final report

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Water Reuse Project Priority Setting Through Assessment of Industry Impact

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Summary

Several projects have been funded by Meat & Livestock Australia in recent years relating to the use and reuse of water in meat processing plants to reduce water consumption. Some of the possibilities for water reuse are relatively easy to implement whereas others have greater technical and regulatory hurdles.

The main objectives of this project were to review the Australian and main customer regulations relating to water reuse in meat processing plants and from the projects funded by MLA select several representative ones to analyse in detail and produce a prioritised list in terms of their benefit to the Australian meat industry and degree of difficulty in implementation.

The following seven projects were selected from project reports to MLA:

1. Slaughter floor knife and equipment steriliser water to cattle and yard washing;

2. Viscera table steriliser and cooling water for paunch initial emptying or initial viscera table rinse;

3. Slaughter floor steriliser and handwash water to non-potable uses;

4. Knife & viscera table steriliser and handwash waste reclaimed using Distech equipment to feed back to sterilisers;

5. Edible offal wash water to stockyards and truck wash;

6. Use of membrane technology to treat final effluent to Class A reclaimed water suitable for high quality reuse off site;

7. High temperature rendering condensate treated by Nanochem absorption cartridge.

These were analysed using input from a panel from MLA and Food Science Australia in co-operation with Dr Barry Miskin of Innovar Pty Ltd.

The analysis indicated that when a treatment requiring high capital and operating cost was applied to the water before reuse, the process was not economically viable under the current average water pricing regime. Even at a water purchase price of $2.00 per kL, the Distech process could, for example, take over 10 years to pay back. Where no treatment was involved, payback periods were in the region of 3 years at a water price of $0.75 per kL and less than 2 years at $1.50 per kL. Water prices vary widely between supply authorities but have increased roughly in line with increases in the consumer price index. Should future increases also be in line with inflation, it is unlikely that costly treatments of water for reuse will ever be widely viable.

The suggested priorities for water reuse projects are:

1. Viscera table steriliser and cooling water for paunch initial emptying or initial viscera table rinse;
2. Edible offal wash water to stockyards and truck wash;
3. Slaughter floor steriliser and handwash water to non-potable uses;
4. Slaughter floor knife and equipment steriliser water to cattle and yard washing;
5. Use of membrane technology to treat final effluent to Class A reclaimed water suitable for high quality reuse off site;
6. Knife & viscera table steriliser and handwash waste reclaimed using Distech equipment to feed back to sterilisers;

7. High temperature rendering condensate treated by Nanochem absorption cartridge.

Introduction

Meat and Livestock Australia and the Australian Meat Processor Corporation have funded several projects related to use and reuse of water in meat processing plants over the last few years. Several possibilities for water reuse were identified. Some are relatively easy to implement whereas others have greater technical and regulatory hurdles.

Prioritisation of the water reuse possibilities in terms of their benefit to the Australian meat industry and degree of difficulty in implementation would allow future emphasis to be focussed on those projects that offer the most benefit.

Objective

Produce a prioritised list of water reuse applications for the Australian meat industry.

Methodology

Review of Regulations

All Australian plants are required to meet the Australian standard for Hygienic production and transportation of meat and meat products for human consumption (AS 4696:2002) but export plants also operate to the Export Meat Orders (1985). The Export Meat Orders are currently being reviewed and an exposure draft became available in April 2004. Export plants may also be required to meet importing country requirements. The Food Safety and Inspection Service of the USDA and the European Union have regulations that pertain to the reuse of water and use of non-potable water.

These regulations were reviewed with regard to their requirements for potable water, reuse of water and where there would need to be applications to regulatory authorities for various water reuse projects to proceed.

Analysis of water reuse options

Reports to MLA on various water reuse and water reduction initiatives were reviewed and several proposals that represented a range of reuse opportunities were selected for further analysis.

Estimates were obtained of the cost of purchasing, treating and disposing of water and for each reuse proposal, capital and operating costs were estimated. In collaboration with Dr Barry Miskin of Innovar Pty Ltd, portfolio analysis of each project was done. This involved the adaptation of software developed by Innovar to the water reuse projects. In addition to a discounted cash flow analysis to calculate a payback period and net present value, the analysis took into account less tangible aspects of the project. These were:

1. **Likelihood of technical success,** which considered:
    a. Ability to access feedwater;
    b. Ability to service the technology, and
    c. Ease of meeting microbial specifications.

2. **Likelihood of commercial success**, which considered:
    a. Ability to get regulatory approval;
    b. Strength and clarity of the need, and

   c. Cost of discharge.

3. **Benefit**, which included:
   a. Customer payback time (years);
   b. Quality of water output, and
   c. Capital cost savings.

4. **Leverage**, which considered:
   a. Synergy with food safety requirements;
   b. Synergy with future development plans, and
   c. Synergy with local environment organisations.

5. **Ease**, which included:
   a. Standard of output water required, and
   b. Ability to articulate technology to regulators.

Each of the categories was allocated a weighting developed through discuss with a team from MLA and Food Science Australia. For each project, the team allocated a score on a scale of 1 to 10 to sub-categories a, b and c.

The analysis was performed for each project on a group of plants selected from the 51 plants operated by the 'Top 25' meat processing companies in Australia. These plants were selected because credible production information was readily available for them. Each plant was allocated a rating of high, medium or low for likelihood of adoption of the technology and rate of adoption.

Results and discussion

Review of Regulations

Australian regulations

Australian Standard for the Hygienic Production and Transportation of Meat and Meat products for Human Consumption (AS 4696:2002)

The Australian Standard defines potable water as:

'Means water quality that is consistent with the 'Australian Drinking Water Guidelines 1996' jointly published by the National Health and Medical Research Council and the Agriculture and Resource Management Council of Australia and New Zealand.'

The requirements for the potable and non-potable water supply are presented in Chapter 21 Essential Services, of the Australian Standard:

'Water

21.4 There is an effective program in place for the supply of water that is sufficient and appropriate to the operations undertaken.

21.5 There is a continuous supply of hot and cold potable water at a volume and pressure that enables hygienic practices for the production of meat and meat products to be met.

21.6 Only potable water is used for the production of meat and meat products unless:

(a) the water is only used:

(i) for steam production (other than steam used or to be used in direct or indirect contact with meat and meat products), fire control, the cleaning of yards, the washing of animals (other than the final wash) and other similar purposes not connected with meat and meat products; or

(ii) in other circumstances where there is no risk of the water coming into contact with or contaminating meat and meat products; and

(b) the approved arrangements expressly provides for the use of the non-potable water in the circumstances in which it is used.

21.7 Potable water is supplied in lines that:

(a) are used only for potable water; and

(b) are physically separate from the supply of non potable water; and

(c) are identified for use for potable water if any non-potable water is used at the business.

21.8 Non-potable water is supplied in lines that:

(a) are used only for non potable water; and

(b) are identified for use for non-potable water.

21.9 The reticulation system prevents the back siphonage of used or contaminated water.

21.10 Ice is made from potable water and is protected from contamination during its making, storage and handling.

21.11 Steam used or to be used in direct or indirect contact with meat and meat products is produced from potable water and does not contain substances which may create a food safety hazard or jeopardise the wholesomeness of meat and meat products.

21.12 Only potable running water that is not recycled is used for immersion thawing or cooling.'

The Australian Standard restricts the use of non-potable water to only a few non product contact application (21.6 (a)). Paragraph 21.6 (b) would appear to allow for the use of non-potable or reused water under approved circumstances.

Existing Export Meat Orders

The requirements for the water supply of a meat processing plant are laid down in Orders 91 to 105 of Division IX.

The use of non-potable water is permitted for certain applications under EMO 94.1:

'94.1 Subject to sub-order 94.2, the uses of non-potable water on a registered establishment shall be restricted to:

a) Ammonia condensers;

b) Vapour lines serving cookers used for rendering material not fit for human consumption;
c) Cleaning of condemned material or material not fit for human consumption;
d) Stockyard washing; or
e) Moving of solid materials in sewer lines.'

EMO 94.2 states:

'Where potable water is used for the final wash, the use of non- potable water may be permitted for initial washing of live animals.'

Order 105 lists only two areas where water may be reused:

105.1 Subject to part 26 of these Orders, water may be reused only for the same potable purpose as first used in the following circumstances:
a) Vapour lines leading from deodorisers used in the preparation of prescribed goods;
c) Subject to sub-order 105.2, where before further dressing the carcases subsequently pass through a bank of sprays that use potable water that has not previously been used, spray units in pig scalding equipment or dehairing machines.

105.2 Where water is to be reused for the purposes of paragraph 105.1(c), it shall be filtered before it is reused.'

Export Control (Meat and Meat Products) Orders Exposure Draft 06/04/04

The draft orders generally follow the requirements of the Australian Standard in relation to the requirements for water but use a slightly different definition of potable:

***'potable** when use in relation to water means water that is acceptable for human consumption*.'

Under Part 1 Operational hygiene, some specific requirements for potable water are given:

'***Requirements for potable water***

2.1 *Water that under the Australian Meat Standard is specified as being potable must be:*

(a) clear, colourless, well aerated; and

(b) free from suspended matter, harmful substances and pathogenic organisms; and

(c) treated so as to ensure a disinfectant residual that is adequate to prevent the growth of microorganisms is maintained in the water system.

2.2 *For the purposes of paragraph 2.1(b) water is taken to be free from pathogenic organisms if it does not contain:*

(a) any Escherichia coli per 100 millilitres; and

(b) more than 10 coliform organisms per 100 millilitres; and

(c) a level of more than 1 to 10 coliform organisms in 100 millilitres in any two consecutive samples.

2.3 *The applicable approved arrangement must specify the treatment and testing regime used to verify that the requirements of subclause 2.1 are met.*'

The draft also uses the concept of an "approved arrangement". All licensed meat processing establishments will be required to have an approved arrangement which in most cases will be their existing MSQA program. Under the approved arrangement various alternative procedures may be allowed such as different time/temperature protocols. At present, the draft makes no mention of water reuse. However, scope should be available under an alternative procedure to obtain approval for reuse of water under certain circumstances, provided sufficient evidence is provided that the wholesomeness of the product is not jeopardised.

United States regulations

FSIS Directive 5000.1 Rev.1 - Verifying an Establishments Food Safety System

The regulations pertaining to meat processing plants in the United States are contained in Title 9: Animals and Animal Products of the Code of Federal regulations [64 FR 56417, Oct 1999]. The Food Safety and Inspection Service (FSIS) provides guidance on these regulations in Directive 5000.1. Pages I-11 to I-14 of this directive relate to the water supply. Section 416 (g) of Title 9 states:

(1) A supply of running water that complies with the National Primary Drinking Water regulations (40 CFR part 141), at a suitable temperature and under pressure as needed, must be provided in all areas where required (for processing product, for cleaning rooms and equipment, utensils, and packaging materials, for employee sanitary facilities, etc.). If an establishment uses a municipal water supply, it must make available to FSIS, upon request, a water report, issued under the authority of the State or local health agency, certifying or attesting to the potability of the water supply. If an establishment uses a private well for its water supply, it must make available to FSIS, upon request, documentation certifying the potabability of the water supply that has been renewed at least semi-annually.

(2) Water, ice, and solutions (such as brine, liquid smoke, or propylene glycol) used to chill or cook ready-to-eat product may be reused for the same purpose, provided that they are maintained free of pathogenic organisms and faecal coliform organisms and that other physical, chemical, and microbiological contamination have been reduced to prevent adulteration of product.

(3) Water, ice, and solutions to chill or wash raw product may be reused for the same purpose provided that measures are taken to reduce physical, chemical and microbiological contamination so as to prevent contamination or adulteration of product. Reuse that which has come into contact with raw product may not be used on ready-to-eat product.

(4) Reconditioned water that has never contained human waste and that has been treated by an onsite advanced wastewater treatment facility may be used on raw product, except in product formulation, and throughout the facility in edible and inedible production areas, provided that measures are taken to ensure that this water meets the criteria in paragraph (g) (1) of this section. Product, facilities, equipment, and utensils coming in contact with this water must undergo a separate final rinse with non-reconditioned water that meets the criteria prescribed in paragraph (g) (1) of

this section.

(5) Any water that has never contained human waste and that is free of pathogenic organisms may be used in edible and inedible product areas, provided it does not contact edible product. For example, such reuse water may be used to move heavy solids, to flush the bottom of open evisceration troughs, or to wash antemortem areas, livestock pens, trucks, poultry cages, picker aprons, picking room floors, and similar areas within the establishment.

(6) Water that does not meet the use conditions of paragraphs (g) (1) through (g) (5) of this section may not be used in areas where edible product is handled or prepared or in any manner that would allow it to adulterate edible product or create insanitary conditions.

Directive 5000.1 includes an explanatory note that states:

'The regulations state that water may be reused "for the same purpose." This means that water used to wash or otherwise process raw product may be reused to wash or otherwise process raw product, even at a different point in processing, provided that "measures are taken to reduce physical, chemical, or microbiological contamination." For example, an establishment could reuse poultry chiller water in a scalding tank. Furthermore water used to process RTE product could be reused to wash or process raw product. But water used to process raw product may not be reused to process RTE product. For example, an establishment could not reuse poultry chiller water for cooking or cooling packaged RTE product.'

European Union

In November 1998 the Council of the European Union issued Council Directive 98/83/EC on the quality of water intended for human consumption. For the purposes of that directive 'water intended for human consumption' included *"all water used in any food-production undertaking for the manufacture, processing, preservation and marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the finished product."*

The directive was prepared in order to adapt a 1980 directive so as to take account of scientific and technological progress and to revise it so as to focus on compliance with essential health and quality parameters.

The emphasis of the directive is on water intended for drinking, cooking, food preparation or other domestic purposes. Although food processing is included in the meaning of water intended for human consumption, there is virtually no emphasis given to water used in food processing. There are references to exceptions and possible circumstances for derogations but they must be interpreted in the context of water for domestic purposes.

In September 2003, The European Commission Integrated Pollution Prevention and Control Bureau (IPPC) published a final draft of a reference document on best available techniques in the slaughterhouses and animal by-products industries. In the document IPPC acknowledges that the consumption of water in slaughterhouses is governed by EU and Member States meat legislations that currently require potable water to be used for almost all washing and rinsing operations and which limit the scope for the reuse of water within the slaughterhouse. However IPPC recommends studies be undertaken to identify possibilities for using non-potable water for some unit operations, thereby allowing certain slaughterhouse water to be reused.

Washing of live animals pre-slaughter is not encouraged in the EU because there is not enough time for them to dry before they are slaughtered. It is stated in the document that official veterinary surgeons will insist on there being sufficient dry bedding in lairages to dry off wet animals. (Chapt 2.1.2.1).

There is reference (4.1.6) to reuse of cooling water for an anus drill in a Danish Poultry slaughterhouse for maintaining the water level in a scalding tank. It is stated that veterinary approval is required before such reuse is implemented in slaughterhouses. There is also reference to reuse of water used for washing poultry crates and of scalding water for the carriage of feathers away from the plucking machine.

The IPPC suggests in the document (7.6) that R & D studies should be done to identify possibilities for using non-potable water for some unit operations, thereby allowing certain slaughterhouse water to be reused. There is also reference to re-use of water to wash vehicles (7.7.3.2.1), lairage floors (7.7.3.2.5) and animals before slaughter (7.7.3.2.7) once technical information becomes available.

Codex Alimentarius Commission

Proposed Draft guidelines for the Hygienic Reuse of processing Water in Food Plants

The Codex Committee on Food Hygiene recommended in 1996 that guideline for reuse of process water be prepared. Drafts have been considered at several meetings since then and the latest version is dated July 2001. An objective stated in the draft is '…*it is essential that water be rendered safe and suitable for its intended use.'*

Reuse water is defined as:

'Water that has been recovered from a processing step, including from the food components, and that after subsequent reconditioning treatment(s), as necessary, is intended to be re(used) in the same, prior, or subsequent food processing operation. Reuse water includes recirculated water, recycled water and reclaimed water, as defined below.'

Some of the guidelines state:

5.2 Reuse water should be safe for its intended use and should not jeopardise the safety of the product through the introduction of chemical, microbiological or physical contaminants in amounts that represent a health risk to the consumer.

5.3 Reuse water should be introduced into a processing system such that it will not add to the microbiological or chemical burden of the product.

5.4 Both the source of the water and/or the prior collection and the intended reuse of water dictate the degree of reconditioning and frequency of monitoring that is necessary. While water should be reconditioned to a level safe and suitable for its intended use, reconditioning to a level of potable water is unnecessary in many cases.

Analysis of water reuse options

The reports to MLA on various water reuse and production initiatives from several plants were reviewed along with other publications such as the Eco-Efficiency Manual and the Water and Waste Minimisation Manual. A list (Table 1) of all water reuse suggestions was prepared. Some of these, such as reuse of water from knife and equipment sterilisers, handwash basins and viscera table sterilisers were repeated in different publications. In consultation with MLA, a shorter list was prepared on which more detailed benefits and costs of implementation would be obtained.

Table 1: Water reuse possibilities

Source	Quantity Available (kL/week)	Potential Use	Quantity Required (kL/week)
Plant A			
Hot water decontamination system	220 @ 75ºC	1. Paunch emptying spigot 2. Blow tanks for rendering	232 @ 25ºC 44 @ 75ºC
Final beef side wash	250 @ 40ºC	1. HW decon system 2. Viscera table initial rinse	220 @ 75ºC 145 @ 25ºC
Viscera table steriliser and cooling water	330 @40ºC	1. Viscera table initial rinse 2. Tendon initial spray wash 3. HW decon system 4. Paunch emptying spigot 5. Blow tanks for rendering	145 @ 25ºC 183 @ 25ºC 220 @ 75º 232 @ 25ºC 44 @ 75ºC
Slaughter floor knife and other sterilisers	1485 @ 75ºC	1. HW decon system 2. Paunch emptying spigot 3. Cattle & yard washing 4. initial post-operational washdown 5. Boiler feed water	220@75ºC 232 @ 25ºC 2,500 @ 25ºC 50 @ 75ºC ?
Dry rendering condensate	66 @ 61ºC	1. Boiler feed water 2. DR polishing centrifuges	 73 @ 90ºC

Source	Quantity Available (kL/week)	Potential Use	Quantity Required (kL/week)
		3. Dry rendering washdown 4. Blow tanks	14 @ 75ºC 44 @ 75ºC
LTR condensate	66 @ 61ºC	1. LTR washdown 2. Reactor and centrifuge supply	14 @ 82º 10 @ 82ºC
Plant B using Distech equipment			
Steriliser, LSU viscera table 2nd bank		Sterilisers	
Carcase wash water		Carcase wash	
Red offal wash		Red offal wash	
Green offal wash		Green offal washing	
Live animal washing		Live animal washing	
Plant C			
Steriliser and handwash	160 @ 70ºC	1. Tannery presoaks and lime washes 2. Stockyard washing 3. Rotating screens	
Eco-Efficiency Manual			
Freezer defrost	25	Cooling tower makeup	225
Knife and equipment sterilisers	600	1. Pig scald tanks 2. Stock washing	100 500
Handwash basins	375	1. Rendering material conveyance 2. Sprays on trommel screens	25 300
Carcase wash Viscera & bleed table wash Edible offal wash water	300 375 150	1. Rendering plant washdown 2. Odour scrubbers 3. Stockyard washing 4. Truck washing	40 25 375 25
Head wash	25	Gut washing	300
Alliance report to Plant D			
Unspecified		Condemn area washdown	
Sl. floor, carcase washing, viscera table & handwash basins		Washing inedible product	
Defrost		Condenser & cooling tower makeup	
Unspecified		Livestock & stockyard washing	

Source	Quantity Available (kL/week)	Potential Use	Quantity Required (kL/week)
Water and Waste Minimisation Manual			
Defrost		Condenser & cooling tower makeup	
Slaughter floor chutes, washbasins, knife & implement sterilisers, viscera table & carcase washing		Gut cutting and washing	
Membrane Technology Scenarios (UNSW)			
Stickwater	150 @ 80ºC		
Steriliser		Steriliser	
Handwash		Non-potable	
Effluent		Potable water	

The following water reuse possibilities were selected by MLA and FSA for further examination:

1. Slaughter floor knife and equipment steriliser water to cattle and yard washing;
2. Viscera table steriliser and cooling water for paunch initial emptying or initial viscera table rinse;
3. Slaughter floor steriliser and handwash water to non-potable uses;
4. Knife & viscera table steriliser and handwash waste reclaimed using Distech equipment for feed back to sterilisers;
5. Edible offal wash water to stockyards and truck wash;
6. Use of membrane technology to treat final effluent to Class A reclaimed water suitable for high quality reuse off site;
7. High temperature rendering condensate treated by Nanochem absorption cartridge.

Portfolio analysis

The following general assumptions have been made:

- The average quantity of water used is 11 kL per tonne HSCW (MLA, 2004)
- The average purchase cost of water is $0.75 per kL (MLA, 2002).
- The cost of treatment and pumping around the site is $0.20 per kL.
- The average cost of pumping water is $0.05 per kL (MLA, 2002).
- The cost of treating the effluent for disposal to:
    a. Sewer $0.50 per kL.
    b. Surface water $0.80 per kL
    c. Land $0.30 per kL (Johns, 2004).
- Calculations are based on the abattoir operating a single shift on 250 days per year.

An estimate was made of the capital and running costs per site for each installation and the number of plants in Australia (from the 'Top 25' processors) that could participate. The net present value (NPV) after 15 years and the payback period were calculated for each water reuse scenario based on replacement of potable water for that application for the Australian industry.

Slaughter floor knife and equipment steriliser waste to stock and yard washing

Most steriliser water is only lightly contaminated and because of the high temperature should be free of pathogenic bacteria. This scenario has been implemented in several plants. However most plants have not gathered the steriliser drains together so that the water can be readily collected. It has been assumed that 80% of plants would need to invest additional capital in altering the steriliser drainage system. The assumptions used in this analysis were:

Average flow per steriliser	4 L/min
No. of sterilisers collected	20
No. of hours of operation per day	10
No. of abattoirs that could implement	35
Capital (drains already in place)	$25,000
Capital (includes extra drainage)	$50,000

The results of the analysis were:

1	Slaughter floor knife & equipment sterilisers to stock & yard washing	
GATE 3		
	Likelihood of technical success	**0.66**
	Likelihood of commercial success	**0.59**
	Ease	**0.40**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**5.5**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.38**
	Leverage	**0.57**
	Project score	**0.48**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**755,112**

This indicates that for most plants, the payback period is quite long. For plants that already have sterilisers draining to one position, capital cost is lower and the payback would be just under three years.

Viscera table steriliser water for initial paunch washing

Viscera table sterilisation and cooling water can be relatively clean and is recognised as a high volume use. Large variations in the quantity used are quoted but a conservative value has been used in these calculations. Contamination of the stream can occur due to drips from carcases and viscera above but steps can be taken to reduce this. If wet dumping of paunches is practised, this stream should be suitable for the initial washing out of the contents before a final potable water wash and machine cleaning. Alternatively it could be used for the initial rinse of the viscera table. The following assumptions were made in the analysis:

Steriliser water flow per table	50 L/min
Cooling water flow per table	35 L/min
No. of hours of operation per day	8
No. of abattoirs that could implement	35
Capital per plant	$25,000

The results of the analysis were:

2	Viscera table steriliser & cooling water for paunch emptying or table ini	
GATE 3		
	Likelihood of technical success	**0.72**
	Likelihood of commercial success	**0.67**
	Ease	**0.50**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**3.5**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.31**
	Leverage	**0.55**
	Project score	**0.50**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**746,143**

The reuse of the viscera table water appears slightly more attractive than steriliser water, mainly due to the assumed lower capital cost. However there may be some technical hurdles to overcome such as ensuring the collected water is free of solid material.

Slaughter floor knife and equipment steriliser and handwash basin waste to stock and yard washing

Handwash basins are normally in close proximity to sterilisers, therefore it would be relatively easy to include their waste with the sterilisers. However the water is at a lower temperature (43ºC) and is unlikely to be sterile. Again it has been assumed that 80% of plants would need to alter their drainage system below the slaughter floor. The assumptions used in the analysis were:

Average flow per steriliser	4 L/min
No. of sterilisers collected	20
No. of hours of operation per day	10
No. of wash basins	20
Flow per basin per head processed	1 L
No. of head processed per hour	80
No. production hours per day	7.5
No. of abattoirs that could implement	35
Capital (drains already in place)	$25,000
Capital (includes extra drainage)	$50,000

The results of the analysis were:

3	Knife & equipment sterilisers + handwash basin water for to yards

GATE 3

	Likelihood of technical success	**0.66**
	Likelihood of commercial success	**0.63**
	Ease	**0.55**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**4.9**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.28**
	Leverage	**0.60**
	Project score	**0.49**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**991,530**

Increasing the quantity of water reused by including the handwash basins has slightly improved the economics of this project over collecting steriliser water alone.

Distech equipment to treat steriliser, viscera table steriliser and handwash water for reuse in sterilisers

The Distech D1000 unit is claimed to be able to produce 4,000 litres per hour of near potable quality water from waste water. The steriliser/handwash water should make an ideal feed for this unit as it is lightly contaminated and is already at a fairly high temperature. Reuse as steriliser feed water would also save the cost of heating ambient temperature water. It is assumed that one Distech unit would be installed per site and would operate for 20 hours per day from water collected during the production period. Collected water that is not processed through the Distech is assumed to be reused for non-potable purposes such as yard washing. The assumptions were:

Output per unit	4 kL/h
No. of hours of operation of unit per day	20
Steriliser and wash basin flows	As above
Ambient water temperature	20ºC
Outlet water temperature of Distech	75ºC
Energy cost of heating water	$5 per kJ
No. of abattoirs that could implement	30
Operating cost	$0.75 per kL
Capital cost of unit	$450,000

4	Use Distech unit to produce clean water fromsterilisers, wash bsins &
GATE 3	

	Likelihood of technical success	**0.73**
	Likelihood of commercial success	**0.55**
	Ease	**0.85**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**99.0**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.47**
	Leverage	**0.55**
	Project score	**0.62**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**-1,510,909**

The results of the analysis indicate that, although the likelihood of technical success and the benefit are relatively high, the economics are not favourable due to the high capital and operating costs.

Edible offal wash water to stockyard and truck wash

Edible offal wash sprays often run continuously and the resultant effluent is lightly contaminated. As it is generated in a relatively compact area, collection of the effluent may not be difficult. However the ambient temperature means that the effluent will not be sterile.

Quantity available per day	30 kL
No. of abattoirs that could implement	31
Capital per plant	$20,000

5	Edible offal wash water to yard & truck washing	
GATE 3		
	Likelihood of technical success	**0.80**
	Likelihood of commercial success	**0.61**
	Ease	**0.50**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**3.9**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.18**
	Leverage	**0.42**
	Project score	**0.44**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**516,982**

The results of the analysis show that the benefit is quite low. This is mainly because the quality is likely to be quite low compared with knife sterilisers or the distilled water from the Distech.

Final effluent treatment using membrane technology to produce a Class-A reclaimed water

The secondary treated effluent from many plants could be used for higher value purposes than irrigation of pastures or crops. In South Australia reclaimed water has been classified into four categories, A, B, C and D. The highest category – Class A – can be used for purposes such as primary contact recreation, residential non-potable and municipal use with public access. These classifications are widely accepted in Australia. It is assumed that Class A reclaimed water can be sold for about 80% of the value of potable water. The cost of membrane treatment by microfiltration (MF) followed by disinfection with UV are estimated (Leslie, 2004) to be:

Quantity of effluent produced	11 kL/T HSCW
No. of plants	20
Cost of secondary effluent treatment	$0.30 per kL
Cost of MF treatment	$0.15 per kL
Sale price of reclaimed water	$0.60 per kL
Recovery rate	85%
Capital cost per unit	$1,200,000

6	Secondary effluent treated to Class A by membrane technology

GATE 3

	Likelihood of technical success	**0.72**
	Likelihood of commercial success	**0.88**
	Ease	**0.85**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**10.9**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**0**
	Benefit	**0.35**
	Leverage	**0.62**
	Project score	**0.64**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**942,947**

This is highly dependent on the sale price obtained for the treated water and the availability of a nearby customer. Under the current estimates the high capital cost results in a long payback period but if the sale price of the reclaimed water is only 50% of the cost of potable water, then the project would definitely not be viable.

High temperature rendering condensate treated by Nanochem absorption cartridge for reuse in rendering plant

The condensate from a dry rendering heat recovery unit is relatively clean but can be odorous and have a high nitrogen level. Nonochem have developed a process for stripping ammonium from waste water using a Mesolite exchange column.

Quantity of condensate available	0.15 kL/T HSCW
Number of plants that could implement	31
Operating cost	$1.50 per kL
Capital cost per site	$325,000

The results of the analysis were:

7	Treatment of rendering condensate by Nanochem ion exchange

GATE 3

	Likelihood of technical success	**0.78**
	Likelihood of commercial success	**0.77**
	Ease	**0.85**
	Planning year R&D costs ($K)	**0**
	Planning year + 1 R&D costs ($K)	**0**
	Planning year + 2 R&D costs ($K)	**0**
	Planning year + 3 R&D costs ($K)	**0**
	Planning year + 4 onwards R&D costs ($K)	**0**
	Sunk R&D costs ($K)	**0**
	Customer payback time ***(only valid if ROI / NPV calculation worksheet has been completed)***	**99.0**
	Time to commercialisation ***(only valid if ROI / NPV calculation worksheet has been completed)***	**99**
	Benefit	**0.39**
	Leverage	**0.54**
	Project score	**0.63**
====> Whole project	**Basic research**	**0%**
	Development	**0%**
	Technical service	**0%**
	Commercialisation	**0%**
	Support	**100%**
	NPV ($) ***(only valid if NPV calculation worksheet has been completed)***	**-3,075,419**

The high capital and operating costs ensure that the Nanochem is not viable under present operating conditions.

A summary of the results of the analyses is presented in Table 2.

Table 2. Payback period and NPV for each project

Reuse Option	Payback (years)	NPV (15 years)
1. Steriliser water to yards	5.5	$755,000
2. Viscera table to paunch	3.5	$746,000
3. Steriliser + handwash	4.9	$992,000
4. Distech treatment	-	-$1,510,000
5. Edible offal wash water to non-potable	3.9	$517,000
6. Membrane treatment of final effluent	10.9	$943,000
7. Nanochem treatment of condensate	-	-$3,075,000

Based on the current average water price, none of the projects has an outstanding payback period. It is clear that the options that require no treatment before the water is reused are the most attractive. Introduction of high capital and operating costs results in the process becoming difficult to justify at these water prices.

Ignoring the two projects with a large negative NPV, the other five are plotted against ease (Figure 1), which relates to the complexity of treatment and the ability to articulate the technology to regulators. A high value for 'Ease' means greater difficulty. Therefore the MF treatment (Project 6) is potentially profitable but due to its complexity may be more difficult to operate. The reuse of steriliser water (Project 1) is the easiest to implement because it produces a quite high standard of water and regulators can appreciate that it is likely to be sterile.

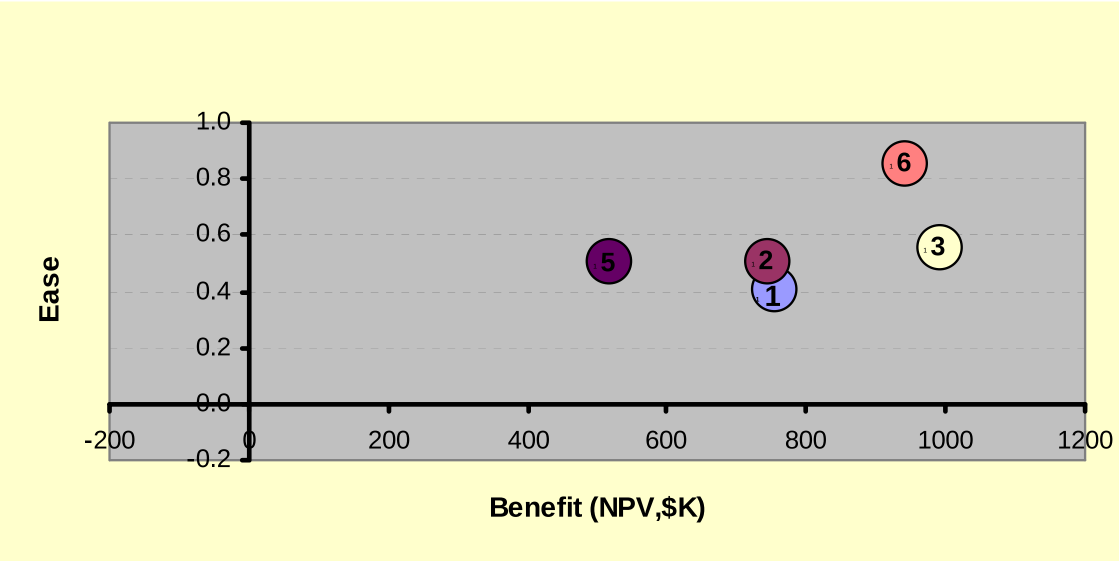

Figure 1: Net present value versus ease of implementation (1. sterilisers, 2. viscera table, 3. sterilisers + handwash, 5. offal wash, 6. membrane filtration)

Figure 2 provides results of the analysis that can be useful to management in comparing the benefit from a project against the probability of it being successfully completed. However, in this case, the benefit could be misleading as all projects scored the same low value for the payback period because they were all 3 years or greater. The benefit is therefore dependent mainly on the score for quality of the water produced which accounts for the Distech project having the highest score.

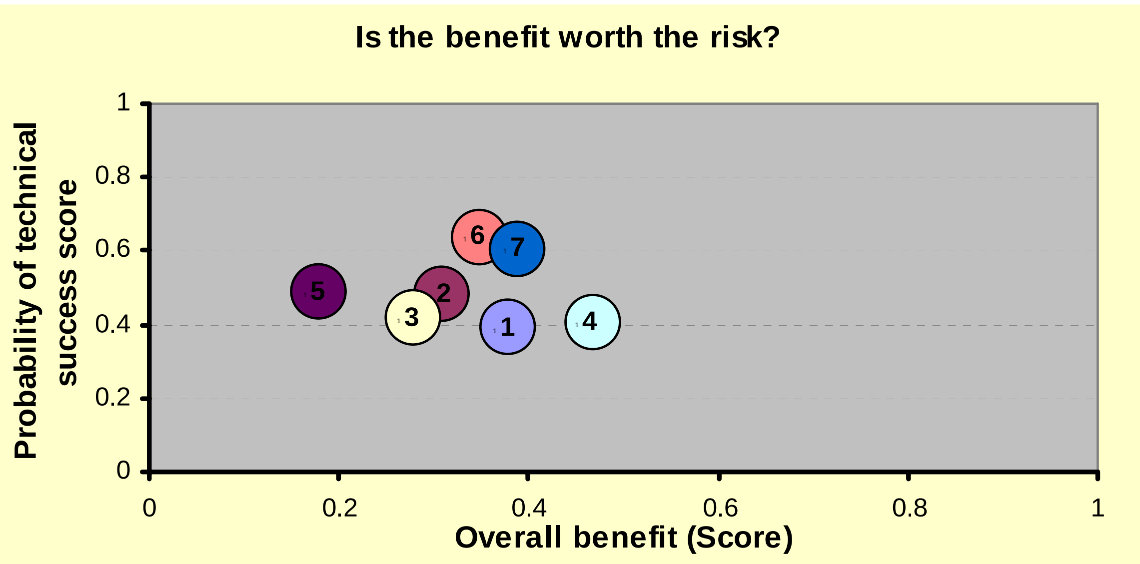

Figure 2: Project benefit versus probability of success

Effect purchase price of water

Average water prices for residential consumers in capital cities increased by about 20% in the seven years to 2002 which is in line with inflation (Figure 2). (The CPI increased by 17.7% over the same period). It is difficult to predict the future trend in water prices but it is likely that prices will continue to track the CPI.

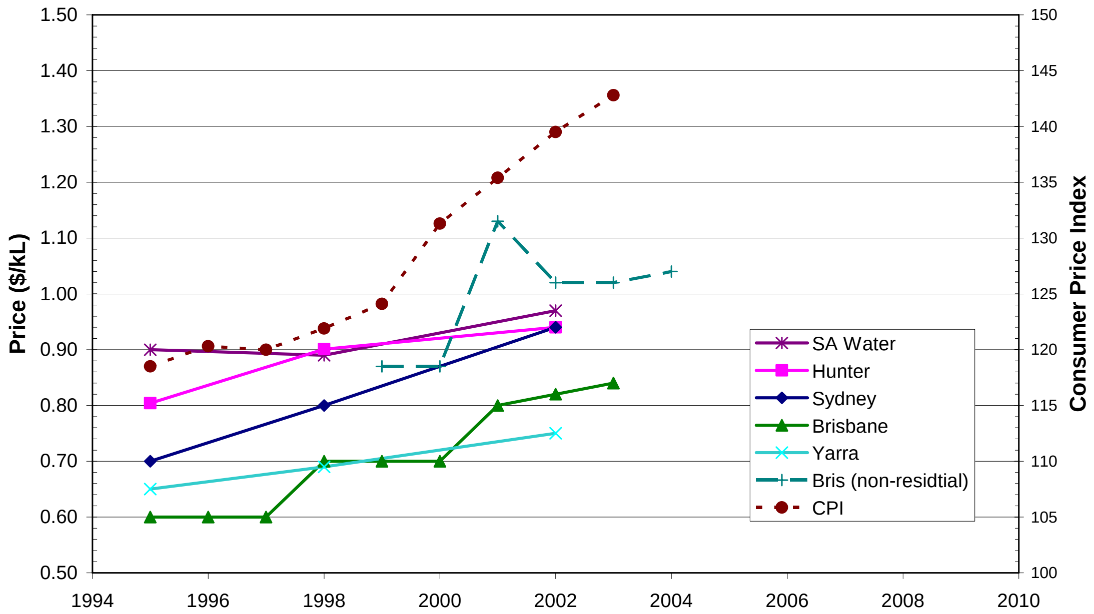

Figure 2: History of water prices in some Australian water authorities

Most of the water prices that are readily available are for residential users. Prices for large users (> 100,000 kL per annum) in Brisbane are higher than for residential users and have increased at a similar rate.

Water prices vary markedly between water authorities. In New South Wales in the financial year 2002/03, prices for non-residential high users varied from $0.20 to $2.68 per kL with most utilities charging between $0.40 and $1.00 per kL for larger users.

The effect of different water prices on the viability of a project can be clearly seen in Figure 3 where, for Project 3, a water purchase price of $2.50 per kL results in a payback period of about one year compared with nearly five years at the average $0.75 per kL. The cost of effluent treatment has been assumed to remain unchanged.

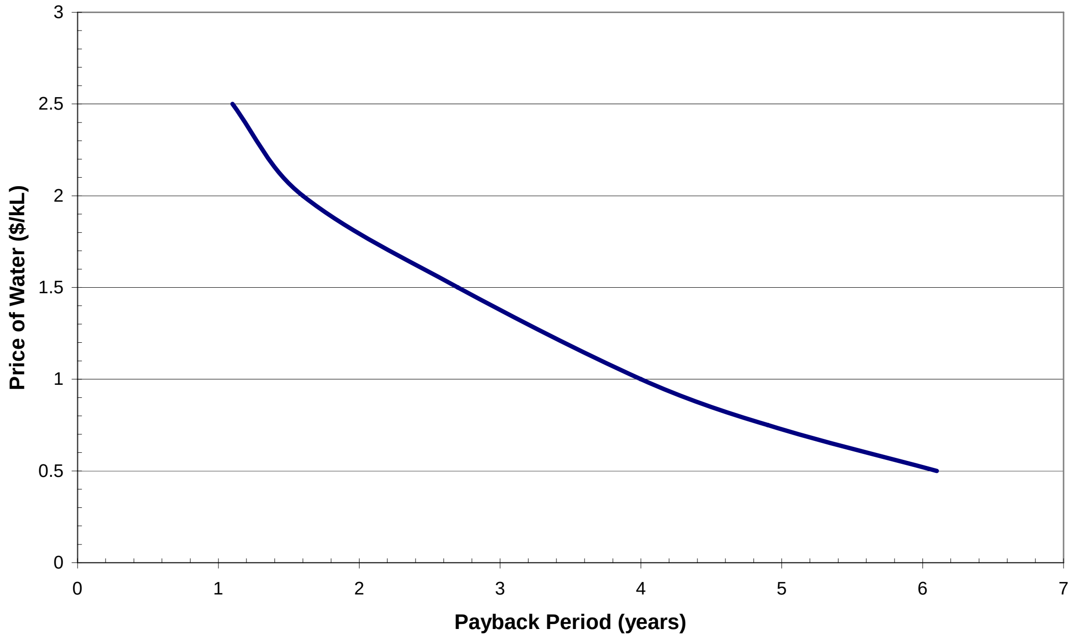

Figure 3: Effect of water purchase price on payback for reusing water from sterilisers and handwash basins

The projects in which there is no treatment of the water prior to reuse generally require the purchase price to be $1.50 per kL before a payback period of three years or less is achieved. In the case of projects such as the Distech, where treatment of the water is involved, the payback period is still over 10 years at a water purchase price of $2.00 per kL. This is a guide only and a full financial analysis would need to be carried out for a specific proposal under the circumstances that prevail at an individual plant.

Prioritisation of projects

At current average water prices, none of the projects achieve particularly high scores. However it is clear that where significant capital and operating costs are involved, water reuse is presently not an attractive area for investment although individual plant circumstances may affect this. If water prices increase in line with inflation, operating costs would need to reduce significantly before some of the treatment technologies become economic.

A suggested order of priority in which projects should be progressed is presented in Table 3.

Table 3: Project priority

Priority	Reuse Option
1	2. Viscera table steriliser to paunch or table initial rinse
2	5. Edible offal wash water to non-potable
3	3. Steriliser + handwash to non-potable
4	1. Steriliser water to yards
5	6. Membrane treatment of final effluent
6	4. Distech treatment of steriliser water
7	7. Nanochem treatment of rendering condensate

This order of priority is based on the calculated payback period and NPV for each project.

Watching brief

During the course of this project a watch has been maintained over the interest in reuse of water in overseas countries such as the United States. This has been done through the internet, CSIRO electronic journals, publications in the Food Science Australia library and through emailed industry circulars.

Regulatory conditions covering water reuse have been covered in the first section of this report. Kirby *et al* (2003) suggest that the quality of water and thus the degree of treatment required should correspond to the water use. Wastewater can be treated to such a high degree that it can be safely used as a supplement to potable drinking water but this is expensive. They recommend developing a framework based on “fit for purpose” for water reuse in food production/processing. They also suggest that future options may include a scheme of water quality classification (i.e. not just potable and non-potable) based on the potential for the water to come into contact with food and the likely outcomes of downstream food processing activities.

Water and food-borne diseases are often closely linked therefore it is important that a HACCP-based approach be used for evaluating the requirements for microbiologically safe and acceptable water quality when reusing process water in the food industry (Kirby *et al*, 2003; Casini & Knochel, 2002).

Nunes (2004) introduced an element of caution in suggesting that although food processing companies are capable of treating wastewater to drinking water quality, they are not using it because of fear the public will find out. There is a perception that treated wastewater is bad and that means that water is not being reused in places where it could be.

Conclusions

Regulations pertaining to meat processing currently allow reuse of water for specific purposes. Reuse for other purposes will require preparation and submission of an application accompanied by supporting documentation. Applications for this alternative procedure should be allowable under the ‘approved arrangement’ under which the processing plant operates.

Analysis of water reuse options indicates that when a treatment is introduced to improve the quality of the water, the capital and operating costs involved result in the process becoming uneconomic for most plants under the current water pricing regime. Even investment in water reuse without treatment would result in a payback period of greater than three years at a water price of $0.75 per kL. For plants with water priced at $1.50 per kL, payback periods would be less than two years.

Water prices have historically increased at close to the rate of increase in the CPI. Provided they continue to increase at this rate it is unlikely that water reuse processes that have high capital and operating costs will ever be viable for the majority of plants unless there are dramatic reductions in costs or increases in water charges. However there may be plants where there is a restriction on the supply of potable water or where water prices and disposal charges are high resulting in several of these options becoming more attractive.

The economic analysis for the Australian industry indicates that reuse proposals where the water can be potentially collected with little capital outlay, such as the viscera table steriliser and edible offal wash, and reused for non-potable purposes should be given the highest priority.

Some of the proposals for reuse, such as in paunch emptying and viscera table initial rinse will require approval of an alternative process from AQIS. It is recommended that the process of obtaining approval be streamlined.

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