9 APPENDIX ONE: UPGRADE STRATEGY – A CASE STUDY

How can the issues presented be integrated to upgrade an existing pond system?

9.1 Introduction

This section presents a case study. Its purpose is to show the reader how some of the ideas developed in this document were refined and applied to an existing pond.

The development work for this case study was commenced part way through the broader research programme. Through this process we were able to take some developing ideas and apply them to a real situation. In its own right this exercise then led to the refinement of many of the final ideas presented in previous sections.

9.2 The Pond Studied

The Ashhurst waste stabilisation pond system is approximately 20km east of Palmerston North, New Zealand. There are two ponds in the system, a primary pond and a smaller (≈ 120m x 60m) secondary pond divided by a block wall. They are connected by a 300mm diameter concrete pipe located approximately 18 metres from one end of the pond. These investigations focussed on improvements to the secondary pond shown below.

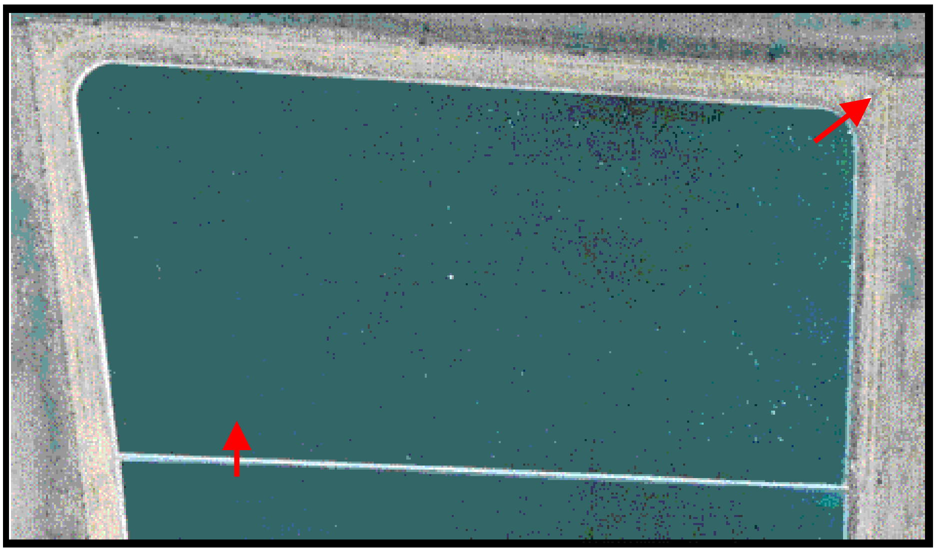


Figure 9-1 Ashhurst secondary pond – unmodified

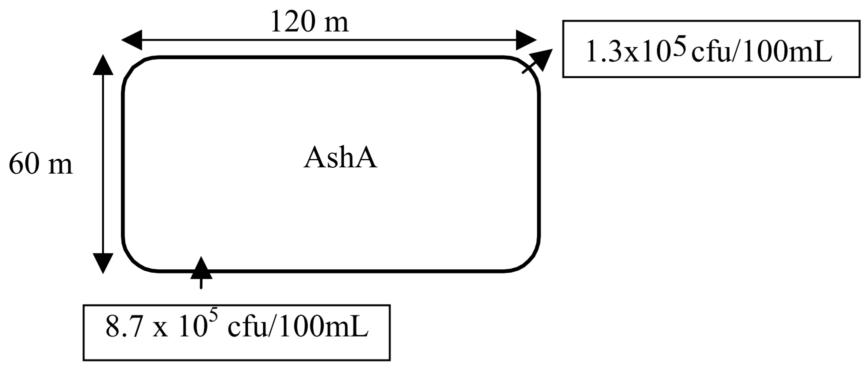
9.3 The Design Process

In total, twenty-five design modifications were evaluated by computer modelling for this part of the project. A number of these were simply minor variations to 'tweak' the design improvements. In this section some of the more effective design modifications are reviewed, while in Appendix 4 some of the other configurations that were tested, and the results obtained, are illustrated.

The success of each configuration was primarily evaluated in terms of the resultant effluent coliform concentration. In a field pond, conditions are constantly changing but for the purposes of this evaluation we needed to select a suitable inlet coliform concentration. Based on an average of samples collected at the inlet pipe into the secondary pond an inlet concentration of *$8.7x10^5$ cfu/100mL* was used.

9.3.1 Existing Pond

Illustrated in the simplified diagram below is the existing base case with no modifications.



As seen the existing arrangement (basic case - AshA) did not significantly reduce the level of coliforms from the inlet.

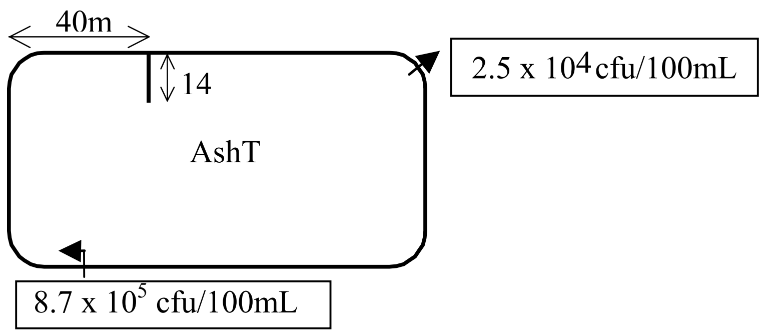
9.3.2 Stub Baffles and Inlet Modification

Because of a limited budget the option of using cheaper, short stub baffles were the main focus of the first of the series of configurations investigated. A number of arrangements were tested including varying baffle position, orientation, and slightly different lengths.

All of these cases gave improvement on the existing situation with the concentration of coliforms at the outlet being reduced by at least an order of magnitude compared to the base case.

Concurrent to this work, the idea of using inlet jet attachment, as discussed in Section 4.3.3, was developed.

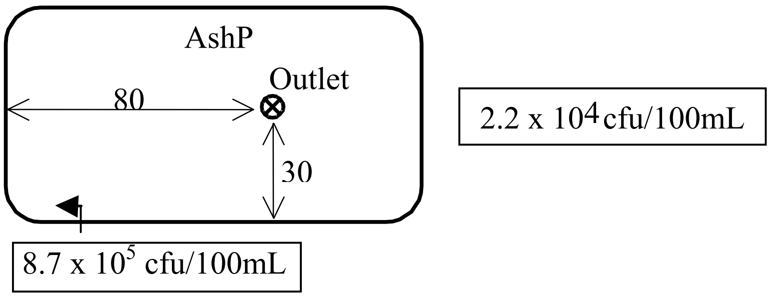
Ultimately it was found that in order to achieve the most effective results these concepts needed to be integrated and this was done in the AshT case shown following.



The coliform concentration for this case was the lowest achieved using a stub baffle and, therefore, held promise as an economic and effective upgrade option.

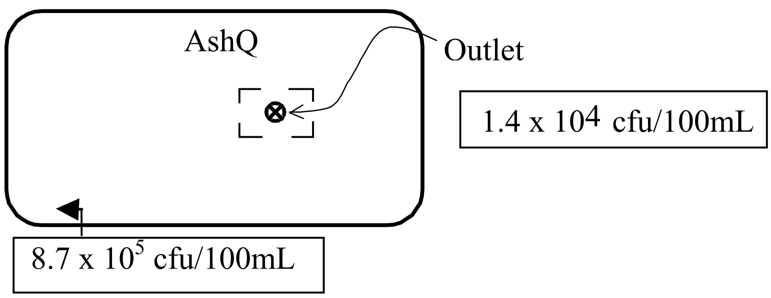
9.3.3 Central Outlet

As part of the development process in this case study research work, the idea of using a central outlet was developed. The tightly controlled flow pattern achieved by turning the inlet into the wall while using jet attachment could again be taken advantage of by placing the outlet in the central 'dead zone'. This was modelled in AshP.



The central outlet yielded a coliform concentration similar to that of the stub baffle case AshT. AshP has the advantage of avoiding the costs of the baffle, although in practice this modification would still have some reasonable cost to implement. Wind may also become an issue in such a design. When the wind speed increases then the tightly controlled outer flow pattern could be pushed across towards the central outlet.

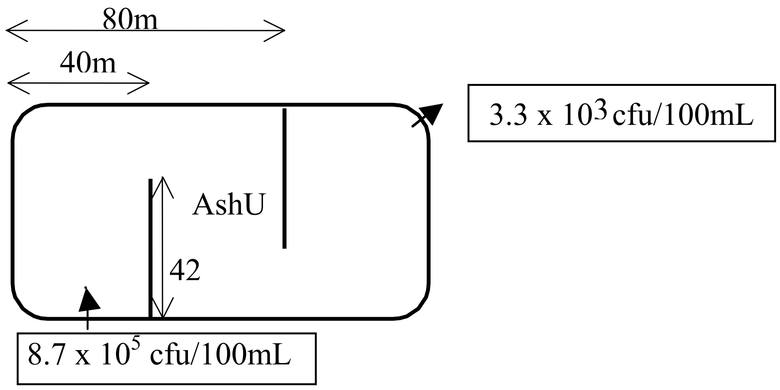
To refine this option further, outlet protection was provided by baffle/deflectors around the central outlet to divert the flow away from the immediate vicinity of the outlet as seen below AshQ.



This flow protection further provided a small further improvement to the treatment efficiency of the pond.

9.3.4 Long Baffles

'Long' evenly spaced baffles were also evaluated for this case study. The use of two long baffles in the traditional evenly spaced arrangement were tested (AshU).



This design produced the best treatment efficiency out of the cases tested.

9.3.5 Final Design

The final selection of an upgrade option for the field pond needed to take into account the following four questions:

1. Will the upgrade result in a reasonable improvement in treatment performance?
2. Is the upgrade practical – i.e. can the changes be implemented without difficulty?
3. What is the cost?
4. How innovative is this demonstration?

Based on the above criteria, it was decided to implement AshT (inlet turned for jet attachment and one stub baffle). This represents a relatively cheap but effective solution, and for the purposes of this project allowed a practical demonstration of two innovation ideas – the edge swirl and a stub baffle.

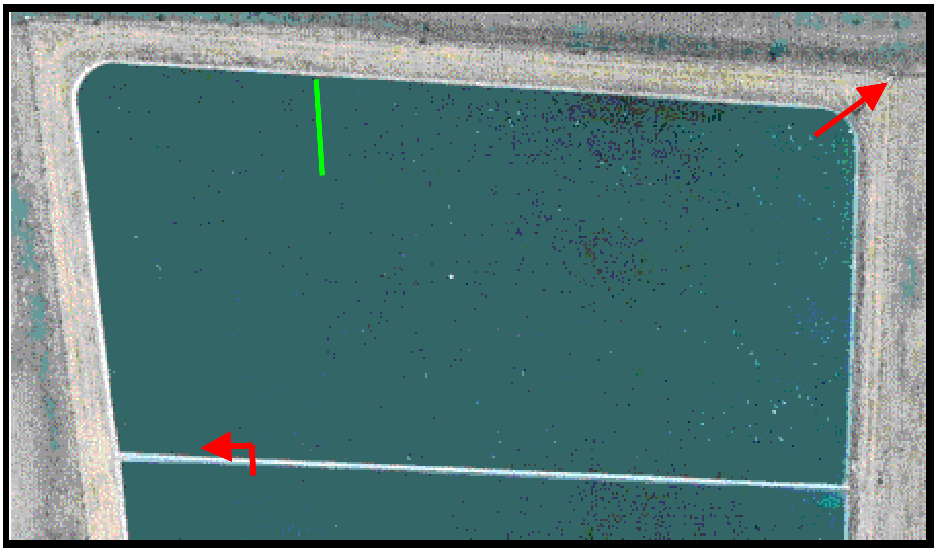


Figure 9-2 Final modification to Ashhurst secondary pond

The inlet was modified using a stainless steel right-angle bend as shown in the following picture. This was tapered at one end to allow it to be inserted and forced into place inside the existing concrete inlet pipe.

Figure 9-3 Inlet insert used in field trial

The baffle was fabricated out of heavy duty (650gsm) PVC, with a sleeve in the top and the bottom for floats and a heavy chain respectively. The floats were made of 3m lengths of 100mm diameter PVC sewer pipe sealed at the ends. The chain had a weight of 100kg per 12m.

The baffle was put together on dry land, bunched together and tied. It was then floated into place with the aid of extra 150mm diameter PVC sewer pipe floats and dropped into place. A wire rope threaded through the top sleeve was then secured on either side of the pond to ensure it maintained position. The following photos show the baffle installation.

Figure 9-4 Baffle being installed at Ashhurst secondary pond

9.4 Field Testing

A tracer study was performed and, as predicted by the computer modelling, the tracer plume from the inlet clung closely to the edge of the pond as it moved around to the stub baffle on the opposite side. At that point the baffle turned and directed the flow back towards the inlet side of the pond.

A comparison of tracer studies undertaken before and after this upgrade showed that this modification was successful in significantly reducing the short-circuiting problem within the pond. The time taken until the tracer concentration measured at the outlet reached its peak was improved by a factor of seven.

The table below shows the improvement expressed in terms of outlet coliform concentrations. The middle column shows the concentration predicted in the CFD computer modelling as presented previously. The column on the right shows the concentration calculated by integrating first order decay kinetics with the experimental tracer data. This calculation allows us to evaluate the hydraulic improvement in terms of treatment efficiency.

Table 9-1 Performance of Ashhurst Upgrade

	Outlet Conc. (cfu/100mL) ***Predicted via CFD Modelling***	Outlet Conc. (cfu/100mL) ***Calculated using Experimental Tracer Data***
Unmodified	1.30×10^5	1.29×10^5
Modified	2.5×10^4	1.1×10^4

The results confirm that the modifications provided an order of magnitude improvement. It also shows that the CFD prediction is very reliable when compared against the result derived from the experimental tracer data. This provides a good degree of confidence that the ideas that have been developed in this document using the computer modelling can indeed be practically applied with success to the field situation.