Appendix F

VOLLENWEIDER MODEL

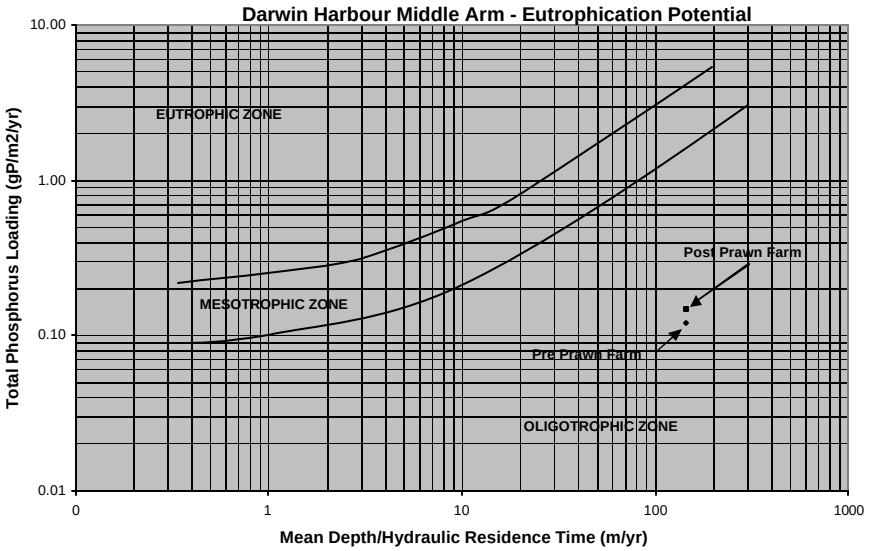
The Vollenweider Model is a useful tool in determining the trophic state of a water body based on phosphorus loading (P-loading) and the water depth. The model was originally developed for application to deep, glacial lakes located in the northern hemisphere (Vollenweider, 1968). More recent reports indicate that the model has application for developing an appreciation of the trophic state of more dynamic systems in Australia such as river reaches, wetlands, impoundments (Harris, 2001) and dams (Kinhill, 1993).

The extent of P-loading in Darwin Harbour for 2003-2004 has been estimated at 120,000 kg P/year (NPI, 2005) and this figure was applied to an area of 998 km^2 (Peerzada and Ryan, 1987). The area of the Middle Arm was calculated area to be 50.6 km^2 with a mean depth of 5.5 m (Wilson, Padovan and Townsend, 2004) and calculated residence time of 20-30 days (Williams, pers. comm.)

The P-loading contribution of the prawn farm was calculated as 1312 kg P/year from a maximum discharge volume of 16,395 ML/year and a mean total phosphorous concentration of 0.08 mg P/L.

The Eutrophication Potential assessment for the Middle Arm of Darwin Harbour has been developed based upon the following assumptions:

- The current P loading in Darwin Harbour is distributed uniformly throughout Darwin Harbour
- The current P loading of Darwin Harbour is applicable to an area of 998 km^2
- The Middle Arm has an area of 50.6 km^2
- P loading due to the Prawn Farm will be 1312 kg P/year
- P loading due to the Prawn Farm will be distributed within the Middle Arm only
- Phytoplankton growth in the Middle Arm is P-limited
- The mean depth of water in the Middle Arm is 5.5m
- The residence time of water in the Middle Arm is 30 days
- Complete flushing of the Middle Arm is effected in one residence time
- There is no internal P loading from sediments.



The effect of increase P-loading in the Middle Arm due to additional input from the prawn farm is minimal (Figure above). Even with the introduction of the prawn farm and assuming that all effluent produced by the prawn farm is contained within the Middle Arm, the system is likely to remain in an oligotrophic state and the potential for eutrophication is very low.

References

Harris, G., 2001, A Nutrient Dynamics Model for Australian Waterways, Land Use, Catchment Biogeochemistry and Water Quality in Australian Rivers, Lakes and Estuaries, Australia State of the Environment Technical Paper Series (Inland Waters), Series 2.

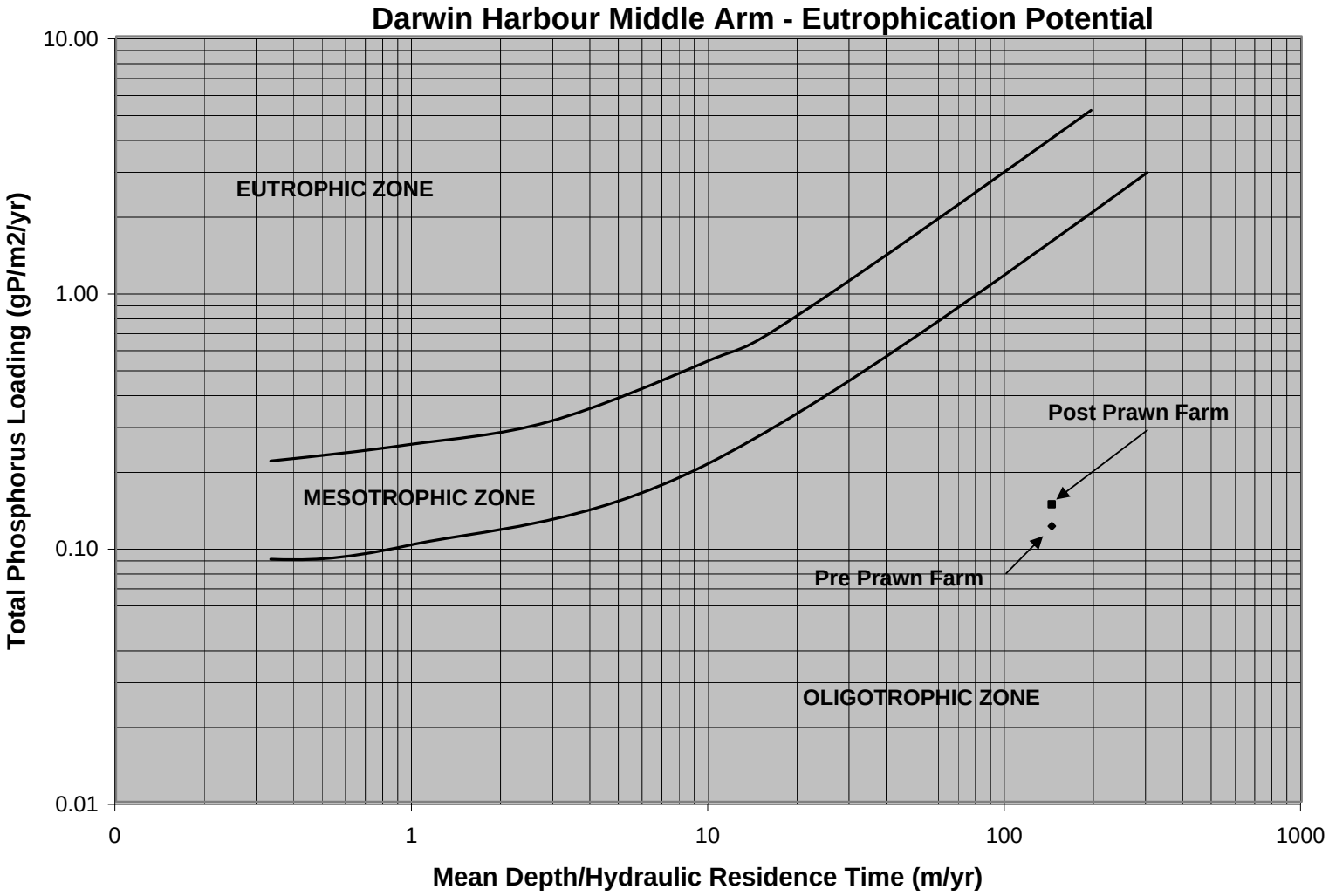
Kinhill, 1993, Grahamstown Dam Augmentation, Environmental Impact Statement, Report prepared for the Hunter Water Corporation.

National Pollutant Inventory, 2005, NPI location report - All sources: Darwin Harbour and Surrounding Catchments, NT Catchments, 2003-2004.

Peerzada N. and Ryan P., 1987, Determination of Pb, Zn, Cu and Cd in Darwin Harbour, Marine Pollution Bulletin, Vol 18, No 8 pp 458-461.

Vollenweider, R. 1968, Scientific Fundamentals of the Eutrophication of Lakes and Flowing waters with particular reference to Nitrogen and Phosphorus and factors in Eutrophication, Organ. Econ. Coop. Dev. Paris Report M. DAS/CSI/68.27. 1968.

Wilson D., Padovan A. and Townsend S., 2004, The Water Quality of Spring and Neap Tidal Cycles in the Middle Arm of Darwin Harbour during the Dry Season. Report 41/2004D, Northern Territory Government.


Darwin Harbour Middle Arm - Eutrophication Potential
10.00
1.00
0.10
0.01
Total Phosphorus Loading (gP/m2/yr)
EUTROPHIC ZONE
MESOTROPHIC ZONE
OLIGOTROPHIC ZONE
Post Prawn Farm
Pre Prawn Farm
0
1
10
100
1000
Mean Depth/Hydraulic Residence Time (m/yr)