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Waterless Cleaning of Meat Processing Plants

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Abstract

Environmental managers within the meat processing industry have identified a need for "a quantum leap in technology and/or practice (associated with plant cleaning) so that food hygiene standards can be maintained, but at a fraction of the water use and at reasonable cost." This project has undertaken a technology search to identify new or emerging technologies or practices to meet this need. Water will always play an important role in cleaning but significant reductions are feasible. A number of recommendations are made that will deliver immediate benefits and position the industry for the future. It is also noted that there are cultural barriers to change that must also be overcome before the industry will benefit from this work.

Executive Summary

Environmental managers within the meat processing industry have identified a need for "a quantum leap in technology and/or practice (associated with plant cleaning) so that food hygiene standards can be maintained, but at a fraction of the water use and at reasonable cost." The objective of this project was "to identify emerging waterless, or water-reduced, cleaning technologies suitable for adoption by meat processing plants."

Review of current cleaning systems and practices

Current cleaning practices were observed at a number of industry sites. The dominant feature of the facilities and equipment was the lack of design for cleanability. Design features that could minimise the extent of soiling and increase the ease of cleaning of plant, were largely absent. Facilities are often crowded, equipment does not restrict the spread of solid materials, access to equipment for cleaning is often extremely difficult, and equipment incorporates features that accumulate soil and/or are difficult to clean.

Cleaning was dominated by manual hosing usually with low pressure high volume hoses without triggers or valves on the user end. Water use in automated systems observed during the site visits was on a par with, or higher, than systems based on manual hosing.

Technology and supplier search

A hierarchical approach was adopted to identify opportunities for reducing water consumption associated with cleaning. At each level of the hierarchy a number of prospective technologies were identified. These are:

Reduce the NEED for cleaning
- Design for cleanability
- Flooring systems
- Advanced surface finishes

Reduce the ROLE of water
- Vacuum collection & transfer systems
- Mechanical floor scrubbing systems
- Alternative cleaning fluids; steam, dry ice, ice
- Ultrasonic cleaning systems
- Novel sanitation systems

Increase the EFFICIENCY of water use
- Pressure washing systems
- High efficiency belt and tunnel washing systems
- Monitoring and targeting water use

RECYCLE and REUSE water
- Automated cleaning & clean in place (CIP) systems

Cleaning the meat plant of the future

Water will continue to play an important role in cleaning of meat plants for the foreseeable future. However significant reductions in water consumption associated with cleaning are feasible.

No single technology will replace the current wide spread use of water. Specific technologies will need to be applied to specific applications and the overall solution will incorporate a range of technologies and practices.

To assist plant managers and engineers to begin to consider how their plants will need to change the outcomes of the technology search process have been used to develop a set of cleaning system design and operating principles for the meat plant of the future. Together the design principles will lead to the development of cleaning systems that use significantly less water than current practice. The study recommendations will allow the industry to progressively adopt these principles.

Recommendations

Recommendations have been made at two levels - actions that will deliver immediate benefits to the industry, and actions that will position the industry for the future.

What to do now because it makes sense NOW:

- Implement Monitoring & Targeting of water use
- Develop a meat industry Good Design Guide
- Be serious about the introduction of high efficiency washing systems
- Eliminate matting from meat processing facilities

What to do now because it makes sense for the FUTURE.

- Review design of product transfer systems for cleanability
- Develop and prove a robotic mechanical scrubber
- Demonstrate clean in place (CIP) technology on new process equipment

Impact of the work

Although a number of prospective technologies have been identified by the study the likely impact of the study is considered to be low unless the industry acts to overcome significant cultural barriers that were also identified in the study.

The meat industry has a poor record of innovation relating to cleaning systems and factors contributing to this inability to successfully adopt technology include:

- Lack of adequate measurement systems to assess technology performance
- Poor engineering integration of the technology into the broader plant infrastructure
- Low priority given to cleaning related investment compared with other issues, eg occupational health and safety
- Poor communication to, and training of, cleaning staff
- Lack of capital for investment in process improvement projects

As a consequence the final recommendation of the study is:

- Adopt a strategic approach to achieve change in water use

Contents

1 Background

1.1 Achieving a Step Change in Water Use

The Terms of Reference for this project state that the meat processing industry has a need for "a quantum leap in technology and/or practice (associated with plant cleaning) so that food hygiene standards can be maintained, but at a fraction of the water use and at reasonable cost."

The Terms of Reference also identified the project objective as being "to identify emerging waterless, or water-reduced, cleaning technologies suitable for adoption by meat processing plants."

The identification of technologies alone will not address the industry need. To achieve a step change in water use associated with cleaning, the industry will need to adopt a strategic approach that incorporates a number of elements:

Physical/Engineering Factors
- Technological innovation
- System design and integration

People/Management Factors
- Management commitment
- Cultural change
- Regulatory change

The focus of this study is the physical/engineering factors.

The industry need identified by MLA will require a change in paradigm with respect to the design and operation of processing plants and as such, this project must be viewed as the first step in a broader industry change process.

2 Project Objectives

2.1 Project Objective and Issues to be Addressed

The project objective is "to identify emerging waterless, or water-reduced, cleaning technologies suitable for adoption by meat processing plants."

To achieve this objective the Terms of Reference required that the following issues be addressed:

1. Provide a concise description of the standard current cleaning technologies and practices used in Australian meat processing plants.
2. Perform a world-wide search for emerging food facility cleaning technologies, systems and practices that have as their central characteristic the use of zero, or much reduced water consumption relative to current practice.
3. Evaluate the technical and economic feasibility of adopting selected technologies and/or practices identified by the search in Australian meat plants. The feasibility study needs to incorporate food safety requirements into the assessment and bear in mind that these will be typically applied to existing facilities – not greenfield sites.
4. Provide recommendations for further work.

3 Methodology

3.1 Review of Current Cleaning Systems and Practices

A cleaning system survey was completed at three sites. The three sites surveyed were selected in consultation with the MLA Project Manager to provide a representative sample of the range of cleaning procedures currently practised within the industry.

The cleaning systems on these sites were reviewed to provide the following data:

- Equipment/process areas being cleaned
- Qualitative estimate of the quantity and nature of soil to be removed
- Frequency of cleaning
- Method of cleaning/equipment used
- Level of cleanliness desired/achieved
- Qualitative estimate of resources (eg water, energy, labour, chemicals) used in cleaning

The scope of the survey was limited to process areas and equipment and excluded stock yards.

3.2 Cleaning System Design Hierarchy

To provide a foundation on which technical change could be achieved, a hierarchical approach to the design of meat industry cleaning systems was adopted.

At each step of the hierarchy opportunities for the introduction of new technologies and/or practices were identified by questioning the key factors that drive the consumption of water during the cleaning process.

3.2.1 Reduce the NEED for cleaning.

The first step of the hierarchy is to understand the requirement for cleaning of a particular plant area or equipment surface.

- What can be done to reduce the level of soiling of the plant/surface?
- What is the nature of the soil to be removed?
- What level of surface cleanliness is required?

The key question at this step of the hierarchy is:

- What process or technological changes can be applied to reduce the severity or frequency of the cleaning task?

For example, changes to the physical design of plant may reduce the rate of accumulation of physical deposits, or modification of surface properties of the materials of construction may reduce the rate at which surfaces become dirty and/or increase the ease with which soils or biofilms can be removed from the fouled surfaces.

3.2.2 Reduce the ROLE of water

Having understood the requirements of the cleaning task, the next step is to understand the role or function of water in achieving that task.

Cleaning (the removal of soil from a surface) is achieved through the application of:

- Mechanical energy (eg high pressure water, manual scrubbing),
- Thermal energy (eg hot water)
- Chemical energy (eg detergents, sanitisers)

The cleaning process can be considered to be the application of these different forms of energy (alone or in combination) in the appropriate sequence for the appropriate period of time.

Conventional cleaning systems have been based on the use of water because it can readily deliver all three energy forms to the soiled surface:

- Turbulence / pressure delivers mechanical energy
- Hot water delivers heat to the surface
- Most of the chemical reactions associated with the cleaning process are aqueous phase reactions and water delivers and removes reactants and reaction products to/from the surface.

To break the paradigm of water based cleaning systems each step of the cleaning process needs to be analysed to determine what function water is playing. The use of water in each role can then be questioned and alternative technologies identified, for example:

- If water is providing mechanical energy, can that mechanical energy be supplied by a different means?
- If water is providing heat, is the heat required, or can it be provided by other means?
- If water is used to deliver cleaning chemicals to the surface, are alternative systems available or can the amount of water be reduced?
- If the water is used to rinse chemicals off the surface, can alternative chemicals be used that do not require removal, or can another medium be used to remove them?

3.2.3 Increase the EFFICIENCY of water use

It is important to ensure that water that must be used is used as efficiently as possible. The amount of water actually used during cleaning may be significantly greater than the amount required to achieve the cleaning duty.

An important aspect of cleaning system design is the automation and control of the cleaning process. Cleaning processes may be manual and thus poorly controlled, or automatic but linked to fixed time schedules or fixed procedures that are not related to the initial level of soil, or the actual surface cleanliness on a particular day.

The questions to ask at this step of the hierarchy are:

- Can existing technology or equipment be replaced by new equipment with a higher water use efficiency?
- What automation, technologies or sensors can be applied to enable the cleaning process to be controlled to the level required?

3.2.4 RECYCLE and REUSE water

Up to this step of the hierarchy the objective has been to reduce water consumption associated with individual cleaning tasks.

In meat processing plants the water/cleaning chemicals are predominantly single use. The water and chemicals are supplied to the area or equipment to be cleaned and waste water containing chemical and soil is removed from the area.

The question to be asked is:

- Can the cleaning system be redesigned to achieve a further reduction in overall water use by the introduction of technologies to recover and recycle water and/or cleaning chemicals?

3.3 Technology Search

The hierarchical approach to cleaning system design outlined above has been applied to the significant water consuming cleaning processes identified in the review of current practice. This has provided a list of prospective technology needs required to enable change of the magnitude required.

A range of technology search techniques have then be employed to identify technologies that have the potential to meet these needs. Extensive use was made of web and literature search engines. In addition research institutions and supply companies known to be active in technology areas relevant to the study were contacted directly. Other meat industry reports (eg MLA 1995, MLA 2002, MLA 2007a) along with cleaning and hygienic design reviews (eg Wilson 2006, EHEDG 2007) have been used to identify emerging technologies.

Companies and organizations that were targeted included:

- Cleaning equipment and cleaning chemical supply companies
- Food industry research facilities/companies
- Materials science research facilities/companies
- Meat processing equipment supply companies
- Meat processing plant design/construct providers

Contact was primarily made by email or telephone. In addition a limited number of face to face interviews were also undertaken.

The objective of the technology search was to enable a listing of prospective technologies to be developed that, where possible, included:

- Technology type
- Industry need addressed by technology
- Potential sources of technology
- Current status/ phase of development
- Summary performance characteristics
- Indicative cost data

Depending on the stage of development of the technology the amount of available information varied widely. Where the technology was well developed sufficient information was obtained from representative suppliers, the technology search was not a comprehensive review of all suppliers.

3.4 Technology Screening and Feasibility Evaluation

The study has identified a wide range of technologies at differing stages of development all offering a different range of benefits, some of which are only achieved if the technology is applied in conjunction with other technologies. To allow for this complexity a simple feasibility ranking scheme has been applied to the technologies.

It is based on an assessment of the technical, commercial and cultural feasibility of the technology. The rating scale for each criteria is as follows:

Score	Technical Feasibility	Commercial feasibility	Cultural feasibility
1	Low risk - Already commercialised or close to commercialisation	Anticipated pay back <2 years	Good fit with industry capability/culture - little change required
2	Medium risk - Available 3-5 years / development from existing technology	Anticipated pay back between 2-5 years	Moderate change required - achievable with integrated change /training program
3	High risk – eg long term development from fundamental science	Payback >5 years	Poor fit with industry - significant change required

A simple scoring system has been used to get a single overall HIGH, MEDIUM or LOW feasibility rating. A HIGH ranking was given to technologies with a total score for the three factors of 3 or 4, MEDIUM to scores of 5, 6 or 7 and LOW to scores of 8 or 9.

4 Results and Discussion

4.1 Analysis of Site Data and Observations

4.1.1 Soil Type and Soil Level

The observations of facilities prior to the commencement of cleaning has been summarised to give a description of the soil type and soiling level by plant area or equipment type. This is presented in Appendix 1.

4.1.2 Cleaning Practices

Although the soil type and soil levels vary considerably across a site, the approach to cleaning of plant and facilities is relatively standardised.

- Pre-clean – manual physical removal of gross solids
- Hose-down – extensive manual hosing of facilities and equipment to remove soil
- Foaming – application of foam based chemicals
- Manual scrubbing – manual cleaning of surfaces to remove soil and prevent scale buildup
- Rinsing – removal of residual foam and soil
- Sanitising – application of sanitiser to kill microorganisms

Some areas of the plant where the level of clean is not critical will not be subject to all of the steps of this process. Other items of equipment may have specific procedures suited to the specific item. The cleaning method typically associated with each area of plant is summarised in Appendix 1.

In all plants visited the hose-down phase was the most significant activity. When combined with the final rinse, many staff spent many hours hosing plant and equipment. Although highly dependent on plant scale, time spent hosing in the plants visited was typically of the order of 50 to 100 hose-hours per clean. With water consumption of order 2-3 kL/hose-hour this approach to cleaning is very water intensive.

Hosing was dominated by the use of standard relatively low pressure systems with simple nozzles, usually without triggers or valves on the user end. Mobile high pressure units were used but in a minority of instances. A fixed high pressure unit was installed in one plant but was only operated as a demonstration, not being used as a standard part of the cleaning process.

Hosing is such a dominant activity because it is an effective and fast way of moving solids, heating and melting fat, and removing soils and it can achieve these outcomes from a considerable distance. In many plants access is difficult and being able to clean from a distance of 2 or 3m makes the cleaning process easier and faster.

Although all plants have internal microbiological standards of surface cleanliness set as part of the quality system, the focus of the cleaning crews is the immediate measure of passing the AQIS inspection of the plant prior to start-up each morning. This is dominated by a visual inspection requiring all meat contact surfaces to be spotless.

4.1.3 Resource Utilisation

Total plant raw water consumption at the plants visited was in the range 6 to 8.5 kL/tHSCW. This compares with 10.6 kL/tHSCW reported as average industry performance (MLA 2005). This indicates that the water use practices in the plants visited is likely to be typical or better than those across the industry as a whole.

On average cleaning operations accounted for approx 21% of the raw water use. This corresponds to approx 1.5 kL/tHSCW. Slaughter floor cleaning use averaged 0.8 kL/tHSCW and boning rooms 0.9 kL/tHSCW.

Labour is the largest component of the cleaning cost. On a simple head count basis cleaning labour is of order 5% of the production labour input.

For plants running double shifts (especially boning rooms) the most pressing constraint on the cleaning process was time. The pressure was on the cleaning crews at all plants to have the plants clean and ready for start-up inspections.

4.1.4 Facility and Equipment Design and Operation

The dominant feature of the facilities and equipment observed across the plants visited was the lack of design for cleanability.

Meat processing facilities are handling large quantities of difficult to handle solids. This makes the design challenge significant, however the meat industry is not the only sector of the food industry facing these challenges. Design features that could minimise the extent of soiling and then to aid the ease of cleaning of plant, were largely absent.

Facilities are often crowded, equipment does not restrict the spread of solid materials, access to equipment for cleaning is often extremely difficult, and equipment incorporates features that accumulate soil and/or are difficult to clean.

Anecdotal evidence suggests that OHS requirements are given a much higher priority in the design hierarchy.

Where cleaning processes have been automated, labour or time saving appear to have been the objective. Water use in automated systems observed during the site visits was on a par or higher than systems based on manual hosing.

Where new cleaning technology, eg pressure washers, had been introduced into plants the level of training and follow-up by management did not appear to have been sufficient to embed the technologies in daily operations. As a consequence the benefits (eg water savings) were unlikely to be achieved on an ongoing basis. In some instances the presence of non-English speaking staff on the cleaning crews may have exacerbated training difficulties.

The key performance measure of the observed cleaning crews was the avoidance of lost production time. Time is lost if the cleaning crew runs late, or if remedial cleaning is required after the pre-start inspection of the plant. Any potential changes to cleaning systems to reduce water consumption must not impact on the ability of the cleaning crew to meet this KPI.

4.1.5 Water Saving Experience and Attitudes

Site personnel were supportive of the objective of reducing water use but were focused on incremental change, seeking knowledge on tools/techniques that could be immediately applied.

Discussion of alternative technologies almost invariable provoked a “We tried that and it didn’t work” response. Step changes in water use associated with cleaning will require a paradigm shift within the industry.

4.2 Prospective Technologies and Practices

A large number of technologies and practices that have the potential to reduce water consumption associated with cleaning have been identified. To allow these technologies and practices to be brought together into a plan for change in the industry they have been grouped and then classified based on their place in the overall hierarchy of cleaning design. The overall listing of technologies and practices is:

Reduce the NEED for cleaning

- Design for cleanability
- Flooring systems
- Advanced surface finishes

Reduce the ROLE of water

- Vacuum collection & transfer systems
- Mechanical floor scrubbing systems
- Alternative cleaning fluids; steam, dry ice, ice
- Ultrasonic cleaning systems
- Novel sanitation systems

Increase the EFFICIENCY of water use

- Pressure washing systems
- High efficiency belt and tunnel washing systems
- Monitoring and targeting water use

RECYCLE and REUSE water

- Automated cleaning & clean in place (CIP) systems

Each of these areas is discussed in greater detail in the following sections. This includes an assessment of the potential benefits of each and an assessment of its feasibility.

To achieve a step change in water consumption associated with cleaning will required many of the identified technologies/practices to be implemented alongside each other. A set of design principles are presented in Section 4.3 to demonstrate how the technologies can come together to enable the level of change required to meet the industry need.

4.2.1 Reduce the NEED for cleaning

Design for Cleanability

Description

Hygienic design and design for cleanability have been the subject of considerable effort for many sectors of the food industry, eg dairy, brewing, consumer ready products.

Good design practices have been formalised through the work of groups such as the European Hygienic Engineering Design Group. A Good Design Guide for the meat industry would capture existing knowledge and provide practical design guidelines for both new and existing facilities.

There is an opportunity for the meat industry to significantly improve its design practices to:

a) Contain solids so that the need for cleaning is reduced or is constrained to specific locations, and
b) Improve the cleanability of plants so that the soil that cannot be avoided can be removed more readily.

Aspects of the design guide would include restricting the spread of solids that become waste, eliminating features that accumulate soils and are difficult to clean, and improving access to plant for cleaning.

Industry Need / Application

This is a general need across most areas of processing plant and the design guide would include flooring systems and advanced surface finishes discussed in following sections.

In addition to the general need for improvement, a reassessment of the design options for boning room conveyor systems is a high priority special need. Modular belt conveyors effectively move product, however they are equally effective at spreading difficult to clean soil across large areas of stainless steel that is used to surround and support the belts and drive systems. The belts are also notoriously difficult to clean. Systems that constrain the spread of meat, blood and fat, need to be the basis for a review of current practice. Systems based on the use of totes could be one alternative solution.

Status

The meat industry lags behind other sectors of the food industry in application of good design practices to improve plant cleanability.

The need for a Good Design Guide was highlighted over 10 years ago (MLA 1995) and the delay in implementing this represents a significant lost opportunity for the industry.

Potential Water Saving / Other Benefits	Potential benefits will vary significantly, however estimates based on reduction in “hose-hours” suggest that a well designed slaughter floor could achieve water savings of up to 15%, while the saving is potentially higher in a boning room, up to 25%. The other significant benefit from improved cleanability is reduced plant turn-around times, and reduced labour costs associated with cleaning.
Feasibility Rating	Overall: HIGH Scores: Technical 1 / Economic 1 / Cultural 2
Recommendations	1) The first priority is the development of a Good Design Guide for the meat industry. A project should be established to draw on the expertise within the industry and combine this with knowledge and experience from other food processing sectors. The project scope should also include technology transfer to inform and train industry designers and engineers along with fabricators and suppliers to the industry of the principles and benefits of design for cleanability. 2) A second priority is a review of options for boning room conveying systems, with the aim of identifying alternatives to modular conveyor based systems that deliver the required operational functionality but are significantly easier to clean.
Source of Technology / Knowledge	There is a considerable pool of knowledge relating to hygienic design of food processing plants generally. Significant hands-on knowledge relating to good and bad practices exists within meat processing facilities, however it has not been brought together in a way that is accessible. Established sources of knowledge include: http://www.ehedg.org/ http://www.hygienic-processing.com http://www.campden.co.uk/content.htm Some work has also been undertaken on hygienic design of conveyor systems eg DTI (2006).

Flooring Systems

Description

Many different flooring systems have evolved and been used in the meat industry to meet the often conflicting industry demands for flooring surfaces or systems that are durable, anti-slip, anti-fatigue and cleanable.

Many different solutions have been adopted by the industry, and they vary dramatically in their cleanability, and hence the use of resources to clean them.

One solution that is widespread across the industry is the use of floor mats to provide an anti-fatigue, anti-slip surface. The anti-fatigue functionality can be provided by work boots that incorporate anti-fatigue layers, or anti-fatigue in-soles in standard boots. A range of anti-slip coating systems are widely available for food industry applications. Combined these options could eliminate the need for floor mats.

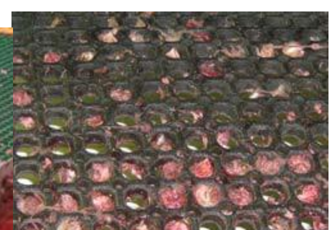
The balance of functionality / cleanability of other flooring systems needs to be reviewed and solutions that increase cleanability while still delivering functionality and durability need to be identified and promoted across the industry.

Industry Need / Application

Matting is used widely across meat processing sites. It is particularly problematic in the meat industry as the mats potentially become very heavily soiled and they are particularly difficult to clean. They interfere with attempts to physically remove soil from facilities prior to cleaning, and the not uncommon practice of hanging the mats and blasting with water spreads undesirable soil around facilities increasing the general cleaning task, and multiplying the risk of microbial cross contamination.

Flooring systems should be an important component of the Good Design Guide recommended above.





Status

Worker fatigue is not a new problem and so the debate about different solutions to the problem of worker fatigue is not new. A recent study comparing the effects of anti-fatigue mats and shoe in-soles found no significant difference in the levels of worker fatigue or discomfort between the two options (King 2002) indicating that alternatives to matting are a real option for the industry. Anti-fatigue in-soles and anti-fatigue boots are commercially available.

Equally many anti-slip flooring surfaces have been developed and are widely available through flooring system providers.

Potential Water Saving / Other Benefits	The potential water saving associated with the removal of mats is marginal depending on the number of mats in use and the areas of the plants in which they are used. Savings of up to 5% are possible. There would also be labour cost reductions associated with the elimination of a cleaning task. The biggest potential benefit is the removal of a significant food safety hazard from the processing plant.
Feasibility Rating	Overall: HIGH Scores: Technical 1 / Economic 1 / Cultural 2
Recommendations	1) Assess the suitability of commercially available anti-fatigue footwear and anti-slip surfaces for application within industry, and develop a change management program to secure adoption of the preferred options in preference to matting. 2) Include a thorough review of flooring systems in the development of the Good Design Guide.
Source of Technology / Knowledge	Suppliers of safety boots incorporating anti-fatigue features include: http://www.timberland.com/ Speciality suppliers of anti-fatigue in-soles include: http://www.viscolas.com/ http://www.megacomfort.ca/personal.aspx

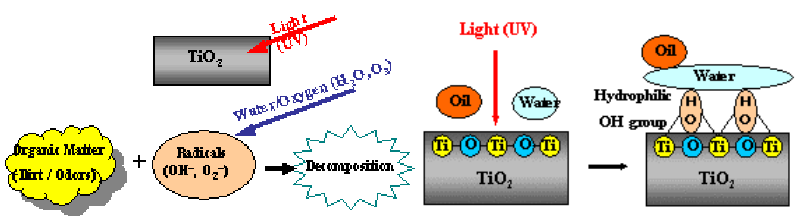
Advanced surface finishes

Description

The application of developments in nanotechnology has had a significant impact on the development of easy to clean, self cleaning and anti-microbial surfaces.

In particular the development of photocatalytic titanium dioxide surfaces (Fujishima et al 2006) has the potential to have a significant impact of cleaning within meat processing plants. These surfaces offer two significant advances over earlier generations of anti-microbial surface. The first is that the antimicrobial activity is catalytic – it has an unlimited life, and the second is that it makes the surface hydrophilic. This means water readily penetrates beneath the soil enabling rapid soil removal. The anti-microbial and hydrophilic activity are photocatalysed by UV light, however standard artificial lighting provides sufficient UV for the activation.

Other developments in surface modification of stainless steels offer significant future benefits in low soiling / easy clean surfaces.



Industry Need / Application

Easy clean surfaces are an enabler that in combination with good design for cleanability and new cleaning technologies discussed elsewhere in this report will be part of the step change to low water use cleaning systems. They are not a solution on their own as water intensive cleaning practices will continue to be water intensive cleaning practices regardless of surface quality unless they are accompanied by other changes in practice.

The potential for change enabled by new surface technologies is enormous. Initial development with focus on material of construction for facilities eg wall tiles, panels and flooring materials. Future developments will include stainless steel.

Status

Photocatalytic TiO_2 technology has been commercialised for tiles, glass and spray on coatings. The status of its application to sandwich panel surfaces and epoxy coatings widely used within the industry is currently unclear, however the high level of research literature in this area is indicative of many emergent products.

Modifications to stainless steel surfaces are still at the research stage.

Potential Water Saving / Other Benefits

As discussed above direct savings from application of this technology alone are low, however advanced surface finishes are an enabler for significant future change.

Feasibility Rating	Overall: MEDIUM Scores: Technical 1 / Economic 2 / Cultural 2
Recommendations	Include surface finishes in the scope for the Good Design Guide. Individual processors undertaking capital works should include commercially available surfaces (eg tiles) incorporating photocatalytic TiO_2 in their project specifications.
Source of Technology / Knowledge	Commercial supply of tiles and spray on coatings, eg: http://www.ceramicsolutions.com.au/hydrotect.asp http://www.teamenviroclean.com/home Research into further application still on-going, eg: http://www.newkast.or.jp/english/index.html http://www.pra-world.com/sig/hygienic-coatings/

4.2.2 Reduce the ROLE of water

Vacuum collection & transfer systems

Description	Two separate roles are feasible for centralised vacuum systems based on liquid ring pumps and the use of cyclone separators. The first is a distributed waste collection system to collect gross solids during breaks in production and post production. The second is the use of vacuum transfer systems to transfer viscera in enclosed systems to reduce the spread of soil associated with current transfer systems. Good design and clean in place capability would be required to maintain the vacuum system in hygienic condition, but developments in pigging with sponges or ice plugs are ideally suited to this application.
Industry Need / Application	The physical removal and collection of gross solids prior to cleaning by other methods is currently haphazard. Under current cleaning regimes application of vacuum collection systems would deliver marginal benefits, but in the future as cleaning becomes more automated, vacuum systems may play an important role removing soil that would prove problematic for scrubbers or automated jet washers. Vacuum transfer of viscera is an alternative to current technology that potentially reduces waste.
Status	Vacuum technology and equipment is well know and established in other sectors of manufacturing. Vacuum technology is widely used in poultry industry to transfer viscera and waste from centralised collection points to waste bins or rendering plants. A demonstration vacuum waste collection has delivered positive results for many years in a Danish pig abattoir reducing water consumption and waste water BOD levels (DMRI 2008).
Potential Water Saving / Other Benefits	Direct water savings associated with the introduction of vacuum waste collection systems are probably low (<2%) but the technology is an enabling technology that has the potential to allow greater application of automated systems in the future.
Feasibility Rating	Overall: MEDIUM Scores: Technical 1 / Economic 2 / Cultural 2
Recommendations	Note availability of technology and adopt in conjunction with adoption of automated cleaning systems for specific areas of process lines or plants. Include evaluation of vacuum transfer systems in the scope of the Good Design Guide.
Source of Technology / Knowledge	Danish pig industry demonstration: http://www.envirowise.gov.uk/home DMRI 2008

Mechanical floor scrubbing systems

Description

Mechanical floor scrubbing systems are widely used to clean floors in many commercial and industrial situations.

The use of mechanical energy from scrubbers in preference to water pressure offers the potential to significantly reduce water consumption. The combination of heat, mechanical action and chemicals needed to provide a thorough clean in the meat industry needs to be defined.

A potential extension of this technology is to combine it with developments in robotic technology. Cleaning robots incorporating sophisticated intelligence are commercially available for domestic /commercial applications. These can utilise autonomous navigation in relatively open spaces, or can follow a fixed path in congested areas.

If the competing demands for compactness vs chemical and energy supply were such that the robot cleaner required an umbilical cord supplying chemical and energy this development could be linked with options for centralised chemical supply systems discussed separately.

Industry Need / Application

Mechanical scrubbers have not been adopted within the meat industry because of barriers associated with the cluttered nature of much of the plant, the nature of the soils and the cost.

There are many relatively open areas in meat plants that require daily cleaning (eg coolrooms, carcase transfer areas) that would be ideally suited for mechanical scrubbing. These should be the focus of initial applications.

Status

Mechanical scrubbing widely applied outside the meat industry. Robotic cleaning technology also widely applied.

Both technologies need adaptation to the meat environment.

Potential Water Saving / Other Benefits

In applicable areas of the plant where floor cleaning is the predominant cleaning need water savings could be dramatic eg >90%. If combined with robotic technology there would also be significant labour savings.

Feasibility Rating

Overall: MEDIUM

Scores: Technical 2 / Economic 2 / Cultural 2

Recommendations	An industry project, potentially in partnership with equipment supplier, should be established to develop and trial a prototype mechanical cleaner to prove the cleaning technology. If this is successful the second step would be the combination of the cleaning technology with robotic technology.
Source of Technology / Knowledge	Mechanical sweepers commercially available eg: http://www.nilfisk-alto.com/ http://www.windsorind.com/products/index.php?f=1 http://www.duplexcleaning.com.au/salla.html Commercial cleaning robot applications eg: http://www.irobot.com/sp.cfm?pageid=95 http://www.floorbot.com/home.html

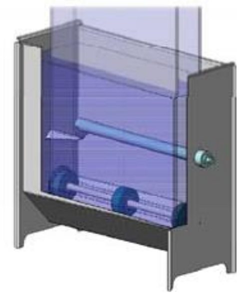
Alternative cleaning fluids – steam, dry ice, ice

Description	These technologies share the common characteristic that they replace the jet of liquid water used in current cleaning applications with an alternative working fluid. They all have the potential to work in a similar manner to water in belt cleaners or tunnel cleaners. The alternative systems are: • Saturated steam cleaners Low pressure saturated steam is the working fluid • Dry ice blast cleaners High velocity air stream used to entrain dry ice pellets providing physical abrasion of the surface • Water ice blast cleaners High velocity air stream used to entrain water ice particles providing physical abrasion of the surface

Industry Need / Application	These technologies potentially have application to the cleaning of slaughter floor conveying systems and hooks, boning room conveyors, and of items that can be cleaned in tunnel wash systems eg tubs, cutting boards and other removable items
Status	The stage of development varies with the working fluid. Steam systems that are designed for cleaning conveyor belting and for application in tunnel systems are commercially available, although the capital cost is higher than high efficiency water systems that are a competitive option. Dry ice and ice blasting systems have also been commercialised although to date these are relatively low technology single lance based systems.
Potential Water Saving / Other Benefits	For the systems that are converted the water savings are very high - >95%
Feasibility Rating	Overall: MEDIUM Scores: Technical 2 / Economic 2 / Cultural 2
Recommendations	Note availability of technology and apply to specific applications as appropriate.

Source of Technology / Knowledge	Steam systems: eg http://www.steamsolutions.com.au/ http://www.tecnovap.it/?synSiteLang=2 Dry ice systems: http://www.co2.com.au/ http://www.coldjet.com.au/index.html Ice systems: http://www.iceblast.net/faq00.htm

Ultrasonic cleaning systems

Description	Ultrasound has been used to enhance cleaning and sanitation efficiency in a number of food applications, including the meat industry, for a number of years. It could potentially be applied to a range of difficult to clean plant items and conveyor belts. A recent development has been an on-line belt cleaning system incorporating the use of ultrasonics. 
Industry Need / Application	Cleaning of tubs, cutting boards and other difficult to clean removable items. Potentially applicable to the cleaning of boning room conveyor belts.
Status	Ultrasonic cleaning principles known for many years. Dip-tank systems and conveyor belt cleaning systems are commercially available.
Potential Water Saving / Other Benefits	As ultrasonic cleaning is used to enhance existing cleaning systems, direct water saving potential is low, but the application of ultrasonics potentially offers time and other cleaning cost benefits.
Feasibility Rating	Overall: MEDIUM Scores: Technical 2 / Economic 2 / Cultural 3
Recommendations	Note availability of technology and apply to specific applications as appropriate.
Source of Technology / Knowledge	Commercial suppliers, eg http://www.ultrasonics.com.au/ http://www.vulganus.fi/index.html

Novel sanitation systems

Description	Water is used to deliver sanitation chemicals to surfaces as part of current industry cleaning processes. Alternative non water based systems may allow surfaces to be sanitised dry eg Pulsed UV, cold plasma. Pulsed UV is the most advanced technology likely to be applied to this application. Surface sanitation is achieved by passing the surface under the UV light source. 
Industry Need / Application	The potential application for this technology is the dry sanitation of boning room conveyor belts, the sanitation of tubs, cutting boards and other removable items.
Status	Pulsed UV systems available for packaging material and medical applications. No process equipment applications. Cold plasma systems in process of commercialisation
Potential Water Saving / Other Benefits	Water use associated with sanitation is a small component of current utilisation but is future potential for elimination of water based systems could be important.
Feasibility Rating	Overall: LOW Scores: Technical 2 / Economic 3 / Cultural 3
Recommendations	Note availability of technology and apply to specific future applications as appropriate.
Source of Technology / Knowledge	Commercial supplers eg: http://www.steribeam.com/ http://www.xenoncorp.com/steril_products.html#3000M Research papers eg Deng et al 2006

4.2.3 Increase EFFICIENCY of water use

Pressure washing systems

Description

Pressure washers reduce water consumption compared with low pressure/high volume uncontrolled hoses. Centralised and mobile systems are commercially available and are utilised within the industry, however application of the technology is still haphazard.

The complicating issue with the application of pressure washers is the level of atomisation of the water jet. When there is a significant atomisation use of pressure washers has the potential to spread bacteria around a facility creating a food safety hazard. The degree of atomisation is dependent on the operating pressure of the system and the nozzle type. Some commercially available systems run at pressures up to 200bar. At these pressures the degree of atomisation is significant and they are not recommended for general use in a meat facility. Systems are also available that run in the range 20-80 bar. At these levels atomisation is significantly reduced and with correct nozzle choice and use, effective, safe cleaning can be achieved with water flows of 15-25l/min. This can represent a significant saving on low pressure systems where water use may be up to 60l/min.

In addition to reducing the water flowrate pressure washing systems are fitted with nozzles that incorporate an on/off trigger. Many low pressure systems are not which results in them being left running when not in use.

Industry Need / Application

Hoses are, and will continue to be a key aspect of cleaning, the important objective is to reduce the volume of water required to achieve the cleaning outcome. Pressure washers operating at moderate pressures are a useful tool to effectively reduce water consumption across the whole meat processing facility.

Status

Many plants employ at least some mobile pressure washing units, however well engineered centralised units are still uncommon. The technology is readily available commercially.

There is considerable scope within the industry for a significant improvement in the application of pressure washing systems. Engineering of existing systems has often lead to reliability issues that have discouraged their use, and operator training has been inadequate to achieve the full benefits the systems offer.

Potential Water Saving / Other Benefits

Water savings are dependent on the existing systems used in plants, however they are significant in many applications typically 20-60%

Feasibility Rating	Overall: HIGH Scores: Technical 1 / Economic 2 / Cultural 1
Recommendations	The technology is available and proven. Companies that are committed to achieving best practice water use need to take serious steps to integrate the technology onto their sites and train cleaning staff to correctly use it.
Source of Technology / Knowledge	Several commercial suppliers eg: http://www.lagafors.com/Default.aspx?tabid=85

High efficiency belt and tunnel washing systems

Description

Washing of modular conveyor belts is a water intensive operation at the end of the shift in boning rooms. Current systems range from manual hosing the belt, to built in spray nozzles at the end of a belt, to purpose built washers. The water efficiency of these options can vary significantly – some purpose built units use more water than manual hosing, offering reduced cleaning time as their major benefit. Commercially available high efficiency built belt washers with low flow nozzles are available to wash modular belts of varying width. Units can incorporate blowers to dry the belt as well if required.

A wide range of commercial tunnel washers are available to clean bins, cutting boards, pallets, totes, crates, etc. Many of these systems incorporate water recirculation and drum filters to reduce water consumption. Many of the items that are suitable for washing in this type of equipment are currently washed using single use hoses.

Industry Need / Application

Belt washers could be applied to many of the belts in boning rooms. They do not solve the problem of washing the stainless steel structure of the conveyor system.
Standard applications of tunnel washers are for crates and totes, however the principle could easily be applied to the washing of other removable items eg cutting boards and tables, floor mats and flooring grids.

Status

Belt washers are commercially available in options that offer low water consumption or are steam based systems.

Tunnel washing equipment is commercially available now with varying levels of water efficiency. Future evolution required to allow for cleaning of a range of removable plant items. Incremental improvements are also required to increase level of internal recycle and reduce overall water consumption. Adoption of tunnels washers needs to be undertaken in conjunction with the redesign of facilities so that items of plant and equipment can be cleaned in this type of system.

Another future adaptation may be the application of other alternative working fluids, Section 4.2.3, or closed loop cleaning systems Section 4.2.4

Potential Water Saving / Other Benefits

Savings would primarily be focused in boning room applicatons. Scope for saving of order 20% of water used to clean boning rooms

Feasibility Rating	Overall: MEDIUM Scores: Technical 2 / Economic 2 / Cultural 2
Recommendations	1) High efficiency belt washing technology is available and proven. Companies that are committed to achieving best practice water use need to take serious steps to integrate the technology onto their sites. 2) Note availability of high efficiency tunnel washing equipment and apply to specific applications as appropriate.
Source of Technology / Knowledge	Belt washers, eg: http://www.machinerydevelopments.com/ Many commercial suppliers of tunnel washing systems. Extensive listing of suppliers of this equipment provided in MLA 2007b.

Monitoring and targeting water use

Description	Monitoring and targeting management techniques are widely used to measure and control resource (especially energy) utilisation. At the simplest level the systems involve installation of sufficient end use metering to provide meaningful use data, alongside data analysis systems to establish consumption targets and reporting systems to highlight, ideally in real-time, significant deviations from target. Successful systems provide real-time, or rapid feedback of resource consumption so that reports are meaningful to operators/cleaners. Measurement systems would also provide underlying information to evaluate application of all technologies discussed in this report.
Industry Need / Application	Monitoring and targeting could be applied to individual areas of plant or it could be applied on a site-wide basis. Once measurement systems were in place both cleaning and non-cleaning related water consumption would be monitored and controlled. The lack of adequate end use measurement systems is a barrier to innovation in the industry as accurate data is not available to assess performance of new technology.
Status	Widespread management approach to controlling resource utilisation, however there are no reported applications to cleaning water use in meat processing.
Potential Water Saving / Other Benefits	M&T systems applied to energy use systems typically report savings of order 15%. Similar savings should be achievable for water use in the meat industry as little systematic effort is currently applied to the measurement and control of water use. The other significant benefit of better water metering systems is that data becomes available for defining the benefits of any other water reduction initiative.
Feasibility Rating	Overall: MEDIUM Scores: Technical 1 / Economic 2 / Cultural 3
Recommendations	Establish a project to develop a meat industry water monitoring and targeting manual and promote its application across the industry. Project should cover all water use, not just cleaning related use, and could also include an energy M&T program to increase industry impact.
Source of Technology / Knowledge	Many best practice guides published for energy M&T systems and many suppliers of M&T software. For introduction: http://en.wikipedia.org/wiki/Energy_monitoring_and_targeting Typical software: http://www.energent.com/SEnergyTargeting.htm

RECYCLE and REUSE water

Automated cleaning and clean in place (CIP) systems

Description	Most cleaning in meat plants is manual, and where necessary requires manual disassembly and reassembly of equipment. Experience in other industries has shown that moving to automated systems where the cleaning cycle is controlled and reproducible, results in both labour and water savings. The water efficiency of automated systems is increased when they incorporate either centralised or distributed supply and recovery of cleaning chemicals and water. These can then be safely reused for cleaning multiple applications. Many variations of CIP systems have been developed to suit end use applications in the dairy and beverage industries.
Industry Need / Application	At the simplest level automated systems could be used to clean individual plant items on the slaughter floor or within a boning room. A good initial application could be high capital cost pieces of robotic equipment that are being introduced to the industry. A simpler potential application is tripe washers. Some conveyor belt cleaning systems are effectively rudimentary CIP systems. More complicated systems could be developed around the use of movable nozzles to clean whole rooms. Cleaning chemicals and water could be recycled via floor drains. A wide range of special use spray nozzles are available and these have been incorporated into many novel cleaning systems, eg automated car wash systems. Closed loop systems supplying chemicals and water could be linked to a number of end uses ranging from robotic floor cleaning, to individual plant item cleaners, to whole of room cleaners.
Status	Use of automated CIP and chemical recycle systems is widespread in other sectors of food industry. Not applied within meat industry. CIP systems widely applied in dairy industry and many design variations available. Many of the components for these systems are off the shelf items and cleaning chemical supply companies have extensive experience in the development of re-use chemical systems. The new element is the engineering of a system/chemical combination to match meat industry requirements.
Potential Water Saving / Other Benefits	The range of different systems encompassed by this grouping of technologies is very broad and so the potential benefits are vary significantly. The enabler that these technologies bring to the meat industry is reuse of chemicals and rinse water. In combination with other technologies identified in this report closed loop systems are the final element that could potentially provide the step change the industry is seeking.

Feasibility Rating	Overall: LOW Scores: Technical 2 / Economic 3 / Cultural 3
Recommendations	The industry should identify target equipment items on which to trial closed loop CIP style cleaning systems. Slaughter floor robots are potentially a good target for such a trial. This would provide industry experience with the technology and start it up the learning curve associated with the adoption of CIP technology.
Source of Technology / Knowledge	CIP equipment supply companies, eg: http://www.flogineering.com/default.aspx Cleaning chemical supply companies eg http://www.apchem.com.au/ http://www.cleantec.com.au/

4.3 Cleaning the meat plant of the future

Water will continue to play an important role in cleaning of meat plants for the foreseeable future. However significant reductions in water consumption associated with cleaning are feasible.

No single technology will replace the current wide spread use of water. Specific technologies will need to be applied to specific applications and the overall solution will incorporate a range of technologies and practices.

No two processing plants within the industry are identical and all plants are subject to differing environmental and financial pressures. As a consequence the final form that the cleaning systems on sites at any point in the future will vary dramatically. However there will be features that are common and to assist plant managers and engineers to consider how their plants will need to change, the outcomes of the technology search process have been used to develop a set of cleaning system design and operating principles for the meat plant of the future.

Together the design principles will lead to the development of cleaning systems that use significantly less water than current practice. The recommendations presented in Section 7 will allow the industry to progressively adopt these principles.

4.3.1 Design and operating principles to enable a low water use future

The proposed design and operating principles are:

- Plants should be designed to contain solids so that the need for cleaning is reduced or is constrained to specific locations.
- Facilities and equipment should be constructed from easy clean materials and should conform with principles of design for cleanability.
- Where possible process line equipment should be designed to be able to be automatically cleaned in place.
- Where equipment cannot be automatically cleaned in place, it should be designed to be removable so that it can be cleaned in high efficiency tunnel or closed loop washing systems.
- Cleaning should commence with the vacuum collection of waste where this is required to enable effective operation of mechanical scrubbers and automated systems.
- Mechanical floor cleaners, either with or without robotic control, should be used to clean open areas of processing plants,
- Use of automated cleaning systems should be maximised to deliver a controlled reproducible level of cleaning with minimum resource use.
- Where manual cleaning is required centralised pressure washing systems should be used in preference to low pressure high volume hoses.
- Cleanability should be a high priority factor in the design of product transfer systems (eg conveyors).
- Plants infrastructure should include closed loop cleaning systems with recycle of cleaning chemicals. These systems will provide cleaning resources to local CIP systems, mechanical scrubbers and whole room cleaners as appropriate. Cleaning protocols will be based on primary cleaning with recycled chemicals followed by potable water rinse and sanitising steps.
- Plant infrastructure should include sufficient end-use metering to enable active management of water use during production and cleaning

5 Success in Achieving Objectives

The project has successfully addressed the issues outlined in Section 2.1

- Current cleaning practices have been observed at a number of meat processing facilities and these have been summarised in a concise description of current cleaning technologies and practices. This description is presented as Appendix 1 to this report.
- A worldwide technology search has been completed to identify emerging food facility cleaning technologies, systems and practices that have as their central characteristic the use of zero, or much reduced water consumption relative to current practice.
- The technical, economic and cultural feasibility of adopting selected technologies and/or practices identified by the search has been evaluated. An overall feasibility rating has been assigned to each technology and is presented in Section 4.2.
- Recommendations for further work are provided in Section 7.

6 Impact on Meat and Livestock Industry

6.1 Impact on Meat Processing Industry – now and in five years

A number of technologies that have the potential to reduce water consumption have been identified. However there is no silver bullet to magically reduce water consumption associated with cleaning. Even in the current situation where water prices are increasing, water is still a cheap low capital cost cleaning resource.

The identification of technologies alone will not address the industry need to reduce water consumption. To achieve a step change in water use associated with cleaning, the industry will need to adopt a strategic approach that incorporates a number of elements:

Physical/Engineering Factors

- Technological innovation
- System design and integration

People/Management Factors

- Management commitment
- Cultural change
- Regulatory change

Observations made during the course of the project indicate that even when prospective water saving cleaning technologies have been identified, there are several examples where the industry has been unable to successfully adopt them. Factors contributing to this include:

- Lack of adequate measurement systems to assess technology performance
- Poor engineering integration of the technology into the broader plant infrastructure
- Low priority given to cleaning related investment compared with other issues, eg occupational health and safety
- Poor communication to and training of cleaning staff
- Lack of capital for investment in process improvement projects

Given these observations the reality of the current situation is that the short term impact of this project is likely to be minimal.

The prospect of change within five years is also dependent on the industry making a strategic commitment to the importance for change in this area.

For example one of the key recommendations of this report is for the development of a Good Design Guide. A similar recommendation was made to MLA in 1995 (MLA 1995). Thirteen years of inaction on this recommendation represents an enormous lost opportunity to change practice in the industry.

7 Conclusions and Recommendations

Recommendations have been made at two levels - actions that will deliver immediate benefits to the industry, and actions that will position the industry for the future. In addition a final recommendation concerning a strategic approach to change is made with the aim of ensuring that the technical recommendations are progressed.

7.1 What to do now because it makes sense now

7.1.1 Implement Monitoring & Targeting (M&T) of water use

Establish a project to develop a meat industry water monitoring and targeting manual and promote its application across the industry. The project should cover all water use, not just cleaning related use, and could also include an energy M&T program to increase industry impact. The scope of project should include resources for technology transfer / training as there is a significant gap between current meat industry practice and what is considered standard practice in other process industries. Improved metering

7.1.2 Develop a meat industry Good Design Guide

The industry should develop a meat industry Good Design Guide. The focus of this should be design for cleanability to:

a) Contain solids so that the need for cleaning is reduced or is constrained to specific locations, and
b) Improve the cleanability of plants so that the soil that cannot be avoided can be removed more readily.

7.1.3 Be serious about introduction of high efficiency washing systems

Medium pressure low volume washing systems are readily available and proven technology. Companies that are committed to achieving best practice water use need to take serious steps to integrate the technology onto their sites and train cleaning staff to correctly use it.

High efficiency belt washing technology is also available and proven. Again companies that are committed to achieving best practice water use need to take serious steps to integrate the technology onto their sites.

7.1.4 Eliminate matting from meat processing facilities

Assess the suitability of commercially available anti-fatigue footwear and anti-slip surface for application within industry, and develop a change management program to secure adoption of the preferred options in preference to matting.

7.2 What to do now to prepare for the future

7.2.1 Review design of product transfer systems for cleanability

The industry should undertake a review of options for boning room product transfer systems, with the aim of identifying alternatives to modular conveyor based systems that deliver the required operational functionality but are significantly easier to clean.

7.2.2 Develop and prove a robotic mechanical scrubber

An industry project, potentially in partnership with equipment supplier, should be established to develop and trial a prototype mechanical cleaner to prove the cleaning technology. If this is successful the second step would be the combination of the cleaning technology with robotic technology.

7.2.3 Demonstrate CIP technology on new process equipment

The industry should identify target equipment items on which to trial closed loop clean in place (CIP) style cleaning systems. Slaughter floor robots are potentially a good target for such a trial. This would provide industry experience with the technology and start it up the learning curve associated with the adoption of CIP technology.

7.3 What to do now to make something happen

7.3.1 Adopt a strategic approach to achieving change in water use

Because of the cultural barriers identified during the course of the study it is noted that the industry should adopt a strategic approach to change that integrates action to address people and management factors, as well as the physical and engineering issues that have been the focus of this work.

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9 Appendices

9.1 Appendix 1: Current cleaning practices

Plant Area / Equipment Type	Predominant materials of construction	Predominant soil	Soil level	Typical Cleaning Procedure
Slaughter Floor				
Knocking box / blood pit - floor & walls	Resin coated concrete/sheeting, tiles, sandwich panel, stainless steel	Blood	Heavy	Hose Foam Rinse Spot clean Sanitise
Knocking box / blood pit - equipment	Stainless steel, mild steel	Blood	Heavy	Hose Foam Scrub Rinse Sanitise
Process area - floor	Resin coated concrete	Hide/wool, blood, fat, ingesta, faeces, offal, consumeables	Heavy	Hose Foam Rinse Sanitise
Process area - walls	Resin coated concrete/sheeting, tiles, sandwich panel, stainless steel	Hide/wool, blood, fat, ingesta, faeces, offal, consumeables	Medium	Hose Foam Rinse Spot clean Sanitise
Process area - fixed equipment	Stainless steel, mild steel	Hide/wool, blood, fat, ingesta, faeces, offal, consumeables	Heavy	Disassemble Hose Foam Scrub Rinse Sanitise
Process area - other equipment eg mats, tubs, trolleys, wheel barrows	Rubber, polymers, plastics	Hide/wool, blood, fat, ingesta, faeces, offal, consumeables	Heavy	Hose Foam Rinse
Carcase transfer / Coolrooms				
Floors	Resin coated concrete	Blood, fat, meat	Medium-Heavy	Hose Foam Rinse Sanitise
Walls	Sandwich panel	Blood, fat, meat	Medium	Hose Foam Rinse Spot clean Sanitise
Boning rooms				
Process area - floor	Resin coated concrete	Blood, fat, meat, bone, consumeables	Heavy	Hose Foam Rinse Sanitise
Process area - walls	Sandwich panel, stainless steel	Blood, fat, meat, bone, consumeables	Medium	Hose Foam Rinse Spot clean Sanitise
Process area - fixed equipment	Stainless steel, plastics/resins	Blood, fat, meat, bone, consumeables	Heavy	Disassemble Hose Foam Scrub Rinse Sanitise

Plant Area / Equipment Type	Predominant materials of construction	Predominant soil	Soil level	Typical Cleaning Procedure
Boning rooms				
Process areas - conveyors, conveyor belts	Stainless steel, plastics/resins	Blood, fat, meat, bone	Heavy	Hose / Auto wash Foam Scrub Rinse Sanitise
Process area - cutting boards	Stainless steel, plastics/resins	Blood, fat, meat	Heavy	Hose Soak Rinse Sanitise
Process area - other equipment eg mats, tubs, trolleys, wheel barrows	Stainless steel, plastics/resins	Blood, fat, meat	Heavy	Hose Rinse
Packaging rooms	Stainless steel, plastics/resins	Blood, fat, meat, consumeables	Light	Disassemble Hose Foam Rinse Spot clean Sanitise
Offal/By-products Floor				
Transfer chutes, augurs etc	Stainless steel, galvanised steel, mild steel	Hide/wool, blood, fat, ingesta, faeces, offal, meat, bones	Heavy	Hose Foam Manual brush Rinse
Processing rooms - walls & floors	Resin coated concrete, concrete, sandwich panel	Hide/wool, blood, fat, ingesta, faeces, offal, meat, bones	Heavy	Hose Foam Rinse Spot clean Sanitise
Processing rooms - equipment	Stainless steel, galvanised steel	Hide/wool, blood, fat, ingesta, faeces, offal, meat, bones	Heavy	Disassemble Hose Foam Rinse Spot clean Sanitise
Packing rooms	Resin coated concrete, sandwich panel, stainless steel	Blood, fat, offal, meat	Light	Disassemble Hose Foam Rinse Spot clean Sanitise
Vehicle access areas	Concrete, resin coated concrete	Blood, offal, other wastes	Medium	Hose