Second Australian Stream Management Conference
8-11 February 1999, Adelaide, South Australia

A Co-operative Approach to Improve Water Quality Tarago Reservoir Catchment Strategy

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SUMMARY: The Tarago Reservoir catchment supports a diverse range of commercial activities including forestry, dairying, beef farming, sheep grazing, deer farming and potato cropping. The quality of water entering the Reservoir is inferior to that of protected water supply catchments, the source of most of Melbourne's water supply. An evaluation of different management options was undertaken. A cost benefit analysis determined that a series of land improvement works would not only improve water quality but also benefit the farming community at large. A high adoption of improvement works have led to a reduction in nitrogen, phosphorus and turbidity levels. Water quality improvements have been effected by adopting a co-operative approach to improving land management practices with the local farming community. The Tarago approach has shown that where co-operation between the farming community and Government agencies occurs, a significant improvement in water quality and overall health of the catchment can be achieved.

1. INTRODUCTION

Melbourne Water is responsible for supplying bulk drinking water to three retail companies which in turn service 1.2 million households in the metropolitan area and surrounding regions. The water supply system which harvests water from 150,000 ha of predominantly forested land includes 13 major water storages. Eighty-eight per cent of water comes from closed protected forested catchments. Melbourne is one of the few cities in the world which has the privilege of harvesting water from protected catchments and consequently the water quality is of a very high standard. The 11,400 ha Tarago Reservoir catchment is located about 85 km east of Melbourne. About 2,800 ha of the catchment is agricultural land and the remaining 8,600 ha is forested (figure 1). As well as generating runoff into the 38,600 megalitre Tarago Reservoir for water supply, the catchment supports a diverse range of commercial activities including forestry, dairying, beef farming, sheep and deer grazing, and potato cropping.

Up until 1991, the Tarago Reservoir, which is owned and managed by Melbourne Water, was used to supply water (under a separate water supply authority) to the Mornington Peninsula and West Gippsland areas. The quality of water from the Tarago Reservoir catchment was noticeably lower than water from Melbourne Water's protected forested catchments. Water quality testing had identified that significant water quality degrade had occurred from the agricultural land. There was a blue-green algal bloom at the Reservoir in April 1991. Since September 1991, the Mornington Peninsula has mostly been supplied with alternative sources of water from protected catchments.

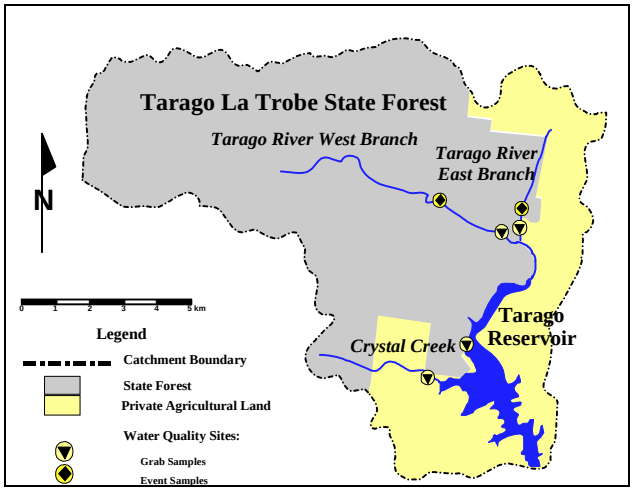

Figure 1: *Tarago Reservoir Catchment*

At present, Tarago Reservoir supplies only the township of Neerim South and bulk water consumers along the aqueduct. It is also used as a reserve for use in periods of extreme demand during dry spells in the Mornington Peninsula. The quality of water from the Reservoir has been improved by holding the water for longer periods and releasing only a small percentage of the Reservoir's total capacity. This allows suspended solids in the water to settle out, resulting in clearer and cleaner water. However, forecasts predict that in about 20 years time, the Tarago Reservoir will be required to progressively return to supply to meet the growing water demand on the Mornington Peninsula as part of Melbourne's water supply system.

For the water supply to meet the national standards (National Health and Medical Research Council, 1987) for drinking water quality, it will be necessary to build a water treatment plant at the Tarago Reservoir. An improvement in quality of the source water would reduce the capital expenditure for a treatment plant and reduce the future ongoing operational costs in running

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the treatment plant. In addition national drinking water guidelines advise that even though drinking water may be fully treated, water supply authorities should aim for maximum protection of the source water.

Melbourne Water is seeking to improve water quality coming from the catchment through an alternative broad-based approach that tackles the source of the problem at a number of levels: through co-operation with landholders, the local municipality and Government agencies. The objective of this co-operative approach is to reduce nutrient and sediment levels in the source water.

2. WATER QUALITY IMPROVEMENT

Evaluation of different management options included the following:

- acquisition and revegetation of privately owned land within the catchment;
- the construction of a diversion drain to intercept runoff from farmland;
- land improvement works, and improvements to land management practices.

The first two options were impractical on a cost benefit and political basis. It was determined that the third option involving a series of land improvement works would not only improve water quality but also benefit the farming community at large. Since 1992, Melbourne Water has been working with the local community to improve water quality in the Reservoir by employing an integrated range of solutions:

- a committee involving major stakeholders was formed to co-ordinate action in the catchment to reduce nutrients flowing into the Reservoir;
- a range of the works was identified and implemented to improve water quality;
- joint research ventures are being conducted in the catchment;
- water sampling and analysis has been done to assess the results of land management improvements.

3. FORMATION OF THE TARAGO RESERVOIR CATCHMENT STEERING COMMITTEE

The formation of the Tarago Reservoir Catchment Steering Committee was necessary to implement a land improvement program for the Tarago catchment to provide a wide platform of ideas and to encourage and enable local landholders to be involved in the process. The Steering Committee comprised the following:

i) landholders (farmers) in the catchment (3 representatives);
ii) the Department of Natural Resources and Environment (a Government body with statutory responsibilities for agriculture, conservation, and the management of Crown Land;
iii) Melbourne Water.

4. ROLE OF STEERING COMMITTEE

The Tarago Reservoir Catchment Steering Committee was formed to identify land and stream management improvements which could be implemented to enhance water quality and ensure that local landholders have genuine representation and input into the water quality improvement strategy.

The Tarago Reservoir Catchment Steering Committee had the following functions:

i) in co-operation with catchment landholders, identify land and stream management improvements which could be implemented to enhance water quality in the catchment;
ii) facilitate landholders' input into the land improvement program;
iii) implement an education strategy pertaining to water quality issues and landholders in the catchment;
iv) develop an agreed strategy and funding priorities for implementation of the land and stream improvements;
v) participate in Melbourne Water's water quality monitoring program;
vi) provide advice to the Catchment Management Authority on any changes required to the Special Area Plan as applied to the Tarago catchment.

5. WATER QUALITY MONITORING

There is an extensive water sampling and data collection program to determine the effectiveness of water quality improvement works. This sampling program includes grab samples taken around the catchment, fixed storm-activated sampling installations and portable sampling and analysis equipment in the catchment.

Melbourne Water has installed water sampling equipment on the East and West Branches of the Tarago River (figure 1). This equipment automatically collects a series of samples during high rainfall events. These are then tested in the laboratory for a range of water quality parameters. This enables the level of nutrient and sediment inflows to the Reservoir from the forested and agricultural areas to be compared.

Much of the work being undertaken by Melbourne Water in the Tarago catchment is contributing to

integrated catchment management practices, hence it is being keenly followed by property owners, Catchment Management Authorities, Government agencies and other water authorities.

6. WATER QUALITY DIFFERENTIAL BETWEEN AGRICULTURAL AND FORESTED COMPONENTS OF THE CATCHMENT

The Tarago catchment contains 8,600 ha of State Forest, managed by the State's forest department, and 2,800 ha of privately owned farmland. Melbourne Water controls and manages the Reservoir and its immediate environs. Water enters the Reservoir through a network of local creeks, but the major source is the Tarago River.

The Tarago River West Branch flows through the Tarago Latrobe State Forest and into the northern end of the Reservoir. The Tarago River East Branch collects runoff from private farmland and joins the Tarago River about 1.5 km upstream of the Reservoir.

Testing over the past 10 years has shown that water quality is consistently poorer in the East Branch flowing through the agricultural land than in the stretch of the Tarago River flowing through State Forest. The parameters tested include turbidity, apparent colour, nitrate and phosphorus. Event storm analyses over the past five years have shown that these values in the agricultural component of the catchment are approximately double those from the forested component of the catchment. It was thus identified that the agricultural catchment needed to be targeted for improvement works.

7. IMPROVEMENT WORKS

Some of the works that the Committee has identified to improve water quality in the agricultural component of the catchment are:

- fencing and revegetating stream banks;
- forming stream crossings for livestock and farm equipment;
- providing off-stream water such as dams or troughs;
- installing appropriate drainage on farm tracks and cow lanes;
- complying with Environmental Protection Authority regulations for the disposal of dairy effluent.

All farms with running water courses were targeted as a high priority for co-operative improvement works. There are 108 properties in the Tarago Reservoir catchment, 41 with running water courses (permanent and ephemeral). A Melbourne Water representative and a farmer representative from the Committee visited each property to identify works that would improve water quality, and at the same time improve farm productivity and increase the value of the farm. There is a widespread belief that the most important task in achieving a more sustainable agriculture is the raising of community awareness and changing of farmers' attitudes to their land. Heightened recognition of land degradation problems will have some influence on the social culture in which beliefs are formed, but will not itself bring about change in management practices. It has been shown that where profitable and practical conservation farming techniques and management strategies have been implemented then widespread or universal adoption can occur (Cary, 1992).

A report from North Carolina (Cook 1992) has demonstrated that where significant water quality problems occurred, farmers were keen to adopt new techniques when properly informed (through a major community education program) and when financial assistance, through cost sharing, was provided.

In Tarago, after potential improvement works had been identified and a plan decided upon (usually in association with a whole farm plan), an agreement was entered into between Melbourne Water and the farmer, identifying cost sharing arrangements and a maintenance plan. It has been shown that incentives should only be used if landholders understand the maintenance requirements and are motivated to practise sustainable land use throughout their catchment (Findlay, 1992). Funding guidelines had already been determined by the Committee. Funds were provided by Melbourne Water for half-cost fencing and up to 80% of the capital cost of structures such as creek crossings and culverts. The farmer's contribution included half-cost fencing, labour for planting and labour for maintenance.

Adoption was very high. Table 1 outlines the number of properties adopting water quality improvement works and maintenance plans. The success of the program is largely attributable to the enthusiasm of the farmer representatives, financial incentives from Melbourne Water, and the ownership by the farmers themselves for the improvement works, which they had to partially fund and fully maintain. These improvement works frequently added to the productivity of the farms in terms of ease of access, shelter and less pugging of stream verges.

Where the property owner did not wish to fence and revegetate the water course, the establishment of stream crossings and off-stream stock water was provided on a cost share basis. These simple elements greatly reduced the risk of livestock entering the streams, resulting in less erosion and a greater efficiency for grass filter strips to filter the water before entering the streams. Where no off-stream stock water and crossings

occurred, stock freely entered the streams causing erosion, nutrient (waste) infiltration and pugging of the grass adjacent to the streams, decreasing the efficiency of the grass to filter water.

Table 1. Number of Properties with Water Quality Improvement Works.

Number of properties with running water courses	41
Number of properties with water quality measures already in place	6
Number of properties with fencing, revegetation, crossings and off-stream water improvement works: 1993-1997	17
Number of properties with crossings and off-stream water improvement works: 1993-1997	12
Percentage properties adopting sound water quality measures	85%

Table 1 shows that 85% of farmers with running water courses on their properties have adopted sound water quality measures.

8. OUTCOMES OF IMPROVEMENT WORKS

The application of research was an important element in the implementation of the improvement works. The Co-operative Research Centre (CRC) for Catchment Hydrology has conducted a number of field experiments in the catchment and the research findings were applied on the individual farms. Dense grass filter strips were found to have sediment trapping efficiencies of greater than 95% for a relatively high intensity sediment source. Near natural riparian forest was found to have trapping efficiencies greater than 90% for a range of sediment laden inflows (Hairsine, 1996).

Preliminary findings from the sediment transfer study within the catchment has identified the bulk of sediment source is derived from surface erosion as opposed to gully erosion (Dyer 1996). The retention of grassed and vegetated filter strips fenced off from livestock helps to control surface erosion.

Grass filter strips and near-natural riparian vegetation have similar trapping effectiveness (MacKenzie & Hairsine, 1996) with the slightly reduced trapping effectiveness of the forest being balanced by the range of ecological functions of the forest.

The analysis of turbidity and apparent colour has provided an indication that land improvement works on farms are having a positive effect on water quality coming from these treated areas. In 1993 a number of tributaries of the Tarago River East Branch were sampled by Melbourne Water and analysed by Water Ecoscience for turbidity over a three month period before the implementation of full treatment on one of the tributaries, which included fencing, revegetation, formal creek crossings and the provision of off-stream water. Testing for turbidity was carried out for a further three months, comparing the treated tributary and the untreated tributary. The fully treated sub-catchment had a lowering in turbidity of 7.1 NTU over the two year study period compared with the untreated sub-catchments which had an increase of (on average) 20.1 NTU over the same period (refer to Figure 2). The

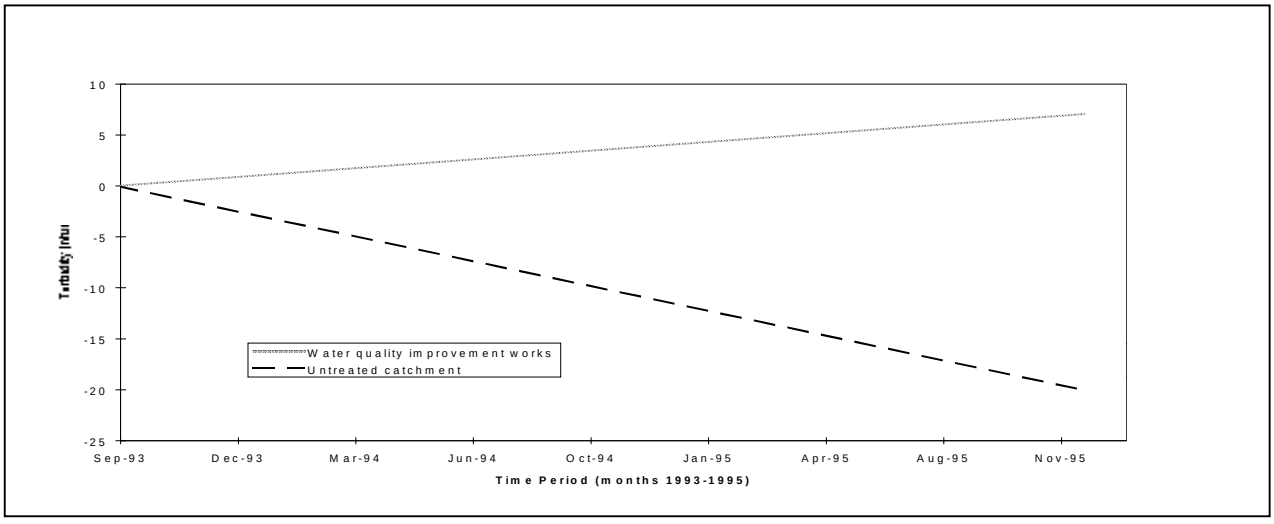

Figure 2: *Rate of Improvement in turbidity in sub-catchments where full implementation of improvement works has occurred.*

higher turbidity values for the untreated catchment may be attributed to higher than average rainfall over this period.

Initial results show that there has been a reduction in the concentration of nitrate in the East Tarago Branch since the improvement works in the agricultural catchment have been implemented. Figure 3 shows that the average level of nitrate during storm flow events has dropped from 1.18mg/L to 0.98mg/L after implementation of the improvement works, a reduction of 16.8%. In terms of total phosphorus, the average level had a decrease from 0.26mg/L to 0.19mg/L after implementation of the improvement works, a reduction of 28.1%. Additionally the peak influxes during storm events have been reduced from approximately 0.65mg/L to 0.30mg/L (refer to Figure 4), resulting in a reduction in total phosphorus loads in the Reservoir.
Reductions in nitrate and total phosphorus should lead to a reduction in the occurrence of blue-green algal blooms triggered by nutrient laden inflows. However blooms are likely to still occur when the prevailing conditions are conducive for blooms and there is a release of nutrients from the Reservoir sediments.

9. CURRENT RESEARCH

Melbourne Water is committed to improving water quality in the Tarago Reservoir. Participation in the Co-operative Research Centre for Catchment Hydrology provides an opportunity for Melbourne Water to co-operate with the Centre to research the means for developing effective and innovative ways of controlling the transfer of nutrients and sediment from land to watercourses.

The CRC is investigating the effectiveness of different types of buffer strips in reducing sediment and nutrient inflow to streams. Studies include:

- sediment/nutrient association;
- identification of sediment sources;
- response times and connection with the sediment store.

A current CRC project to determine sediment sources from forest roads and farm tracks within the catchment will be useful to aid road design to minimise sediment production during rainfall events in both the forested and agricultural areas. The CRC is also assessing

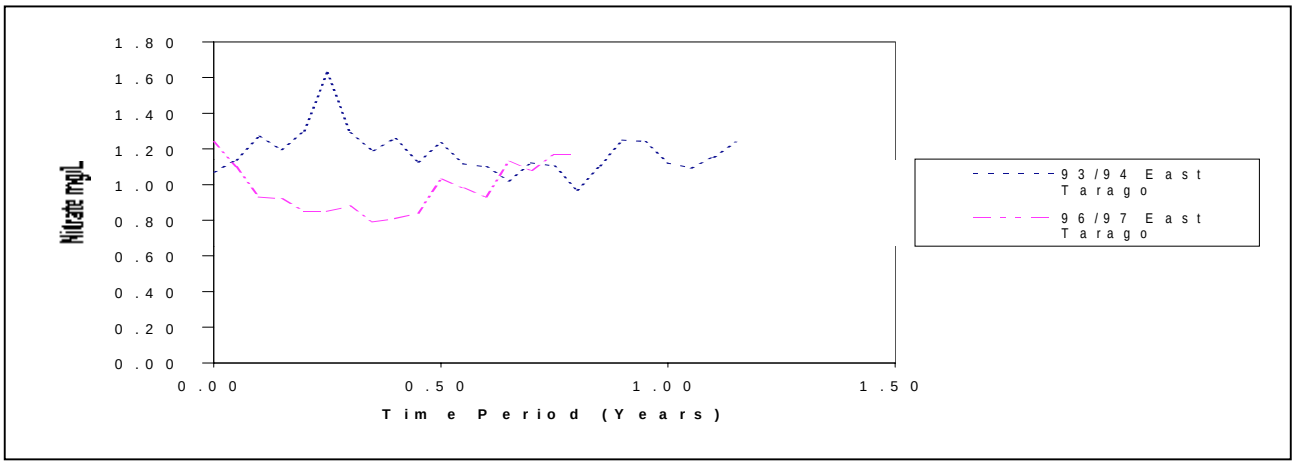

Figure 3: *East Tarago Nitrate Sampling for Storm Events Before and After Implementation of Water Quality*

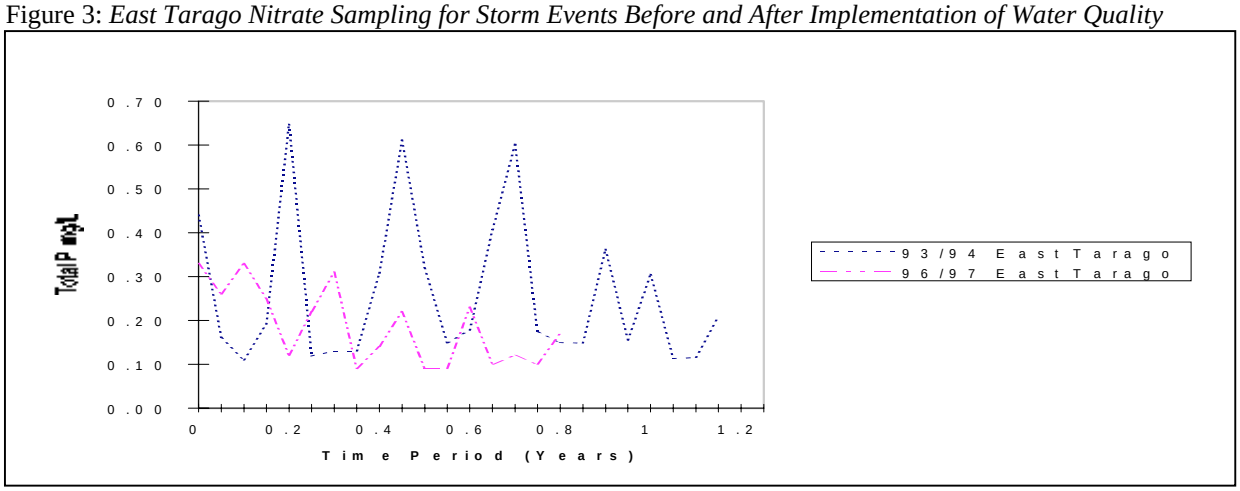

Figure 4: *East Tarago Total Phosphorus Sampling for Storm Events Before and After Implementation of Water Quality Improvement Works.*

sediment and nutrient levels during very high rainfall events using high volume sampling techniques.

Melbourne Water is also financially contributing to a Victoria University of Technology post graduate research project in the Tarago catchment. The project aims to develop a computer model simulating the relationship between rainfall, streamflow, land use and water quality. This model will be used to identify the sections of the catchment most urgently in need of rehabilitation and to estimate the effects of remedial land measures on water quality. The model will also enable Melbourne Water to carry out scenario studies.

10. CONCLUSION

Water quality improvements have been effected by adopting a co-operative approach to improving land management practices with the local farming community.

The Tarago approach has shown that where co-operation between the farming community and Government agencies occurs, a significant improvement in water quality and overall health of the catchment can be achieved. This is further enhanced by adopting best management practices based on scientific research. It is essential that all parties financially contribute to water quality improvement works, so that there is ownership of, and an ongoing commitment to, these works.

11. ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance of Melbourne Water and the Tarago Reservoir Catchment Steering Committee - Frank Lawless, Rod Pretty, Shirley Trenery, Ken White and Richard Habgood; Peter Hairsine for assistance through the Co-operative Research Centre for Catchment Hydrology; and Judy Ryan for editorial contributions.

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