final report

Project title: Water Quality Improvement Strategy

Project code: P.PSH.0449

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Date published: July 2010

PUBLISHED BY
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NORTH SYDNEY NSW 2059

Water quality improvement strategy for a processing site

This is an MLA Donor Company funded project.

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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1 Description of the project

The project involved a meat processing company assessing all potential solutions to improve its current wastewater practices in line with regulatory requirements. This included investigating options for water reuse, which will then improve wastewater systems at the plant. The project also looked at what new technology is available for waste water treatment.

Strategic Fit – Industry Strategy
The MLA/AMPC environment strategy shows water reuse as being a key risk (and opportunity) for the industry. Currently the only solutions available to industry are to buy more land to irrigate waste water onto or to implement expensive waste water solutions. This will provide important baseline data for the industry strategy as well as identifying areas that may require further research.

The objectives of the project were to:
1. Review current water use and waste water generation
2. Identify potential innovative waste water solutions
3. Develop a waste water innovation strategy for the company.

The scope of this project included:
- Collation and review of existing information;
- Assessment of water use and wastewater generation in the works;
- High level review of existing wastewater treatment plant;
- Identification of waste minimisation options;
- Identification of additional treatment requirements;
- Option analysis;
- Capital and operating cost estimates; and
- Provide conclusions and recommendations.

2 Overview of water use

In beef processing, water is used to clean cattle before slaughter, wash carcasses, continuously clean and sterilise equipment, convey waste products and in cleaning operations at the start and end of the working day. The site is chemically cleaned everyday. Water is also used to generate steam, cool equipment and provide water for cooling towers.

At this site, in 2008, the consumption for production days at 1600 head/day or more was:
- Average water usage: 4.0 ML/day
- 80-percentile usage: 4.2 ML/day.

At an average daily water consumption of 4.0 ML/day, the water consumption metric is of the order of 8.6 kL/t HSCW. This is well below the average Australian value of 10.6 kL/t HSCW measured in a recent industry survey, but there is still some room for improvement.

3 Wastewater sources

Wastewater is generated directly from production processes undertaken at the site, including contaminated stormwater originating from non-production areas. Individual streams originate from many sources within the plant, but the main waste flows are associated with the following sources:

- Cattle yards;
- Slaughter floor and Boning room;
- Tripe, offal and intestines processing;
- Plant cleaning;
- By-products and rendering plant;
- Paunch dewatering facilities;
- Boilers blowdown and wet scrubber;
- Refrigeration and associated facilities and cooling towers;
- Biofilter;
- Truck wash and load out area;
- Stormwater from stockyards, plant surrounds and gardens.

The company estimates the ex saveall discharge volume to be 90% of current consumption per week. Flows between different wastewater ponds are not known with any accuracy.

4 Current Wastewater Treatment Process

The company's treatment process consists of some basic primary treatment followed by off-site secondary treatment. Wastewater is captured from all sources (except the hides processing wastewater and amenities) and directed to the primary treatment, where the fats and other solids are separated and taken offsite for composting. The liquid effluent from the contra shear screen enters the 'save-all' tanks. From there, it is pumped through an underground pipeline to the off-site secondary treatment facility.

The primary treatment is basic by modern standards for Australian abattoirs. However, there is no evidence that this causes problems in the treatment ponds downstream.

The wastewater undergoes a reduction in organics, suspended solids and nutrient levels in the biological wastewater treatment ponds.

The primary-treated effluent undergoes the following treatment process:

- Wastewater is pumped into two similar anaerobic ponds, which operate in parallel.
- Each anaerobic pond discharges by gravity into a large facultative pond. Effluent from this pond exits through a single discharge point and flows into a further pond, containing pump intakes for an adjacent turf farm;
- The majority of the effluent enters this pond. The outlet structure is located in this pond.

Treated wastewater is managed of in two ways:

- Approximately 19 ML per annum is pumped across to an adjacent 6 ha turf farm.
- The remainder is discharged from the third pond into the nearby river.

Releases are authorised and regulated under an amalgamated permit issued by EPA.
Water issued to the turf farm is measured by in-line flowmeter.

Possible incremental improvements might include:

- Addition of a grit removal device treating the effluent from the lower ante-mortem yards. This would intercept and remove grits and sand prior to their settling in the save-all, which lacks any means to remove them; and
- Consideration of an appropriate system to recover fat from the slaughter-floor area for rendering (with appropriate upstream screening).
- Investigate the need for a mixed balance tank to allow cooling of wastewater after screens but before fat removal.
- Investigate the need to replace the save-all with a dissolved air floatation (DAF) unit.

5 Wastewater Upgrade Options

A feasibility study assessed options to upgrade the wastewater treatment plant to improve discharge quality. Waste minimisation strategies were also considered. The company currently uses approximately 4 ML per production day, (approximately 1000 ML per annum) of town water.

Wastewater produced from the works is screened and passed through a save-all and then pumped to an off-site treatment facility for further treatment. Currently the majority of the wastewater is discharged into a nearby river and only a small portion of that (Approximately 19 ML p.a.) is used to irrigate an adjacent 6 ha turf farm.

Wastewater discharge quality analysis indicated that the site does on occasion not meet some of its discharge water quality requirements.

Table 5 gives the summary of the mean water quality established:

Table 5 Wastewater quality data for the 'save-all' tank, and the anaerobic ponds 1a and 1 b

	Save-all tank*	Anaerobic pond 1a**	Anaerobic pond 1b**
pH	6.5	7	7
BOD_5 (mg/L)	4400	115	115
Suspended Solids (mg/L)	1900	120	360
Oil and Grease (mg/L)	1150	<10	<10
Total Kjeldahl Nitrogen (mg/L)	280	180	180
Conductivity (µS/L)	1700	2400	2400
Phosphorus (mg/L)	54	30	30

* The data in the save-all tank are derived from grab samples because it has only a few hours hydraulic retention time.

** Even though the samples taken from the anaerobic ponds are grab samples, they are equivalent to composite samples due to the long hydraulic retention time.

Three wastewater treatment upgrade options were considered:

- **Option 1:** includes the existing anaerobic and facultative treatment ponds combined with *High Rate Algal Pond (HRAP)*, modified *settling pond* and a cost effective *filtration* system;

- **Option 2:** includes the existing anaerobic and the facultative treatment of the wastewater combined with further *aerobic treatment* and finally a cost effective *filtration* system;
- **Option 3:** comprises constructing an entire new plant at the site. The process would include a modified primary treatment plant, followed with anaerobic and aerobic treatment and lastly, with tertiary treatment polishing of the effluent.

The preliminary cost estimates associated with the recommended options are shown in Table 1 below.

Table 1 Treatment Option Summary

Treatment Options	Capital Cost ($AUD)	Net Operating Costs ($ AUD / year)	Additional Power Demand (MWh/year)
Option 1	2.7 Million	150, 000	630
Option 2	3.5 Million	225,000	1700
Option 3	8.2 Million	530,000	4550

Table 1 Treatment Option Summary

Although Option 1 is the cheapest option, there are a lot of unknown technical issues that make this approach risky. To confirm Option 1 design assumptions would require extensive large-scale pilot test work run under real plant loading conditions.

The preferred approach, at this stage, is to upgrade the wastewater treatment plant is Option 2. This option provides water that meets river discharge limits and is suitable for irrigation. It has a robust and relatively straightforward operation.

Option 2 also has benefits of reduced power consumption for nitrification in pond 3 due to pond 2 volatilisation of ammonia in summer.

These upgrades would create the following impacts on operations:

- Additional power supply needs to be sourced from the main power lines (~400m from the ponds).
- There may be significant additional operating costs associated with sludge disposal, if the sludge cannot be managed through the existing offsite composting facility.
- The impact of the carbon pollution reduction scheme (CPRS) due to additional power consumption has not been included in the options.

6 Assessment of Treatment Pond Performance

Using the BOD concentration of 4,400 mg/l ex the save-all and assuming an even flow split between the ponds, the BOD areal and volumetric loading is 13,200 kg BOD/day on a 7-day basis (e.g. allowing for the no flow weekend).

The relatively high loading ensures excellent mixing of the pond contents by biogas generated by the microbial flora and this should ensure that most fine solids remain in suspension until discharged into pond 2.

The treatment pond system achieves reductions in the way of:

- BOD removal is 97%;
- TSS levels diminish by approx. 95%; and
- Nitrogen removal averages 74% and phosphorus removal is negligible.

The current performance of the ponds is excellent.

7 Recommendations

7.1 Modified wastewater treatment plan design criteria

General design preferences for a modified wastewater treatment plant (WWTP) are:

- Ensure effluent quality requirements are met at the nominated design flow rates and loadings;
- Operate with a margin sufficient to ensure efficient operation for the life of the plant and equipment;
- Be simple and robust to operate and maintain;
- The control system should control the existing and new plant;
- Ensure that the modified or new WWTP can be integrated into the available land area;
- Negligible odour production, or provision of odour control;
- Utilise if possible the existing WWTP or parts of it; and
- Can be easily adapted in a future upgrade.

7.2 Reduce water consumption and wastewater discharge

During this study, the following in-plant modifications were identified which result in less water consumption and wastewater discharge:

1. Decrease the weekend flows (in hand already);
2. Grit and manure removal from the Ante-mortem yards' wash wastewater;
3. Hide area- ensure all goes to sewer
4. Metal tote bin washing-water minimisation
5. Paunch / inedibles under slaughter floor
6. Improved blood capture on the slaughter floor
7. Boning room-water is recycled in non processing areas
8. Consider dry transport of raw material to rendering; and
9. Reuse the cooling tower and boiler blowdown for ante-mortem yard wash.

Some of these modifications can be done cost effectively (eg items 1, 2, 3 and 4). Implementation of other items (5- 7) may reduce nitrogen and phosphorus loads (kg/head) by up to 30 %, however the cost of implementation will be quite high.

7.3 Irrigation Management Plan

A high level assessment of irrigation of the wastewater indicated that the site does not currently have sufficient land to meet the wastewater land application guidelines throughout the year. The phosphorus load in the wastewater is the key limitation. To remove further phosphorus to allow sustainable irrigation would require the precipitation of phosphorus and production of large amounts of sludge requiring dewatering and disposal. The costs associated with this would be significant.

Therefore, It is recommended that a detailed irrigation management plan be developed to design a sustainable irrigation system. This may require:

- The confirmation of flow and wastewater characteristics.
- Assessment of the soil type and condition.
- Investigation of the groundwater in the region.
- Topography of land.

7.4 Incremental Improvements to Wastewater Treatment

The following future actions are also recommended:

- Addition of a grit removal device treating the effluent from the lower ante-mortem yards. This would intercept and remove grits and sand prior to their settling in the save-all, which lacks any means to remove them; and
- Consideration of a system (with appropriate upstream screening) to recover fat from the slaughter-floor area for rendering.
- Investigate the need for a mixed balance tank to allow cooling of wastewater after screens but before fat removal.
- Investigate the need to replace the save-all with a dissolved air floatation (DAF) unit.
- Install better metering of discharges.
- Conduct more analysis of samples at outlet of the ponds;
- Continue to identify and reduce high weekend water consumption during non-production weekends;
- Remove accumulated sludge in pond 2 near the discharge of the anaerobic ponds by suitable method (eg Sludge Rat) to minimise the risk of odours developing.
- Analysis of soils and MEDLI modelling is required to confirm the land requirements for irrigation.
- Pursue further detailed engineering on the recommended option to refine the design and increase reliability in cost estimates.

7.5 Metering

As a minimum we would recommend installing additional sub-meters to measure water use on:

- Slaughter floor;
- Hot water and steriliser water;
- Boning room;
- Engine room;
- Rendering plant;
- Yards; and
- Offal room.

7.6 Expected Results

By implementing these changes we may expect the following reductions in kg per head may be provided.

- 15 – 30 % in water consumption;
- 15 – 30 % in wastewater production;
- 5 – 25 % of COD and nutrients per head to WWTP;

- Temperature of wastewater; and
- Solids and grit load to the save-all.

Although the kg per head may reduce, concentrations may remain similar or even increase as water reductions may be higher than nutrient reductions. The benefits of these changes will mean that the save-all will operate more efficiently and reduce fat load to the ponds.