Comparing the performance of a High Rate Algal Pond with a Waste Stabilisation Pond in rural South Australia

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Early Sanitation:- Latrines inside Housesteads Fort, Hadrians Wall. Northumberland, UK – circa 124 A.D.

CONTENTS

ABSTRACT

This study compares the performance of two natural wastewater treatment systems; waste stabilisation ponds (WSP) and High Rate Algal Ponds (HRAP) in rural South Australia. The systems were located in similar geographic and climatic zones, East North East of Adelaide.

The WSP treated the domestic wastewater from the township of Lyndoch, with an approximate population of 1,750 inhabitants, and daily treatment plant influent of 165 kL. The HRAP treated domestic wastewater from the smaller township of Kingston-on-Murray, with an approximate population of 140 producing daily treatment plant influent of 12 kL. All households in both townships had domestic septic tanks connected to a reticulation system to harvest their overflow to a central sump and pump station that pumped to the treatment plant. The WSP treatment plant was a three cell system with gravity feed between ponds, and a theoretical hydraulic retention time of 36 days in pond 1 and 15 days each in pond 2 and 3, for a total of 66 days. This system was observed over a period of two years. The HRAP was a single raceway 30 m x 5 m with adjustable depth settings. The HRAP was run at 0.32 m, (θ=4.7 d), 0.42 m (θ=6.6 d) and 0.55 m (θ=9.2 d). The depth setting was altered regularly to encompass observation periods in all seasons at all depths. This system was observed for a year. A second period of 9 months of HRAP observations was made in a similar manner, this time using wastewater that had already spent approximately 36 days in a facultative pond.

Parameters measured at both sites in all ponds were:-

- Continuously logged water temperature, dissolved oxygen and pH
- Continuously logged weather data – temperature, wind speed & direction, total solar radiation, UV radiation, rainfall.

- Water samples collected at regular intervals from inlets and all ponds and returned to the laboratory for estimations of the following:-
    - *E. coli* enumeration
    - Chlorophyll a
    - Suspended solids
    - Turbidity
    - BOD_5
    - Nutrients:– NH_4-N, NO_2-N, NO_3-N, PO_4-P

The results were analysed to compare both the disinfection performance of the two systems and the relative ability to remove nutrients. A comparison was also made of the albazod productivity of the two systems.

A mathematical model to predict the *E. coli* concentration in the HRAP effluent was constructed and the model outputs were compared with eight separate periods of intensive observation of *E. coli* numbers over periods of two to five days at a time. There was good correlation between model output and *E. coli* concentration observations.

The study answered in the affirmative the question of whether a High Rate Algal Pond system could replace a Waste Stabilisation Pond system in rural South Australia. It also offers clear advice on the design and operation of a High Rate Algal Pond system in rural South Australia.

DECLARATION

I, Alan Neil Buchanan certify that this work contains no material which has been accepted for the award of any other degree or diploma in any University or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Signed

ACKNOWLEDGEMENTS

This project is dedicated to my grandchildren and all of their generation. It is the only way I know to contribute to their future well-being in a world reluctant to acknowledge the fast approaching end of boundless resources – primary amongst those, water and energy. Only my family really understand the personal sacrifices needed to complete this task. Their unquestioning support remains critical to the mission.

Many people contribute over the extended journey that is the candidature involved in the creation of a thesis of this size. Primary amongst those are the two academic supervisors, Professors Howard Fallowfield and Nancy Cromar. Their enthusiasm for the task was palpable and infectious and advisory in good measure. They jointly and gently taught me the process of research, knowledge of which I have hankered after for many decades now. Remarkably, they eased me past the University bureaucracy. When I first arrived, I still carried the scars of too much 'other' bureaucracy, and they have helped the slow healing with their gentle good humour. Their years of 'hands-on' experience cannot be overrated as a resource when taking on a project of this complexity.

Dr Simon Williams provided all the mathematical grunt to distill complex biological activity into a series of formulas able to accurately predict outcomes.

The project arose from a collaboration between the Local Government Association (LGA) of South Australia and Flinders University. Within the LGA, Rick Gayler played an outstanding role as project champion and keeper of the funds. He almost single-handedly kept the project afloat as many initial capital intensive changes had to be made. He really believes in what we are trying to achieve and that makes all the difference.

Michael Clark, wastewater treatment manager for Barossa Council also deserves special mention for his 'freeing-up' of access to the Lyndoch waste stabilisation ponds for a number of years as we deployed various instruments in and around them. His long experience in the wastewater treatment industry meant he was always good for practical advice. We could always count on Michael's help when required, otherwise he stayed in the background and left us to get on with the job. Loxton-Waikerie Council also contributed greatly with their willingness to let us get on with the job, and to offer practical assistance with pumping on the occasions that the site flooded. It is my fervent hope that good use will be made of the treated wastewater available to them.

Coming into a University laboratory as an older student with no particular lab skills creates interesting inter-generational dynamics. To their credit, the younger cohort taught me well and soon treated me as their colleague and peer. I value that greatly. Over the time, a number stood out for their willingness to engage, including (in no particular order), Guaxin Huang, Yu Lian, Lei Mai, Ryan Cheng, Jess Hall, Michael Taylor and in particular, Natalie Bolton, who was always available to discuss techniques, and interpretation of results. Great assistance was also received from the laboratory manager, Raj Indela.

TABLE OF FIGURES

Figure **Page**

Figure	Page

Figure **Page**

Figure **Page**

Figure	Page

Figure **Page**

Figure	**Page**

Figure	**Page**

Figure **Page**

Figure **Page**

Figure **Page**

Figure **Page**

Figure **Page**

TABLE OF TABLES

TABLE **PAGE**

TABLE **PAGE**

TABLE **PAGE**

TABLE **PAGE**

TABLE **PAGE**

TABLE **PAGE**

TABLE **PAGE**

TABLE OF PLATES

TABLE OF EQUATIONS