CONTROL OF ALGAE IN POTABLE WATER SUPPLY – BEMM RIVER SHADECLOTH TRIAL

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ABSTRACT

Bemm River is a small coastal community located in East Gippsland. High numbers of algae have been consistently experienced in the Bemm River Storage Basin over a number of years. These occurrences resulted in taste and odour complaints as well as interfering with the effectiveness of the disinfection process. In 2000 East Gippsland Water initiated an innovative proactive response to the algae problems in Bemm River. Of the three growth limiting factors of algae - nitrogen, phosphorus and light – it was decided that light would be the easiest parameter to control. This control was achieved via the construction of a 95% UV blockout shadecloth structure covering the entire surface of the storage basin. Monitoring to date has shown an apparent decrease in algae numbers on a seasonal basis.

KEY WORDS

Algae, Taste and Odour, Shadecloth

1.0 INTRODUCTION

The Bemm River water reticulation scheme was installed between 1981 and 1983. The system consisted of a river offtake pump (Bemm River) and a 6.8ML clay lined, rock beached "turkey's nest" storage basin and a 3 km gravity supply main to the township of Bemm River. Not long after the completion of the scheme, the township experienced a gradual decline in industry and population (350 in 1975) for a variety of reasons. Currently there is around 170 people living in Bemm River (69 connections). The population peaks at ~400 during holiday seasons.

Detention time in the gravity supply main is about 4 days with possibly 5-6 days for customers at the extreme ends of the system. The detention time in the storage basin is also significant. Even conservatively estimating 70% of the storage to be available, and doubling the daily consumption rate, there is 120 days (4 months) of storage detention.

There was not a lot of raw water data available prior to 2000, as the historic monitoring program consisted mainly of quarterly sampling for basic physical-chemical parameters. From April 2000 a new monitoring program was implemented that increased the frequency of monitoring these parameters and in February 2001 an intensive monitoring program was instigated to assess the impact of the shadecloth cover.

Given the above information it is not hard to see how the Bemm River storage basin became an ideal environment for algae growth – low turnover time, sunlight and nutrients. This proved to be the case. Anecdotal evidence suggests high algae numbers occurring during the Summer months for many years. Whenever staff noticed a problem with the water (usually cloudiness or colour change) or earthy/musty taste and odour complaints triggered an investigation, an algae sample was taken and, if necessary, the storage basin was manually dosed with sodium hypochlorite.

During a discussion on the algae issue the suggestion of covering the storage basin was raised as a long term solution. The suggestion being based on the premise that the limiting factors for algae growth were, basically, nutrient availability and light. A cover would also limit the amount of windblown debris and access by birds. Limiting nutrients or treating the basin for nutrient removal were not viewed as viable options however limiting light availability was a feasible option. A

floating cover or a solid roof structure were dismissed as options due to inherent problems with both in terms of maintenance, possible bacterial growth, security, longevity and cost.

The concept of a shadecloth cover was raised as an off-the-cuff remark and ensuing discussions found merit in the idea. A surf of the Internet revealed a number of companies specialising in large shadecloth structures. Several of these companies were approached and asked for comment on the viability of the idea, both in terms of achieving the limiting light level as well as structural and economic feasibility.

1.1 Design of shade cloth cover

As the goal of the project seemed to be able to be realistically achieved, contract documents and specifications were drawn up and the works advertised. The following is a brief summary of the information provided to the tenderers:

Area to be covered: The horizontal area to be covered has been estimated from the existing plan as 2582 square metres. The shade cloth cover is to cover the basin including a 300mm strip beyond the top of the internal embankment.

Vertical clearance: The lowest point on the underside of the cover is to have a minimum vertical clearance above the full water level surface of 500mm and above the top of bank of 300mm. The top of bank level is RL 59.70 metres AHD and top water level is RL 59.15 metres AHD.

Shape of vertical section of cover: The Authority has a preference for a cover design which arches in a convex shape over the basin in order to promote shedding of bird droppings and leaves etc off the cover.

Seal between cover and top of bank: Contractor to provide in tender submission details of how the shade cloth cover is to be sealed between outside edge of cover and top of bank to prevent ingress of light, vermin and wind blown material.

Rock beaching: The rock beaching around the top of bank may have to be removed to prevent potentially harmful contact with the shade cloth.

Internal supports: It is proposed that the cover clear span the basin with no support columns or other structural elements in the basin.

Compliance with standards: Design and construction of the shade cloth cover is to comply with all relevant Australian Standards or where no Australian standard is available either USA or International standards.

Maintenance access below cover: Access by O&M staff for maintenance of the basin is to be provided in the shade cloth cover by allowing a section to be easily released and rolled back and then following maintenance work be reinstated by Authority's O&M staff.

Light exclusion: The shade cloth is to exclude a minimum of 98% of sunlight and have a minimum guaranteed life of 20 years.

The contract was awarded to Super Span Pty Ltd and works commenced in February 2001 and were completed in May 2001. Over the next 12 months there was some maintenance of the structure required as the shadecloth stretched more than was anticipated and some of the supporting poles had to be realigned.

The 'skirt' around the bottom of the structure also had to be reinstated as it had been weighted down with rock beaching and the movement of the structure had resulted in tearing of the shadecloth. A few other minor holes / tears also occurred where the shadecloth was in contact with some of the structures in and around the basin (level gauge board, concrete inlet pit) however these were all repaired with minimal fuss and effort.

2.0 DISCUSSION

An indication of the water quality of the Bemm River storage is shown in Table 1. The data presented in the table consists of samples taken either from Bemm River or from the Bemm River storage (both sites classified as raw / source water). As can be seen, the water quality is quite good – not too highly coloured or turbid, oxygenated and low levels of iron. The nutrient data was only gathered for 12 months and so it is unknown whether these are typical base levels or seasonally elevated.

Table 1 : ***Indication of Source Water Quality (1993 – 2002)***

Source Water	Average	STD Dev	No. of Samples
Dissolved Oxygen (mg/L)	9.52	0.91	206
Iron (mg/L)	0.40	0.14	6
pH (units)	7.13	0.38	149
Total Organic Carbon (mg/L)	2.66	0.87	91
Total Nitrogen (mg N/L)	0.34	0.06	100
Total Phosphorus (mg P/L)	0.014	0.009	101
True Colour (PCU)	33	13	134
Turbidity (NTU)	3.1	1.7	134
UV Ttransmission (%)	77.0	2.8	2

An intensive monitoring program was instigated in February 2001 and ran for 12 months. Biological, microbiological and physical-chemical parameters were monitored in the storage basin to determine whether (a) there was any affect on algae numbers and (b) there was any effect on water quality as a result of the installation of the shadecloth cover.

A series of siphon lines were installed to enable samples to be taken from the storage basin with minimal fuss and effort on the part of field staff. These lines were suspended from the floating arm offtake structure using weights and anchor lines and were positioned such that a sample could be taken from the bottom (~ 50 cm from the bottom), middle (~2m from the bottom) and surface (~ 30 cm from the surface) by simply turning on a tap. Note: at full supply the basin is 4.5m deep. The results of this study are shown below. Note that the data has not been analysed statistically, interpretation of results in based on 'eye-balling' of data and graphs. Viewing the data, there was little difference discernable between the bottom or surface samples in terms of overall values and trends of parameters – only the surface results are presented graphically in this paper.

From looking at the graphs presented below, it can be seen that there appears to have been minimal impact on the physical-chemical parameters by the installation of the shadecloth cover.

Figure 1 : ***Bemm River Storage Basin (Surface) – Nutrients and Total Organic Carbon***

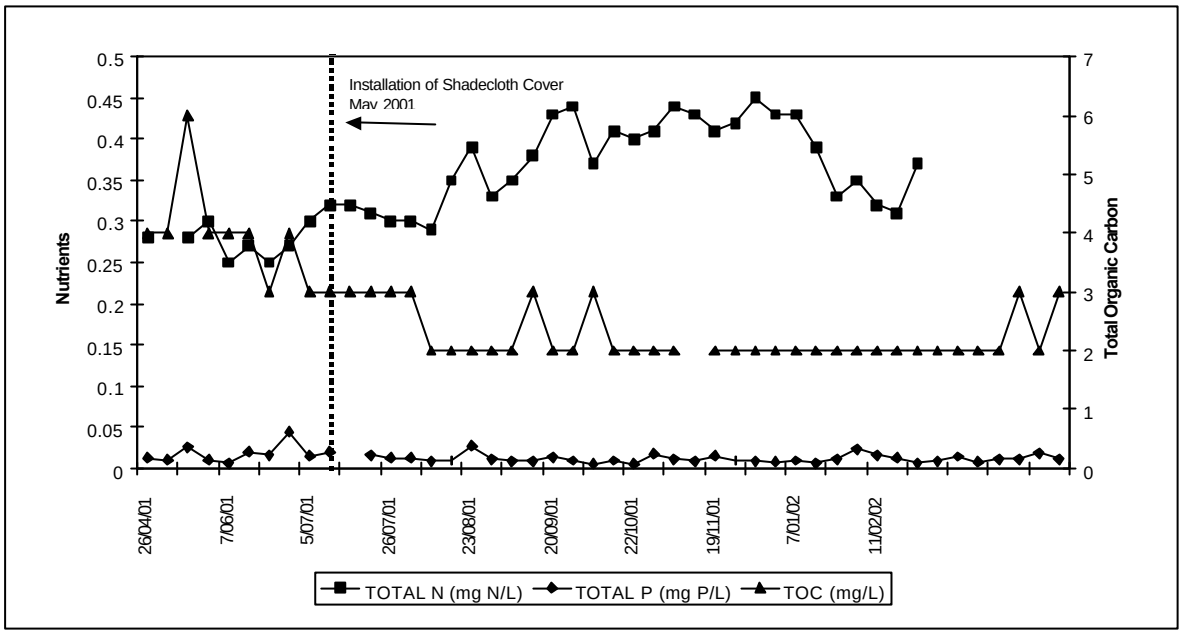
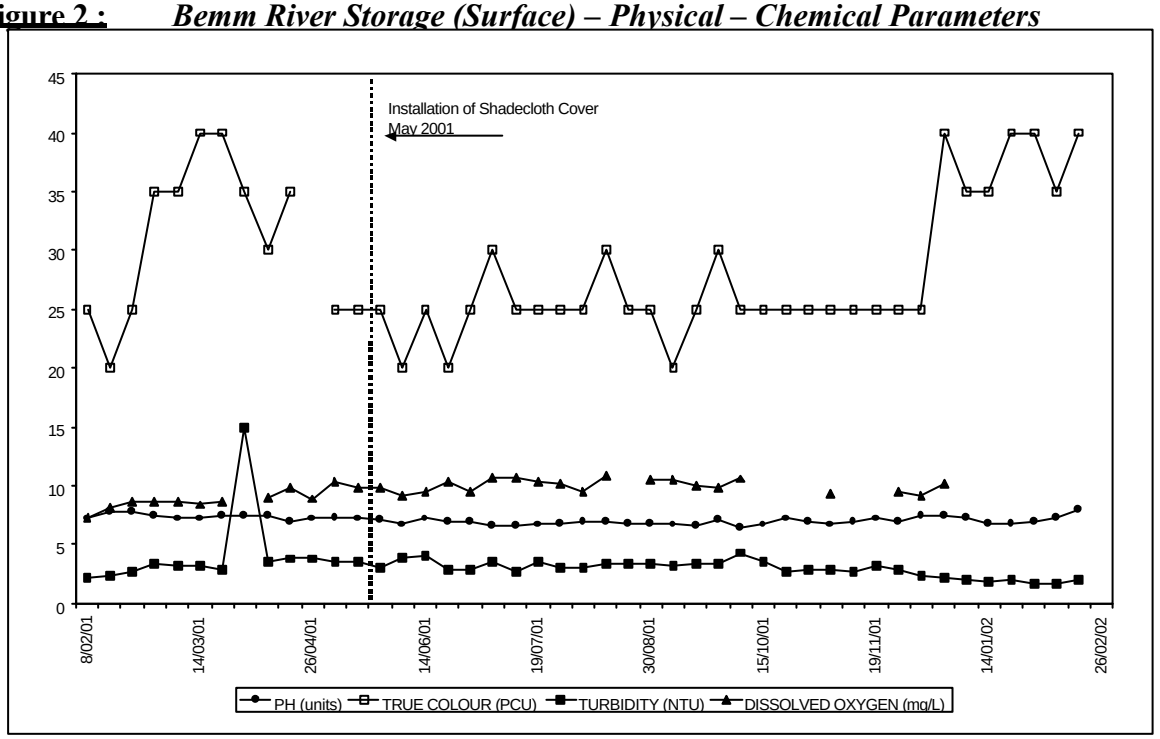


Figure 2 : ***Bemm River Storage (Surface) – Physical – Chemical Parameters***

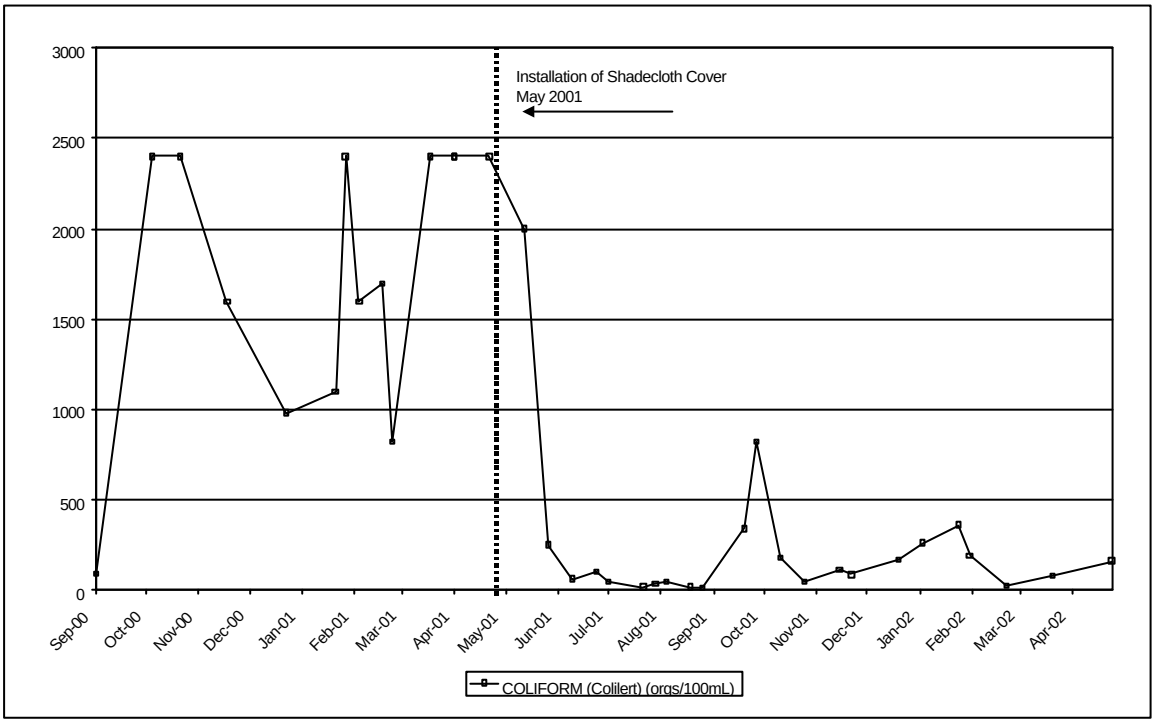


In terms of the impact on nutrients and total organic carbon for both the surface and bottom samples taken, there appears to be have been a decrease in the levels of total organic carbon since the installation of the shadecloth. This is assumed to be a reflection of the barrier to windblown dirt / debris into the storage basin. The total phosphorus levels appear to have been unaffected however the total nitrogen levels appear to be rising slightly.

Of the total nitrogen components analysed, the most significant increase was in oxidised nitrogen (NOx - nitrates and nitrites), sometimes referred to as 'available' nitrogen in terms of nitrogen required for plant growth.

As there is no historic nutrient data for this site it is not known whether this is a seasonal phenomena or whether it is in response to the decreased numbers of algae (see later discussion) – no algae / plant growth to remove available nutrients from the water column – or an increase in nitrogen levels as a result of decaying matter in the storage basin. However, a time series graph of total coliforms (refer Figure 3) as an indication of the bacterial load in the storage basin does support the theory that the dying algae did decompose and the consequent bacterial activity converted some of that biomass into available nitrogen which is now sitting there with very little biological activity present in the storage basin. With no further 'food' and minimal input into the storage as pumping from Bemm River occurs only 3 – 4 times per year, the bacterial load also decreased. Monitoring for both nutrients and total organic carbon is continuing on a monthly basis.

Figure 3 : ***Bemm River Storage – Total Coliforms***



Algae samples were taken from the surface (via the siphon line) on a fortnightly basis for 12 months. The analyses was qualitative and results were indicative of the abundance of algae present. In order to graph the results, an arbitrary numeric value was assigned to the results as follows:

Result	Interpretation	Value assigned
Rare	1 – 50 cells/mL	25 cells/mL
Occasional	50 – 500 cells/mL	250 cells/mL
Frequent	500 – 5000 cells/mL	2500 cells/mL
Common	5000 – 50000 cells/mL	25000 cells/mL
Abundant	> 50000 cells/mL	50000 cells/mL

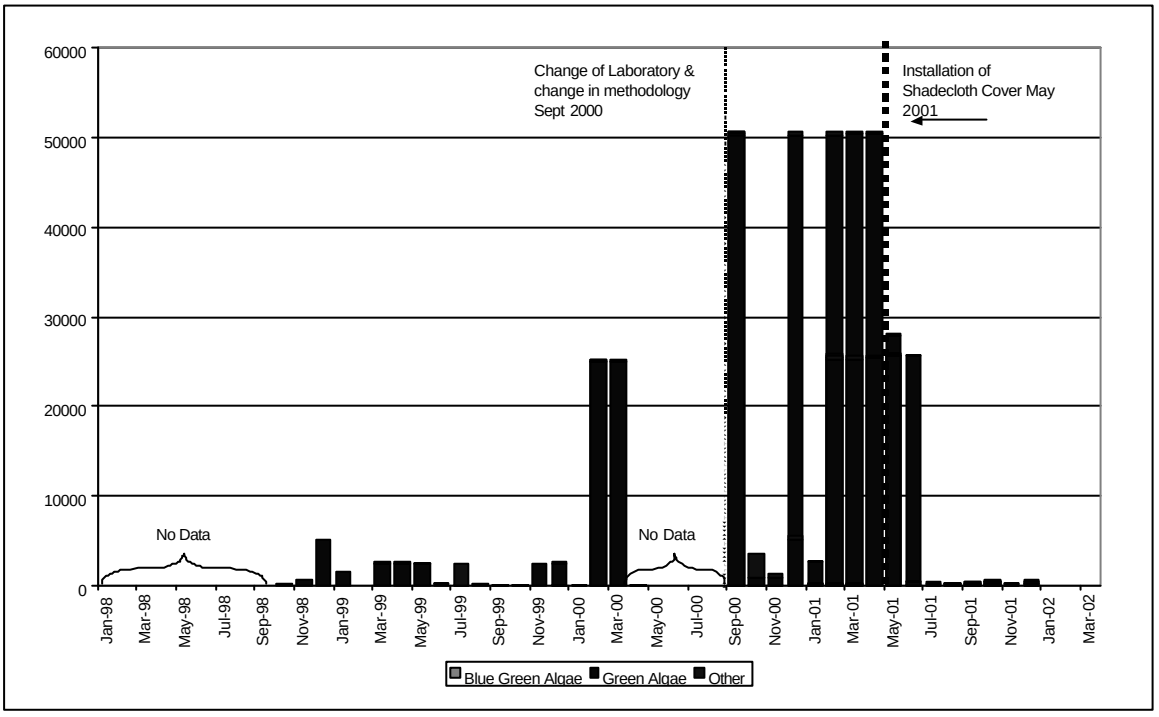
The algae species were then grouped into 'Green Algae', 'Blue-Green Algae' and 'Other', the latter category covering species such as diatoms, cryptomonads, synedra etc.

The values of the individual species were summed into their relevant categories for each month and then the three categories plotted as a stacked bar chart to present the overall abundance of algae in the storage basin. The figures shown on the Y axis are indicative of abundance only.

As mentioned earlier, there was no formal algal monitoring program prior to September 2000. This was also the time when there was a change in laboratory service providers. The two laboratories used different algae enumeration methods and so, strictly speaking, the data is not comparable. However, for the purposes of demonstrating the presence of algae historically, the results from the first laboratory were assigned a numeric value using the same logic as in the above table and added to the stacked bar chart. Most of the evidence for algae presence / blooms is anecdotal from both the local community and the field staff – there was very little formal sampling undertaken prior to 1998.

The available algae data – historic and from the 12 month monitoring program – is presented below:

Figure 4 : ***Bemm River Storage – Algae Data***



From the available data it appears that the installation of the shadecloth cover resulted in a decrease in algae numbers and frequency of occurrence. This is also supported by the nutrient and bacterial levels as discussed earlier. Monthly monitoring is continuing to confirm that this decrease in algae numbers is real and permanent and not a reflection of a poor Summer season.

3.0 CONSTRUCTION OF SHADECLOTH COVER

The construction of a shadecloth cover over a potable water storage attracted media interest with two articles published in the The Age *"A Shade Over The Top? For Sure"* (09/07/01) and Weekly Times *"Covering up keeps it clean"* (31/10/01).

Super Span Pty Ltd also won First Prize in the 2002 ASCASPA (Australian Canvas and Synthetic Products Association Inc) Awards for a Tension Structure (Shadecloth).

The following are some photos taken before and during construction of the structure in order to give you some appreciation of the task undertaken by East Gippsland Water and Super Span Pty Ltd:

Arrival of shadecloth on site

Pulling the shadecloth across the basin

Birds-eye view of tensioning the structure

The Super Span team demonstrating the strength of the structure!

Finished Structure!

4.0 CONCLUSION

The aim of this project was to limit (or eliminate) algae growth in the Bemm River Storage Basin and the data to date has shown that this aim has been achieved in that the levels of algae numbers has decreased and appears to be remaining low.

In terms of the effect of the shadecloth cover on other parameters in the storage basin, there has been little effect on physical-chemical parameters however there appears to have been an increase in total nitrogen levels within the basin.

The overall value of total nitrogen is still low but this situation will continue to be monitored to determine whether this increase is as a result of the die off of algae and whether the levels will change (increase / decrease) or reach a plateau over time.

Another positive aspect of the shadecloth cover is the potential increase in efficiency of disinfection – there is now little or no algae present in the water to provide a 'mask' for bacteria to avoid disinfection and, from the microbiological load (in terms of total coliform data), there are less bacteria to deal with.

5.0 ACKNOWLEDGEMENTS

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