final report

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A comparison of environmental implications of various treatments of abattoir waste water

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1 Scope of the project

The scope of the project was to compare and contrast the effectiveness of the two alternate methods of waste treatment that are used at Dubbo and Albany, two similar sized lamb/sheep abattoirs which both have hot rendering plants The impact of a possible CPRS on the two different methods was also to be targetted.

When this project was first discussed in early 2010, the federal government was in the process of developing an emissions trading scheme, the Carbon Pollution Reduction Scheme (CPRS). This CPRS increased the focus of many red meat processors on their environmental challenges. The Federal government planned for the CPRS to use the National Greenhouse and Energy Reporting Guidelines (NGER) as a basis for calculations. While no emissions trading scheme has yet been voted on, a similar system is planned and the Federal government is proposing that the initial price will be set at $23 per tonne CO_2 equivalent for GHG emissions which is used for calculations in this report.

The major causes of GHG emissions from abattoirs are the fuels burned on the site in boilers to generate heat, and the generation of biogas and carbon dioxide by those plants that treat their own wastewater. The ability to minimise the emissions generated by waste treatment will greatly influence the economic impact of any emissions trading scheme. Generally, red meat abattoirs that treat their waste use a sequence of anaerobic and aerobic ponds. The major reduction in BOD_5 (and COD) occurs in the anaerobic pond(s) where biogas is produced. Biogas is generally 55% to 70% methane with the remainder carbon dioxide. Methane is considered to have 21 times the global warming potential of an equal weight of carbon dioxide. Further biological breakdown occurs in the aerobic ponds producing carbon dioxide. Spreading organic solids on land does not affect the emissions but composting does. Land fill costs are likely to increase as are electricity costs due to the owners of those operations having increased carbon tax impositions. Heavy transport fuel costs will also have a carbon tax impost which will impact on the transport of material off site by contractors.

Fletchers were uniquely positioned to compare and contrast their two similar sized abattoirs with regard to their waste treatment plants. Dubbo has the usual series of anaerobic and aerobic ponds while Albany uses a dissolved air floatation (DAF) system to remove most of the BOD_5 (and COD) from the wastewater, removing the need for an anaerobic system and therefore that part of the waste treatment system that generates the major portion of GHG emissions.

Methane has a calorific value similar to natural gas so there is an opportunity to turn a negative into a positive by recovering the biogas from anaerobic digestion and using it to replace some or all of the boiler fuel with the added advantage that it no longer counts towards emissions from the site, as under the NGER/CPRS scheme, the carbon dioxide in the biogas and the carbon dioxide produced by burning methane are not counted in a site's emissions if the biogas is burned. One of the objectives of the project was to look at the possibilities raised by capturing biogas.

Most plants judge the quality of their waste water by reviewing the analyses taken to conform to their licence. These are usually snap samples taken only a few times a year usually in the middle of the day. Dubbo wastewater was analysed by external NATA laboratories 21 times over 7 years from March 2003 by taking single snap samples. The BOD_5 varied from 700 to 33,500mg/L (average 5,571mg/L), SS from 420 to 39.000mg/L (average 9,827mg/L) and O&G 64 to 32,800mg/L (average 5,509mg/L). There were similar variations at Albany.
So, a major part of the project was to take representative samples of the waste water over the full day and calculate a weighted average. After discussions with all stakeholders it was decided to

take hourly samples over 2 non consecutive trial days at each site in October and November 2010. Other site parameters such as head processed, t HSCW, and flowrate could then be used to assess what this would calculate out to be if applied to the whole of 2009.

Detailed milestone reports were produced for each site following the trial visits. Most of that detail is not reproduced in this Final Report.

At Dubbo, red and green waste streams are separately screened by two Contrashears. The liquid waste then flows into a pit along with the underflow from the alum treated water clarifier, bloodstick water, condensate from hot rendering, and waste from the amenities. The wastewater is then pumped through a meter approximately 1km to a series of treatment lagoons.

The 5.8m deep anaerobic pond (HRT 23 days) has a thick crust of floating vegetation. The overflow goes to a 1.8m deep aerobic pond (HRT 15 days) which is aerated by diffused air using a 3kW and a 4kW blower. There was visual evidence of considerable accumulation of solids in both ponds. The overflow goes into a 1.8m deep mixing pond (HRT 24 days) and an irrigation pond (HRT 12 days). There is a wet weather reserve pond with a residence time of 32 days and a further dam of 54ML.if required. Treated water is irrigated on to pasture land within the limits of the licence. The screened red solid waste contains some plastic and goes to the tip. The screened green solid waste is mainly cellulosic paunch solids which are composted on site.

At Albany, wastewater flows via a 90kL sump and Contrashear screen into a 300kL equalisation tank. The screened solids and manure from the raised yards are transported off site. The screened waste water is dosed with alum and polymer and fed to a DAF tank. The DAF overflow goes via a meter into a pond (HRT 24 days) aerated by 4 x 18.5kW mixers then via reed beds into two maturation ponds of combined residence time of 56 days/metre depth. The DAF sludge is spread on to non irrigated land. Treated water is irrigated on to pasture land within the limits of the licence. The water that is used for amenities is treated by a separate BIOMAX system.

2 Results

The results from the two trials at each plant were converted into weighted averages. A summation of the wastewater results is given below.

	Dubbo	**Albany**	**Dubbo**	**Albany**	**Dubbo**	**Albany**
	kg/day	**kg/day**	**kg/head**	**kg/head**	**mg/L**	**mg/L**
COD	13,126	10,954	2.737	2.120	6,162	12,336
BOD	6,788	3,308	1.415	0.640	3187	3,725
TSS	3,974	10,536	0.829	2.039	1866	11,865
O&G	612		0.128		287	
TP	52	53	0.011	0.010	24	60
TN	113	385	0.024	0.075	53	434
NH_3-N	102	68	0.021	0.013	48	7
Kj-N	11	318	0.002	0.061	5	358
NO_3/NO_2	<0.2	4.3	0	0	0	5
TDS	3,403	760	0.709	0.147	1,598	856
Na	1,104	341	0.230	0.066	518	384
ec mhos/cm	4,349		4,349			
pH	7.3		7.3			
BOD/COD	0.53		0.53	0.30		
Flow ML/d	2.13	0.888	2.13	0.888		
Trials head/day			4,797	5,167		

Overall, the anaerobic/aerobic pond system at Dubbo and the DAF/aerobic system at Albany are doing an excellent job in treating the wastewater. On both sites, the first stages ie anaerobic pond at Dubbo and DAF at Albany, are doing most of the work, as shown in the Table below. The reed beds at Albany appear not to be doing any pollutant removal. The Albany DAF has the advantage that sludge is produced continuously above ground in a pumpable state which can be easily spread on land. This would also apply to an above ground anaerobic reactor. However, in ground anaerobic ponds have the difficulty of desludging at intervals. Some engineered covered anaerobic ponds can be desludged by dropping in a portable pump.

	Albany			Dubbo	
	DAF	Bio system	Overall	Anaerobic pond	Overall ie Anaerobic +Aerobic ponds
COD	88%	8%	96%	89%	92%
BOD	84%	14%	98%	98%	99%
TSS	73%			84%	44%
TN	69%	6%	75%		17%
TP	96%	0%	96%	88%	88%
TDS	-10%	0%	-10%	0%	
Na	2%	0%	2%	0%	
O+G				87%	98%

The final effluents at both plants are good as can be seen below. Phosphate removal at Albany is much higher than at Dubbo as it is precipitated by the alum, though the phosphate is not lost to agriculture as it is in the DAF sludge which is spread on land. Another major difference is that the nitrogen at Dubbo has been broken down more into NH_3-N which occurs during anaerobic digestion.

	COD	BOD	TSS	NH_3-N	Kj-N	NO_3/NO_2	TN	TP	TDS	Na	O+G
Albany	234			76	108	3.5	112	1.4		384	
Dubbo	380	35	155	24	38	28	90	8	1,932	520	9

The cost and GHG emissions produced from waste treatment can be reduced by reducing the sources of the major polluting material ending up in the wastewater. Blood stickwater, rendering hot condensate and polisher water are three continuous flows that many abattoirs have which were sampled at both sites. There was no rendering plant bin drainage at Albany as they ensure this strongly polluting waste flow does not happen.

Using the trial results and 2009 annual data, site emissions were calculated for both sites based on their boiler fuels used (natural gas at Dubbo and LNG/waste oil at Albany), and both the NGER default values (Method 1), and actual values (Method 2) for waste treatment. It can be seen from the following table that using the default values results in a lower overall calculated discharge of COD for both sites and as the emissions are based on COD (BOD_5) and HSCW, the default values result in lower overall GHG emissions.

		Dubbo	Albany
Actual flowrate factor	kL/t HSCW	13.27	5.88
Default flowrate factor	kL/t HSCW	13.70	13.70
Actual concentration factor	kg COD/kL	9.8	16.5
Default concentration factor	kg COD/kL	6.1	6.1
Actual overall discharge factor	kg COD/t HSCW	129.7	97.0
Default overall discharge factor	kg COD/t HSCW	83.6	83.6

Case studies were also calculated for Dubbo if they changed from an anaerobic digester to a DAF, and for Albany if they converted from a DAF to an anaerobic digester.

Calculations showed the potential energy available in the biogas with the present waste treatment systems in place, and also if Albany changed their DAF to an anaerobic digester and Dubbo chose to replace their anaerobic digester with a DAF. Calculations are shown in the table below.

					methane	boiler fuel (Table 1)	% of abattoir heat energy
		t/yr CH_4	GJ/m^3	m^3/t	GJ/yr	GJ/yr	
actual	**Dubbo**	1,217.5	0.0377	1,400	64,261	155,887	41%
actual	**Albany**	0.0	0.0377	1,400	0	85,403	0%
DAF	**Dubbo**	0.0	0.0377	1,400	0	155,887	0%
anaerobic	**Albany**	561.6	0.0377	1,400	29,641	85,403	35%

Some calculations were done based on recent pricing showing the approximate costs of covering the Dubbo anaerobic pond and installing a flare. An alternative cost estimate was also given for an above ground anaerobic reactor and cogeneration.

3 Conclusions

The following conclusions were reached.

1. Compared to Albany, Dubbo abattoir discharged to waste 30% more COD, 4 times the sodium ion (salts), 1/3 of the total nitrogen and the same total phosphate, on a per head basis.
2. On a per head basis, Dubbo used nearly 50% more potable water than Albany.
3. The Dubbo anaerobic/aerobic pond wastewater treatment system ran very well with an overall COD removal rate of 94%, total phosphate removal of 88%, and total nitrogen removal of 17%.
4. A saving in excess of $4,000 per year could be made by reducing the running time of the Dubbo blowers on the aeration pond without affecting performance.
5. The Albany DAF achieved excellent results with an 88% removal of COD, 96% of total phosphate and 69% of total nitrogen.
6. The Albany DAF used $108,000 per year in chemicals but this gave it a much easier method of handling the sludge.
7. Overall, the Albany waste treatment system removed 96% of the COD.
8. The Albany wetlands did not remove any pollutants.
9. A saving in excess of $63,000 per year could be made by reducing the running time of the Albany aerators on the aeration pond without affecting performance.
10. Neither Dubbo nor Albany exceeded the 25,000 t CO_2-e threshold, so no carbon tax would be payable at either site.
11. If Albany converted from a DAF to an anaerobic digestion system similar to Dubbo then they would still not exceed the 25,000 tonne carbon dioxide equivalent emissions threshold using the NGER default values.
12. The biogas generated at Dubbo could potentially replace 41% of the boiler fuel energy.
13. If the DAF at Albany was replaced with an anaerobic digester, the biogas generated could potentially replace 35% of the boiler fuel energy.
14. If water use at Albany was reduced to industry best practice, the DAF performance would improve, by reducing carryover solids.
15. Dubbo will exceed the carbon threshold when the kill is increased to 2.12 million head. This will then trigger an annual carbon tax of $575,000 at $23/ t CO_2-e.
16. If the anaerobic digester at Dubbo was replaced with a DAF, it would ensure the GHG emissions would always be below the threshold so no carbon tax would be payable but Dubbo would have to change from Method 1 to Method 2 which may involve expenditure on systematic testing and analysis of waste water.
17. Covering the anaerobic pond at Dubbo plus a blower and closed flare would cost approximately $600,000 to $700,000 but would save paying an annual carbon tax if the GHG emissions threshold was exceeded in future.
18. If the Dubbo anaerobic pond was covered and biogas collected then it would be worth investigating a cogeneration plant and using the energy and electricity.