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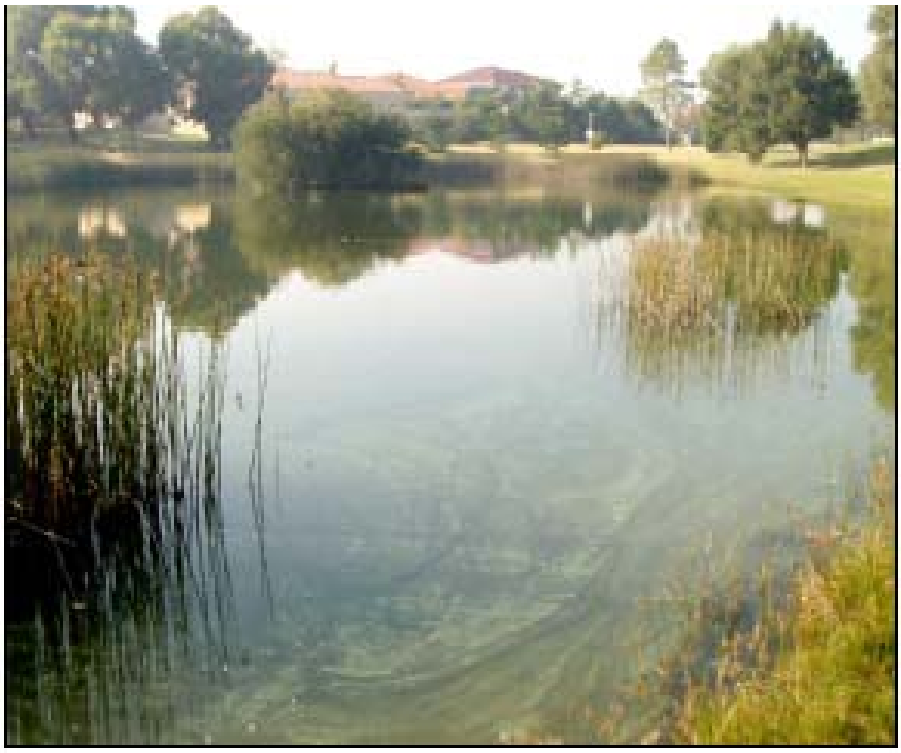

Urban Lakes Water Quality Management Report Broadbeach Park Lake No. 2

City of Joondalup

20 SEPTEMBER 2005
Reference C453
Revision 1

Connell Wagner

5. Management Options

5.1 General

Inputs of fertilisers and recycling of nutrients have led to elevated phosphorus concentrations within the lake waters. Measurements of lake water quality (see Table 4.8) indicate that total phosphorus ranged from 10 - 560 µg/L over the period of November 2000 to May 2005. Plant available phosphorus stored within the lake sediments was seen to vary from 120 - 900 mg/kg from 19 samples taken in May 2005.

Given these large storages of phosphorus and high (eutrophic) levels of lake water concentrations, effective management will need to be employed to reduce the likelihood of an algal bloom in 2005/2006.

The following methods (or combination of methods) are proposed for assessment.

1. Catchment management
- Reduction in nutrient loading to urban lawns and gardens
- Removal of parkland lawn clippings

2. Lake biology management
- Reduction in water fowl numbers and feeding
- Removal of fish (carp)

3. Chemical and other control
- Removal of existing lake sediments
- Chemical dosing with aluminium sulfate
- Addition of barley straw for algal control

Each of these options are summarised in terms of technological advantage. Where possible items 1 and 2 above should have defined involvement of the community to add to effectiveness of the management of the lake.

5.2 Catchment Management

5.2.1 Reduction in nutrient loading to urban lawns and gardens

The responses of the survey to rates of fertiliser application could not be used to indicate potential Phosphorus or Nitrogen loading to Broadbeach Park Lake No. 2.

The total input of phosphorous from fertilisers can be estimated by assuming that each household applies about 20 kg of fertiliser per year and assuming a phosphorus content of 6%. For an estimated 250 households, this gives an estimate of 300 kg of Phosphorus per year applied to lawns and gardens. If only 1% of this fertiliser was washed into the lake inflow water, this would amount to 6 kg/yr. It is important to note that this is of the same order as estimated inputs from waterfowl and fish and is equivalent to the estimated storage within the lake sediments and water.

In view of the larger apparent variation in application rates it is recommended that the City of Joondalup undertake an effective education program to provide residents with information regarding fertiliser application rates and timing to minimise loss of nutrients by runoff as groundwater flow. It should also be noted that reproduction of fertiliser manufacturers data sheets and recommendations may not be appropriate because of their interests in maximising sale of their product. The 'fertiliser use awareness' program could be in the form of a letterbox drop together with an information stall/display at the council offices, or by a more proactive series of meetings.

Table 5.1 Summarised table of *Horticulture & Turf Diagnostic Services* laboratory results. See Appendix D for complete results.

Sample Date	Nitrite (mg/L)	Nitrate (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Ammonia (mg/L)	pH	Dissolved Oxygen (mg/L)	Temperature °C	Total Dissolved Oxygen (mg/L)	Electrical Conductivity (mS/cm)
Nov-00	<0.1	<0.1	0.04	1.3	<0.01	10.07	6.2	25.2	241	0.5
Feb-01	<0.1	<0.1	0.02	1.4	0.04	10.03	6	20.7	398	0.79
May-01	<0.1	<0.1	0.01	0.88	0.04	8.89	8.2	15.6	390	0.74
Aug-01	<0.1	<0.1	0.03	0.55	0.08	7.16	7.2	14.7	96	0.18
Nov-01	<0.1	<0.1	0.03	0.19	0.28	9.75	8.5	24.1	205	0.39
Feb-02	<0.1	<0.1	0.03	1.2	0.04	9.5	8.5	21.7	343	0.65
May-02	<0.1	<0.1	0.56	0.8	0.19	9.12	10	17.8	240	0.39
Aug-02	<0.05	<0.05	0.01	0.6	0.07	9.32	9.1	14.1	163	0.31
Nov-02	<0.05	<0.05	0.06	1.4	0.11	9.5	9.4	24.2	232	0.44
Feb-03	-	-	-	-	-	9.34	7.1	26.3	330	0.64
May-03	<0.05	<0.05	0.08	1.5	0.04	8.96	6.5	16.4	273	0.5
Aug-03	<0.05	<0.05	0.04	0.3	<0.01	8.77	9.4	14.8	125	0.25
Nov-03	<0.05	0.9	0.04	2.1	0.2	8.05	10	22.6	345	0.67
Feb-04	<0.05	<0.05	0.03	1.6	<0.05	8.85	7.4	25.7	435	0.84
May-04	<0.05	<0.05	0.05	1.4	<0.05	7.96	6.3	16.8	408	0.79
Aug-04	<0.05	<0.05	0.08	3.4	0.17	8.71	10.1	13.9	242	0.47
Nov-04	<0.05	0.7	0.08	5.8	<0.05	8.35	12.3	23	351	0.68
May-05	<0.05	0.11	0.4	<0.05	<0.05	-	-	-	-	-

5.2.2 Removal of parkland lawn clippings

All lawn clippings should be removed (along with animal droppings and other sources of nutrients) by the parkland maintenance personnel to prevent recycling of nutrients from the decomposing wastes.

5.3 Lake Biology Management

5.3.1 Remediation in waterfowl numbers

Waterfowl can provide a significant source of nutrients (phosphorus) to the lake in terms of them

- being fed household scraps
- importing nutrients via their droppings

The birds, particularly ducks, may release phosphorus containing sediments to the lake water sediments during their extensive foraging activities.

It is possible to determine the contribution of waterfowl contribution to phosphorus loading to the lake. If we assume there are on average 20 resident waterfowl that contribute 100 g of droppings daily each, then the total annual generation of droppings in the lake would be about 730 kg of which about 10 kg would be elemental phosphorus. Additionally, waterfowl stir up the lake sediments further introducing nutrients to the water column for algal adsorption.

Reduction in the numbers or waterfowl would occur by reducing feeding by residents and visitors to the lake. It is unlikely that the birdlife would totally abandon the lake, however, the residents must consider the down side of their presence.

5.3.2 Removal of exotic fish

In a similar vein, the carp or 'koi' are notorious bottom feeders and can contribute significantly to the lakes nutrient accretion by eating of insects, and household scraps when fed by the residents. Depending on the number of fish (and some of them are very large) they could contribute of the same order of phosphorus as the waterfowl. Given that this species is declared noxious in other states, the City of Joondalup should remove all fish from Broadbeach Park Lake No. 2.

5.4 Chemical and other controls

5.4.1 Removal of existing lake sediments

Removal of the lake sediments can be effected by suction dredging the lake (without removing the water). Sediments would be pumped into disposable or reusable bags for removal by trucks to be disposed of at a landfill or reused as a nutrient source. The total volume of sediments to be removed would amount to between 1,500m^3 and 2,500m^3 (50% water by volume) which would contain approximately 10-15 kg of phosphorus.

This would remove the built up phosphorus sediment source which contributes to algal blooms when released.

5.4.2 Chemical dosing with aluminium sulfate

Aluminium sulfate is used to reduce the amount of phosphate in the water, and by limiting the availability of the nutrient for phosphorus production.

Phosphorus is released from the lake sediments under anoxic conditions when oxygen is depleted from the lower layers.

Dosing rates are in the order of 15 mg/L (AL^{3+}) (Kennedy and Cooke 1982). For Broadbeach Park Lake No. 2 having a storage volume of 4,000 m^3, 60 kg of aluminium would be required (1,500L at

10% by weight as $Al_2[SO_4]_3$). This would be applied, sprayed onto the lake surface by hose using the Joondalup boat or, by pumping into a pressure hose to cover the lake area.

5.4.3 Addition of Barley Straw

Recently, baled barley straw has been seen to be effective in reducing the amount of algal growth in lakes. The reader is referred to fact sheets published by Ohio State University (Lynch 2005) and the University of Nebraska-Lincoln (Holtz 2000). Numerous researchers are promoting the use of barley straw since it is not known to have toxic effects on rooted vegetation, zooplankton or insect larvae.

In the case of Broadbeach Park Lake No. 2 barley straw may be a highly cost effective way to prevent algal blooms, particularly following longer term build up of sediment prior to its removal. The amount of straw required per square metre of lake surface is 0.05 to 0.1 kg. For Broadbeach Park Lake No. 2 with a surface area of approximately 3,000m^2, 10-20 bales (150-300kg) of straw would be sufficient for treatment.

A source of barley straw should be located or created in Western Australia, and trialed for effectiveness in controlling algae. If effective the treatment could have an extensive cost effective benefit in managing Perth's urban lakes.

5.5 Lake Management Schedule

The schedule for management of Broadbeach Park Lake No. 2 is given as follows:

Action	Date
Community Consultation	Late September
Removal of Lake Sediments	Early October
Aluminium Sulfate Dosing	Early-Mid October
On-going Monitoring and Assessment	October - January