the lowest community cost. While YVW is currently well below its cap, we expect that we will breach the cap in the future.

As YVW is expected to have nitrogen reduction projects available in excess of what is required for us to remain under the Nitrogen Cap in the short to medium term, we can offer these to other parties with nitrogen targets. This could help to achieve both YVW's and Melbourne Water's environmental objectives at the Lowest Community Cost.

Therefore, YVW has been looking to use environmental offsets. Using offsets allows one party to meet their obligations by paying for action to be taken by another party. This can be external, e.g. YVW pays for Melbourne Water to reduce nitrogen discharges on their behalf, or internal, where YVW could meet its obligations at one site by carrying out alternative works at another YVW site.

We currently use offsets to achieve net zero greenhouse gas emissions. Our experience with this process has led YVW to pursue the development of offsets for other reasons. Offsets will allow the cost of nitrogen discharge reductions to be distributed evenly (i.e. at the Lowest Community Cost) and easily even if the available projects are not equally spread.

YVW is currently consulting with both EPA and Melbourne Water on the use of environmental offsets for our nitrogen discharges. YVW is aiming to develop a nitrogen offsetting framework with the EPA whereby EPA could potentially endorse increases in

future discharges of nitrogen at one site by offsetting these increases with equivalent reductions at other sites.
This will have implications for local mixing zones and these changes would have to be negotiated with the EPA. This paper is concerned only with discharges to Port Phillip Bay and therefore will not consider these issues in depth.

YVW would like to work with other stakeholders in the Port Phillip Bay catchment, including Melbourne Water, to develop the concept of nitrogen offsets further. We are working to establish a pilot offset trial to test this concept.

3.0 CONCLUSIONS

Nitrogen in Port Phillip Bay needs to be managed in the long term to ensure the environmental sustainability of the bay. The development of YVW's Nitrogen Cap is an important step in ensuring that YVW provides its services within the carrying capacity of nature.

YVW has enough projects available to provide significant benefits to Port Phillip Bay through the reduction of nitrogen discharges from its STPs, but requires a driver and available funding to carry out these projects. Other stakeholders within the Port Phillip Bay catchment may have further opportunities. Yarra Valley Water sees an opportunity for the water industry and all stakeholders in the Port Phillip Bay catchment to work together to achieve the required nitrogen reductions at the Lowest Community Cost.

YVW is currently consulting with both EPA and Melbourne Water on the use of environmental offsets for our nitrogen discharges. YVW is aiming to develop a nitrogen offsetting framework with the EPA, and the use of these offsets could include trading between Melbourne Water and YVW. We will develop a pilot study to investigate the use of nitrogen offsets in this scenario.

4.0 ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions of Chris Brace, Francis Pamminger and Hieu Dang in reviewing the content of this paper and providing suggestions and advice.
Melbourne Water have provided input and estimated costs to this paper.

5.0 REFERENCES

AWT, (2010). *Nutrient Budget Study, Yarra Valley Water, May 2010 – Final 2. Internal report for Yarra Valley Water*. AWT Australia Pty Ltd.

Harris, G, G. Bately, D. Fox, D. Hall, P. Jernakoff, R. Molloy, A. Marray, B.Newell, J. Parslow, G. Skyring and S. Walker. (1996). *Port Phillip Bay Environmental Study Final Report*. CSIRO, Canberra.