Environment Bay of Plenty

A Statement of the Significance of Phosphorus and Nitrogen in the Management of Lakes Rotorua/Rotoiti

January 2004

1 This statement is the collective thoughts of a Technical Advisory Group (TAG) established by Environment Bay of Plenty and Rotorua District Council to assess technical aspects of lakes research. It aims to present a scientific view on the significance of phosphorus and nitrogen to the current condition of lakes Rotorua and Rotoiti.

2 From the early 1960's the water quality of Lake Rotorua deteriorated because of excessive phytoplankton growths caused principally by increased inputs of phosphorus and nitrogen.

3 The outflow from Lake Rotorua penetrates into Lake Rotoiti and has caused a deterioration of water quality in Lake Rotoiti. It is estimated that 73% of the nitrogen load and 76% of the phosphorus load to Lake Rotoiti comes from Lake Rotorua via the Ohau Channel.

4 Phosphorus and nitrogen enrichment is not considered to cause excessive growths of introduced aquatic macrophytes (oxygen weeds) in Lake Rotorua. Indeed, lake management aimed at reducing phytoplankton growths and improving water clarity in Lake Rotorua may cause the present macrophyte beds to become more vigorous and expand in area. Established procedures are available to deal with such problems.

5 During the 1980s nutrient inputs from the sewage treatment plant increased significantly and contributed to the water quality problems.

6 Sewage diversion in 1991 was followed, in 1993-5, by significant improvements in Lake Rotorua's water clarity and nutrient and chlorophyll concentrations, but since then lake water quality has again deteriorated.

7 When the decision was made to divert sewage away from the lake it was believed that control measures put in place through the Kaituna Catchment Control Scheme would reduce catchment nutrient loads. These control measures have reduced the inputs of

sediment, total phosphorus and particulate nitrogen, but have not controlled nitrate inputs.

8 A linear trend of increasing mean baseflow nitrate concentration, from 1968 – 2002, has recently been identified in 8 of the 9 major streams. Some evidence of increasing baseflow nitrate concentrations in the Ngongotaha Stream was found in an earlier study (Williamson et al. 1996) but there is now evidence that the trend is widespread throughout the Rotorua catchment and shows no evidence of abatement.

9 Recent work in the Lake Taupo catchment shows a trend of increasing nitrate concentrations in streams draining catchments on the northern and western sides of the lake. It is believed that nitrate generated 30 – 70 years ago following land clearance may contribute to this increase via deep groundwater. It seems likely that similar land-use/groundwater linkages operate in the Rotorua catchment. Preliminary age data has indicated groundwater feeding the lake and streams in the Rotorua catchment is in the order of 50 – 100 years old. These ages may vary throughout the catchment.

10 The total stream nitrogen load is currently approximately 250 t-N/y higher than the target load for streams, established in the 1980s. Sewage nitrogen loads were high during the 1980s but currently comply with the target load for sewage. In terms of nitrogen loads to the lake, the benefits from sewage diversion have been negated by the increases in nitrogen load in streams. The majority is associated with increasing nitrate concentrations in streams draining agricultural land.

11 In marked contrast to nitrate, there is no evidence of a trend in baseflow soluble phosphorus concentrations in the major streams of the Rotorua catchment. Stream phosphorus loads currently comply with the target load for streams. Sewage phosphorus loads were high during the 1980s but currently comply with the assigned target load.

12 Internal nutrient loads (viz., nutrient releases from the lakebed) also contribute to continued poor lake water quality and are likely to delay recovery even when external nutrient loads (viz., from sewage and/or the catchment) are reduced.

13 In 1992 – 1993 bioassay studies showed that the level of phosphorus in Lake Rotorua was in excess of that required to support the phytoplankton biomass at that time. This indicates that, following sewage diversion, phosphorus was unlikely to have been a limiting nutrient for phytoplankton growth. Bioassays in the 1970s and 1980s consistently gave the same result. This bioassay work is currently being repeated.

14 Reduction of nitrogen and phosphorus inputs should be undertaken concurrently.

15 Reduction of phosphorus inputs alone may produce no measurable improvement in lake conditions unless phosphorus can be made the limiting nutrient. Currently the phosphorus concentration in the lake averages 40 mg/m^3 and would need to be reduced to approximately 15 mg/m^3 to become limiting. To achieve this, phosphorus inputs from the catchment and sediment would need to be reduced by approximately 50%. The ability to reduce the sediment releases of nutrients is currently uncertain but needs continuing investigation.

16 The collective view is that nitrogen is driving phytoplankton productivity and therefore needs to be targeted if the community is to see water quality improvements in the medium term (10 – 20 years). Dependent on actions taken for Lake Rotoiti, improvements in that lake could occur more quickly.

17 The primary objective should be to reduce the concentrations of nitrogen and phosphorus in the lake water to the point where they limit the productivity of phytoplankton. This will require

- (i) reducing the nitrogen and phosphorus inputs from the catchment, and possibly
- (ii) intervention to reduce nutrient releases from the lake bed.

18 A secondary objective should be to prevent the algal population becoming dominated by undesirable blue-green algae by maintaining a high N:P ratio, together with low nitrogen and phosphorus concentrations, in the lake water.

19 In Environment Bay of Plenty's Proposed Regional Water and Land Plan, the water quality target, is based on restoring lake conditions to those of the 1960's, before there was a wide spread public issue with phytoplankton blooms. The scientific view is that as a result of the increased nitrogen input from the catchment there is a risk that:

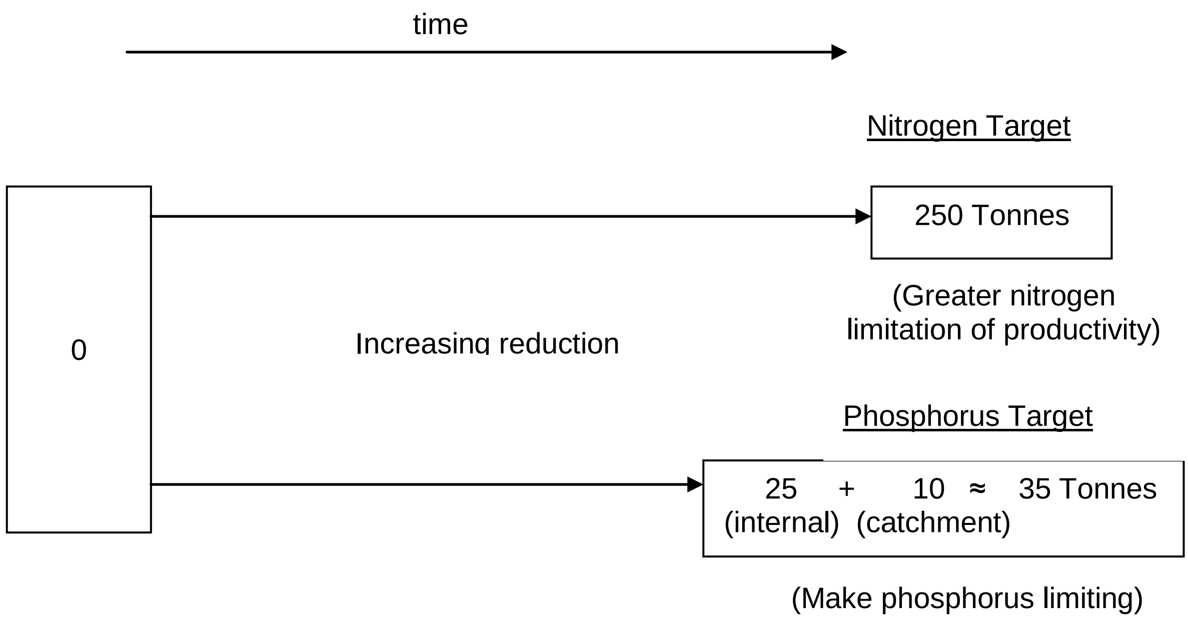
- (i) There will be an increased frequency of occurrence of nuisance algal blooms in lakes Rotorua and Rotoiti.
- (ii) Lake water clarity will decline.
- (iii) There will be increased periods of de-oxygenation of the bottom waters of the lakes and associated increased releases of phosphorus and nitrogen from the lake sediments.

20 Total nitrogen loads would need to be reduced by approximately 250 t-N/y to comply with the target load (established in the 1980's) considered likely to restore lake water quality to that which prevailed in the 1960s. However, the actual load may increase over time as a result of the increasing trend in stream nitrate concentration.

21 To achieve the required nutrient reduction targets, a mix of options will be required. The options for Lake Rotorua are likely to focus on catchment activities although control of in-lake sediment releases may also be possible. Options for Lake Rotoiti are more likely to involve adaptive management including such options as, groynes into Lake Rotorua around the Ohau Channel intake, diversion of the Ohau Channel and oxygenation.

22 It is recommended that the easily identifiable high nutrient load sources be targeted as an early action (1 – 2 years), while land use change/land use management options are evaluated over a longer time scale (2 - 3 years).

23 The following outlines the nutrient reduction target options.



Notes:

(i) *It is uncertain whether phosphorus could be driven low enough to limit productivity.*

(ii) *Major efforts are currently required to control productivity by reducing nitrogen.*

(iii) *A minimum N:P ratio of 10:1 for the catchment inputs should be a guideline.*

(iv) *Partial reduction of the non-limiting nutrient, which is currently believed to be phosphorus, will have little or no immediate effect in reducing productivity. The target for the limiting nutrient needs to be adhered to in order to reduce productivity, while concurrently reducing the non-limiting nutrient.*

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