Water Recovery and reuse for Industrial Water Security

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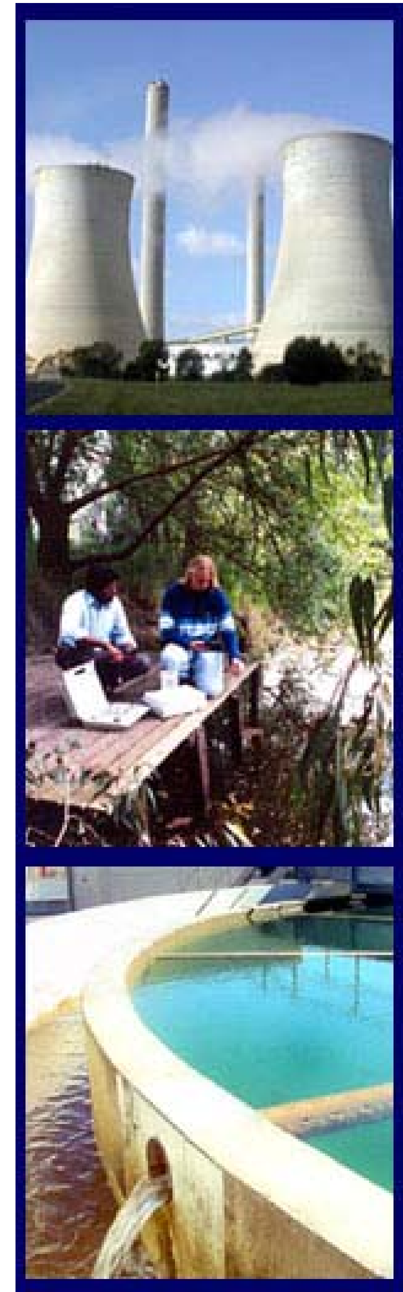
Presentation outline

- Introduction of Deakin University
- Challenges facing the Urban Water Management
- Regulatory framework
- Industrial Water Management
- Case studies
- Industry partnership model



Deakin University

- Established in 1974 as one of the new generation of Australian universities.
- Australia’s tenth largest university with 27,600 students of whom 23% are international students from 112 countries .
- Deakin combines a university's traditional focus on excellent teaching and research with a desire to seek new ways of developing and delivering courses.
- Four campuses
- Four Faculties

Deakin University

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- Faculty of Arts and Education
- Faculty of Business and Law
- Faculty of Health
- Faculty of Science and Technology
  - School of Architecture and Building
  - School of Engineering
  - School of Information Technology
  - School of Life and Environmental Sciences
- Institute of Technology Research and Innovation

Challenges facing the urban water sector

Some of the challenges facing the urban and industrial water sector in Australia are:

- *Catering for rapid population growth*: providing services to a growing population and rapidly expanding urbanised areas.
- *Managing impacts of climate variability and climate change*
- *Managing current and future investment programs* and associated cost increases
- Optimising the use of a diverse portfolio of water supply sources
- Managing *energy use* and *greenhouse gas emissions*
- Effectively harnessing technological development
- Continuing to protect public health in the context of increased recycling
- Dealing with an ageing workforce

Regulatory Framework

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- *Core objectives for trade waste management* reflect the risks of handling trade waste discharges. These risks are commonly described as the *four 'Ps*':
  - Protection of health and safety of all people working in the sewerage system, and the public;
  - Protection of sewage collection system and treatment plant assets;
  - Protection of treatment processes; and
  - Protection of receiving environment.
- Water businesses and their industry associations have been active in developing and refining processes to address these risks.
- Trade waste management objectives and policies also usually include an objective to facilitate water and biosolids recycling

Regulatory Framework

- Trade waste management framework is consistent with an ***ethic of water conservation***, and ***facilitate water and biosolids recycling***.
- Trade wastes are managed to reduce the impacts of discharges from wastewater treatment plants on the environment.
- The economies of scale of *centralised treatment of wastewater* are significant and for the majority of industry customers and the community, discharging trade waste to municipal sewer system for treatment and disposal is the *most efficient* choice.
- Some industries have their *own independent treatment systems* and some waste loads can be more efficiently removed locally while still in a concentrated state.
- To achieve the best balance between on site treatment by industry and water authority treatment of trade wastes requires a trade waste management framework that has *efficient prices and transparent standards and regulations*.

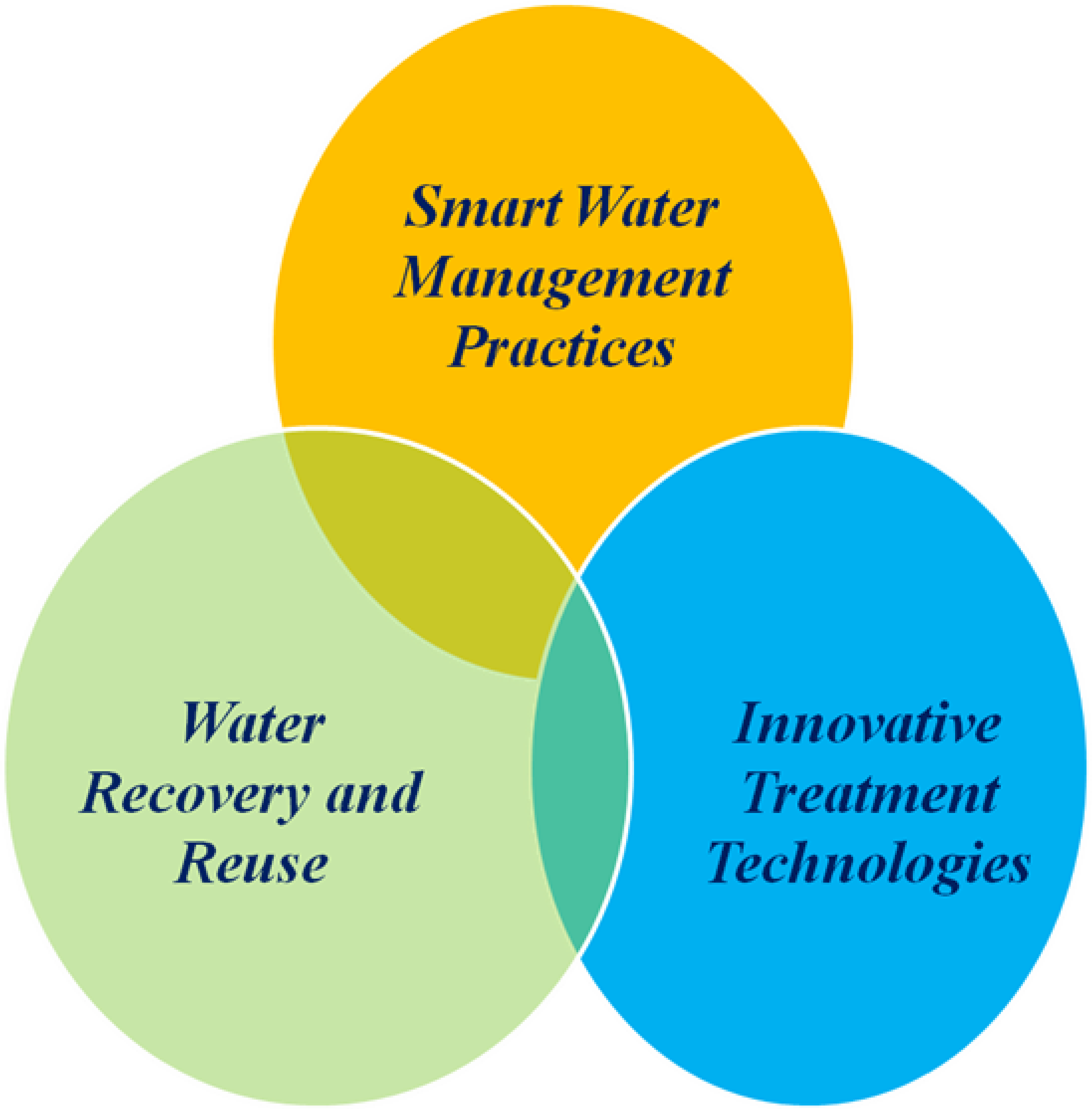
Regulatory Framework

- The ***waste hierarchy*** set out in the *Environment Protection Act 1970 provides guidance to the water authorities in the way that waste should be managed rather than enforcing a precise set of technical priorities . They are:*
  - *Avoidance*
  - *Re-use and recycling*
  - *Recovery of energy*
  - *Treatment*
  - *Containment, and*
  - *Disposal*
- The waste hierarchy is applied in a balanced manner with other environmental and economic management principles including efficient pricing and incentive mechanisms

Regulatory Framework

- Victoria's trade waste management system allows water authorities to charge industry to recover their costs of transport, treatment and disposal of trade waste.
- Water authorities have introduced *load based charges* for their trade waste over recent years that reflect the cost of treatment and disposal
- Trade waste prices are regulated by the *Essential Services Commission* of Victoria (ESC)
- Water authorities continue to develop efficient trade waste prices that *accurately reflect costs of treatment, disposal and management* and signal to trade waste customers the costs of discharging to the sewerage system compared to waste minimisation and on-site treatment.
- The basis on which prices are set should be supported by *sound scientific and technical assessment*, and made transparent to customers.

Industrial Water Management



Smart Water Management Practices

- In depth investigation of industrial water use
- Analyse water management practices through industry surveys (flows, quality parameters for various streams)
- Tailored monitoring programs in plants
- Decision support system to collect and analyse data
- Model water consumption scenarios
- Design tailored recycling options for individual industries, including identification of needs of potential end users.
- Develop stormwater management plan on a factory-scale
- Develop integrated water management system for industries

Smart Water Management Practices

Outcome for water sector and industry

- Improved quality effluent discharged to trade waste (reduced cost of cleanup by industry and water authorities)
- Increased reuse of water and other resources.
- Lower impact on environment through better treatment
- Higher volume of water recycled due to improved quality
- Reduced reliance on water as a commodity, creating room for sector growth
- Reduced costs for treatment
- Lower production costs
- Clean and green image for the industry

Innovative Treatment Technologies

- Removal of inorganic contaminants (with strong focus on salt); organic contaminants; and Pathogens
- Cleaner production strategies:
  - Changes in cleaning procedures / cleaning agents to increase reuse options and reduce ecological impact
  - Optimise stream segregation to allow for targeted treatment
- Develop / Improve / Assess performance of tertiary treatment processes based on:
  - Membrane processes
  - Adsorption processes
  - Wetland and other natural treatment system
  - Physical, Chemical and biological treatment technologies
  - UV/ other disinfection methods

Innovative Treatment Technologies

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- Conduct short-term and medium-terms trials to
  - to assess and improve process reliability,
  - optimise energy consumption,
  - identify and address potential operational issues (such as fouling),
  - develop appropriate pre-treatments,
  - assess economic viability of developed technologies.
- Investigate and create reuse / disposal options for the rejected brine / concentrated stream
- New technologies to recover water and remove contaminants, which are cost-efficient, to be competitive with drinking water prices, easy to use/handle, scalable to suit various scales of industries, Flexible/adaptable technologies to suit different needs, and high reliability

Water Recovery and Reuse

- Fitness For Purpose
- Tools and criteria for assessment of required water quality
- Matching streams to most suitable reuse options
- Agricultural and/or environmental application issues
- agronomic, technologies, food safety, health, unknowns
- Community acceptance including social and cultural issues
- Assessment of economic, environmental and social costs and benefits.

Outcomes:

- Contribute to the Victorian government's targets of a *20% reuse of treated effluent and 15% demand reduction*
- Demonstrate whole system approach to water use from company plant to environmental or agricultural use.
- Identify and demonstrate economic and environmental benefits

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Case Studies

Wastewater Management Study - Mantzaris Fisheries Pty. Ltd.

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- Wastewater generated at Mantzaris Fisheries is currently being discharged into Municipal sewerage System with very minimal pre-treatment (Sedimentation).
- It's high organic and nutrient loading has imposed additional loading on the current treatment systems.
- In order to reduce the waste loading a preliminary investigation of wastewater management issues was carried out with the following tasks:
  - Detailed investigation of the current processes and practices
  - Characterisation of various wastewater streams to identify key contaminants and their major contributors
  - Review of existing analytical data collected by Barwon Water
  - Identification of potential pre-treatment options to meet current and future trade waste limits

Wastewater Management Study - Mantzaris Fisheries Pty. Ltd.

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Defrost Room

Squid table 1 – removing guts

Squid table 2 – removing skins etc

Scallop shelling

Wastewater Management Study - Mantzaris Fisheries Pty. Ltd.

Squid tenderising bath

Current on-site treatment system

- Screening and sedimentation

Wastewater Characteristics:

BOD	2,500 – 3,500 mg/L
COD	3,250 – 3,750 mg/L
Total Nitrogen	340 – 355 mg/L
Total Phosphate	200 - 290 mg/L
TS Solids	615 – 660 mg/L

Trade waste discharge limits

BOD	500 mg/L (83%)
COD	1,200 mg/L (66%)
Total Nitrogen	60 mg/L (83%)
Total Phosphate	14 mg/L (94%)
TS Solids	500 mg/L (21%)

Recommendations

- Treatment options for targeted key parameters:
  - Primary treatment - Sedimentation Tank or Dissolved Air Flotation and Filtration
  - Secondary treatment - Upflow Anaerobic Sludge Blanket Reactor or Anaerobic Bio-filter
- Combined Baleen filter and Anaerobic Bio-filter was been identified as the best system to effectively treat the wastewater stream to meet necessary discharge limits.
- Advantages for this option are the ease of operation and low capital and maintenance costs compared to other options.
- Wastewater stream coming out of the tenderising baths can be reused two or three times for the same process, then segregated from the overall wastewater stream, it has the potential to reduce the phosphorous content significantly and encourage water reuse/recycling option

Integrated Water Management and Reuse in Poultry Processing Plant

Bartter Enterprises

- Australia second largest poultry producer
- Processing over 2.4 million chickens and 100,000 turkeys in peak season per week
- Geelong plant processes around 95,000 birds/day and uses water at the rate of 13 L/bird approximately
- About 1000KL of fresh water usage in a day and approximately 70% of this water discharged as trade waste
- According to new trade waste agreement waste charges need to be paid based on both volume and load

Integrated Water Management and Reuse in Poultry Processing Plant

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Aim of this Study

- Develop an Integrated water management plan to minimize the water usage and improve the wastewater quality

Objectives of this Study

- Review of water usage and wastewater quality data and appropriate treatment levels
- Investigation of current water and waste water management practices
- Evaluate options for wastewater minimization and potential opportunities for reuse of water within the plant
- Cost benefit analysis for the proposed options

Integrated Water Management and Reuse in Poultry Processing Plant

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Live By Area

Kil Room

Scalding

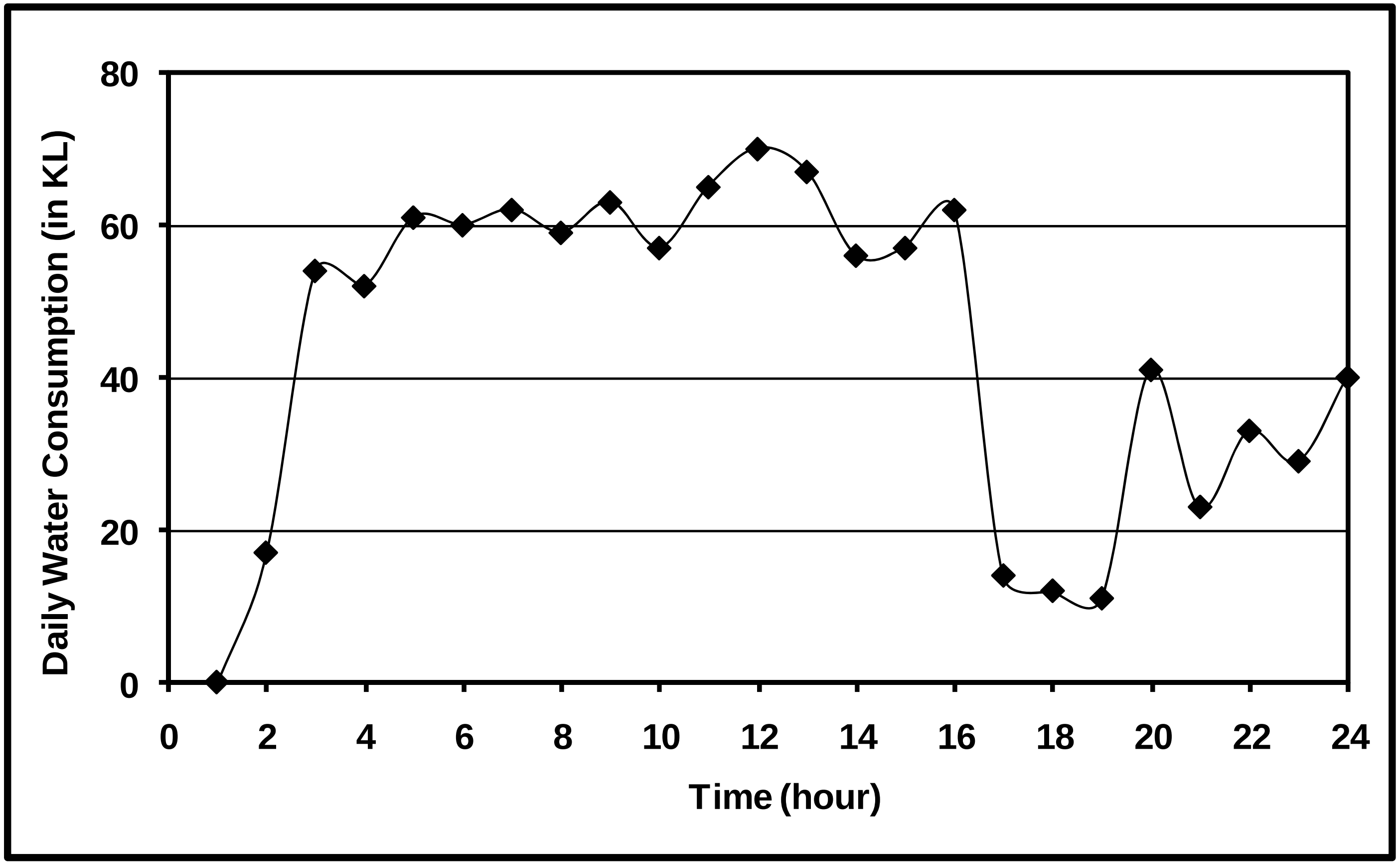
De-feathering

Plucking & Evisceration

Chilling

Integrated Water Management and Reuse in Poultry Processing Plant

Fresh Water Consumption During the 24 Hour Period



Integrated Water Management and Reuse in Poultry Processing Plant

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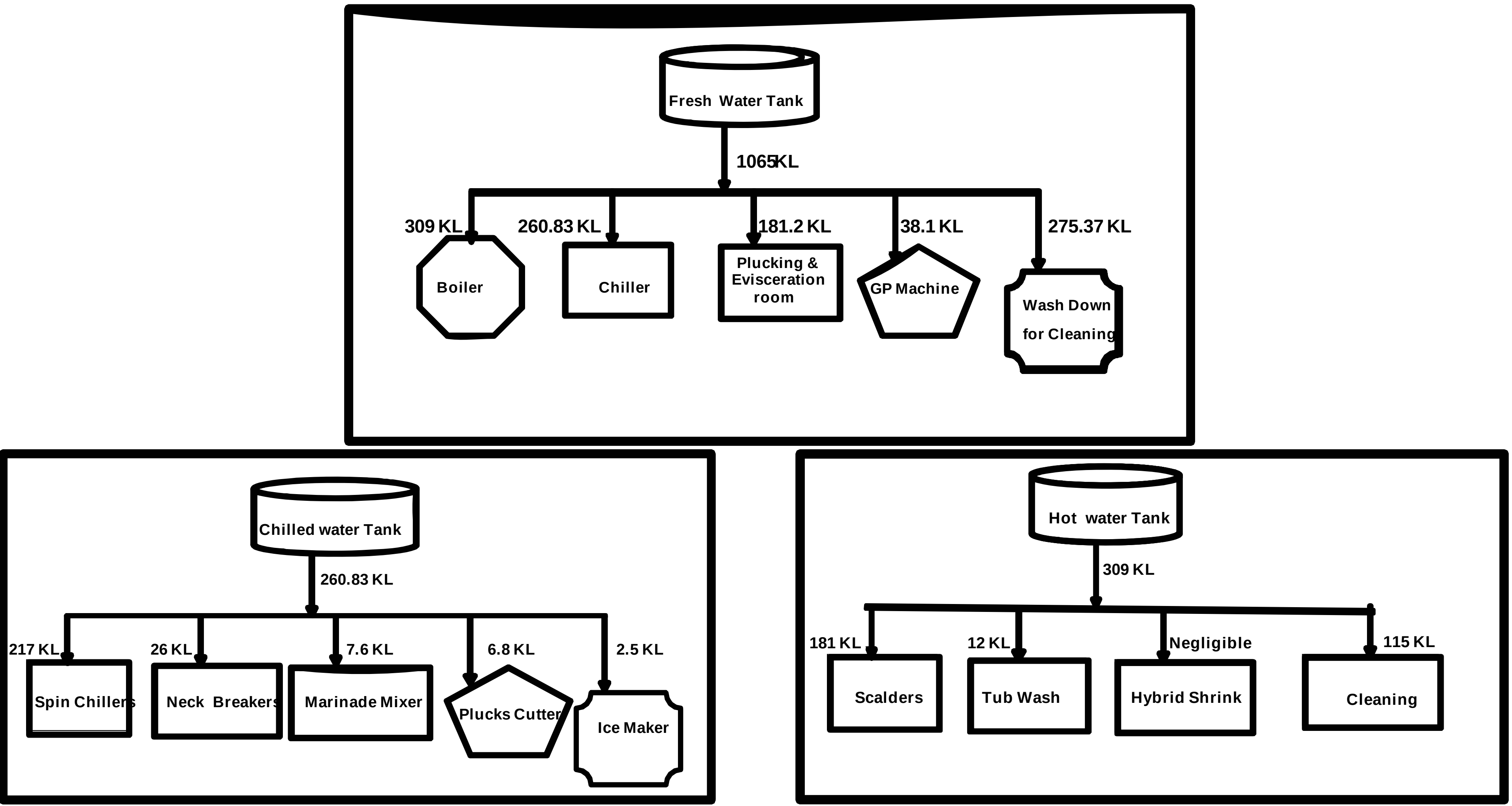
Breakdown of Water Use by Different Process Areas



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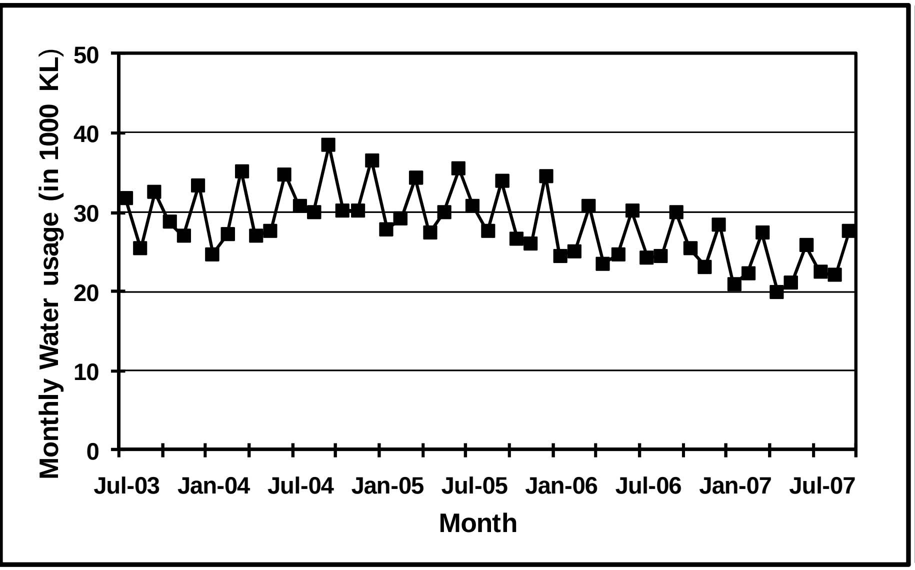
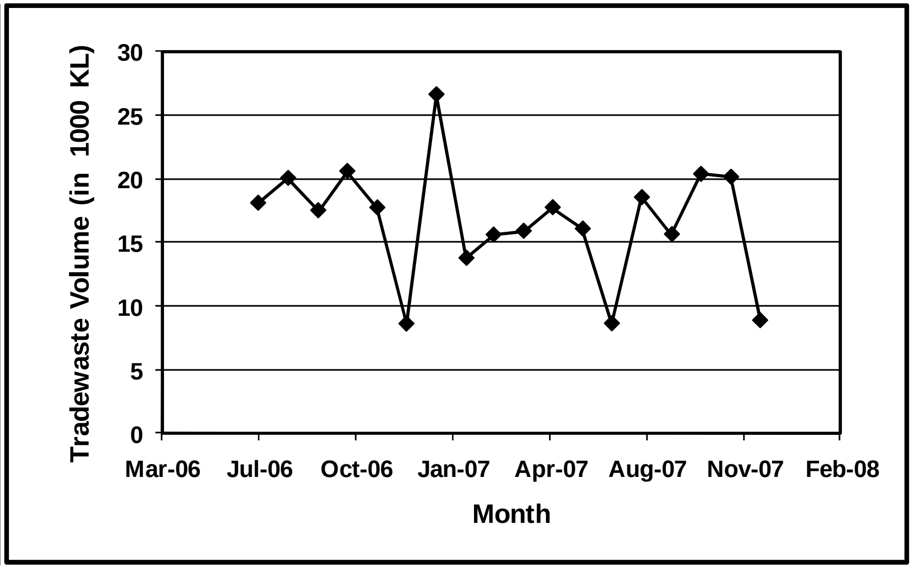
Monthly Water Usage and Trade Waste Generated





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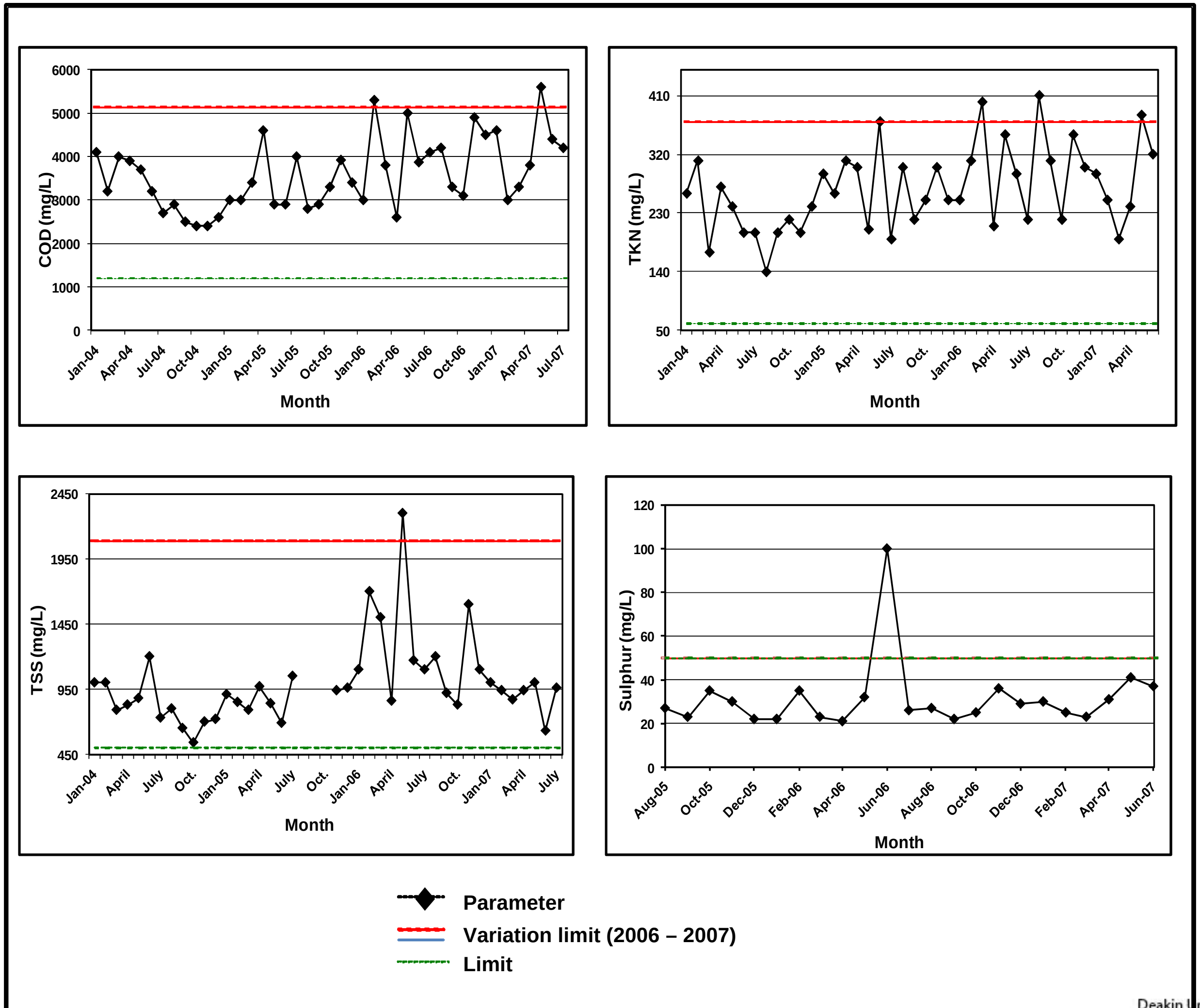
COD, TKN, TSS and Sulphur Trend of the Final Effluent from 2004 to 2007



Wastewater Characterization

Sample	Sample Site	COD (mg/L)	TKN (mg/L)	TSS (mg/L)	pH
1	GP Machine + Live bay	14497	1009	6040	6.3
2	Chiller1	1060	86	88.5	6.9
3	Chiller3	654	36	46	6.8
4	Scalder exit	4610	196	366	6.3
5	Final Pit (Processing phase)	4001	300	1308	6.3
6	Pre-Wash	939	64	85	7.3
7	Sub-Pit	3198	320	810	6.52
8	Plucking & Evisceration room	1210	48	286	7.1
9	Final Pit (Cleaning phase)	2830	130	-	-

Sample	Type of Treatment	COD (mg/L)	TKN (mg/L)
GP machine + Live bay	No treatment	14,497	1009
GP machine + Live bay	Centrifugation	5648	515
GP machine + Live bay	24 hr settling	5588	166

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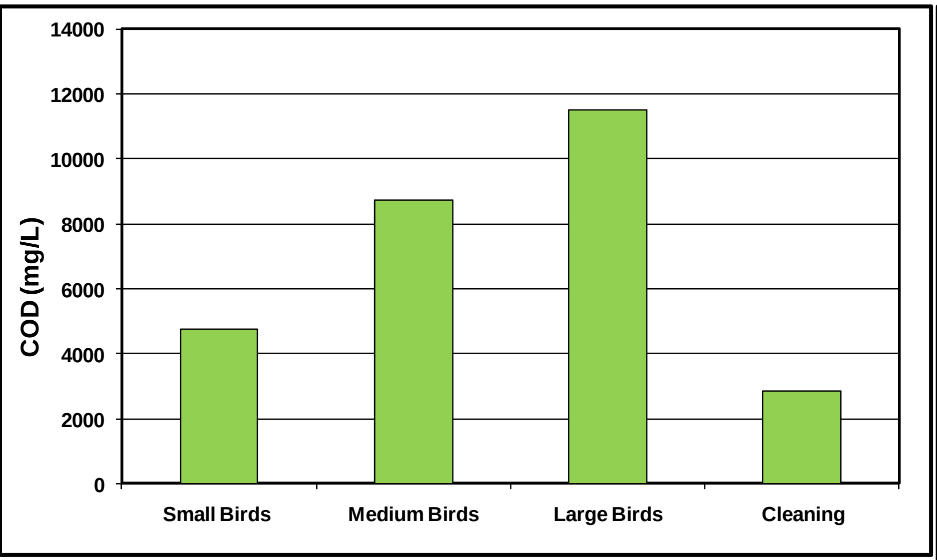
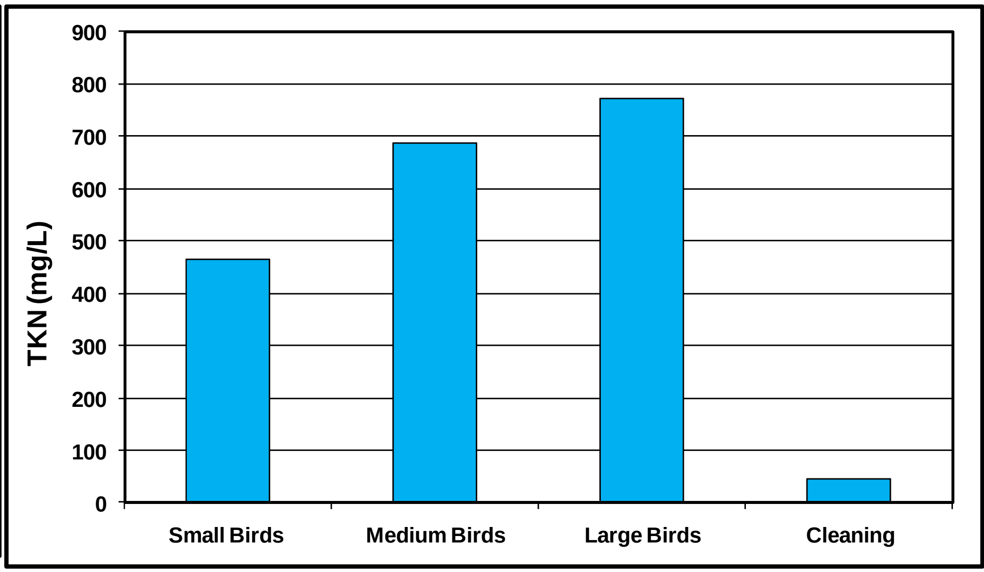
Wastewater Characterisation by Size of the Birds
GP Machine & Live Bay Area





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Recommendations

Suggested Treatment Options to Reduce Pollutant Load

- Isolation of GP machine and live bay area wastewater from other stream followed by on-site treatment system will enable to reduce the overall load
- Preliminary treatment system such as a grit removal system which would help to reduce 20-25% of the pollutant load

Suggested Options for Multiple Reuse of Water

- Chillers water can be reused for the scalding purposes
- Chillers water can also be reused for GP machine and washing trucks at live bay
- Total potable water savings about 217 KL/day

Integrated Water Management and Reuse in Poultry Processing Plant

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Cost – Benefit analysis

- Cost benefits of reducing water consumption = $58,800/year
- Cost benefits due to trade waste volume reduction by 25%= $73,615
- Trade Waste quality charge increased after fresh water reduction =$ 27,526/year
- Overall cost benefits= $ 46,089/year
- Cost benefits due to trade waste quality charge reduction by 25% = $51,541/year

  Total cost saved (approximately) =$ 156,430/year
- Significant reduction in potable water consumption
- Improvement of wastewater quality and able to meet the trade waste discharge limits
- Significant cost savings in water bills

Dye house water management – Carpet Manufacturer

Dairy Industry in Australia is the third most important industry

- Valued ~ $3.2 billion in 2006/07
- Directly employ about 40,000 people
- One of Australia's leading rural industries
- Bulk of milk production occurs in Victoria (>65% in 2006/07)
- Milk production remains strongly seasonal, reflecting the pasture-based nature of the industry. (peaks in October/November)

Dairy industry includes:

- *Farm sector* – agricultural consultants, soil scientists, animal health workers, environmental scientists
- *Milk Processing sector* – Chemists, microbiologists, engineers, marketing, economists, accountants, etc.
- *Supply and distribution sector* – super markets, transport industry etc.

Milk processing industry sector

- Farmer-owned co-operatives:
  - Murray Goulburn ~ 35% of Australia's milk production
  - Dairy Farmers group
  - The Bonlac Supply Company
  - Tatura Milk Industries
- Major multi-national companies – Fonterra, Nestle, Kraft, Parmalat etc

Major manufactured product streams are:

- Drinking milk – 20%
- Skim milk powder / butter milk powder / butter – 24%
- Butter / casein – 4%
- Cheese – 36%, and
- Whole milk powder – 12%

Closing the Loop: An holistic approach to the management of dairy processor waste streams

- One of five projects to receive inaugural R&D funding from the Geoffrey Gardiner Dairy Foundation – *principle investor*
- The project investigates a “whole of system” approach towards waste minimisation and reuse across Victorian dairy factories
- Other investors – **Dairy Australia**, Milk processing industries, Waste management companies, Water authorities, research institutions
- *Total project cost* – over $4.3 million over four years
- *Project team – Dairy Industries Sustainability Consortium*
  - Deakin University, RMIT University, Victoria University
  - Department of Primary Industries
  - Food Science Australia, CSIRO, Dairy Innovation centre

Project Objective:

- The CTL Project investigates a 'whole of system' approach towards waste management in the dairy industry with the aim of reducing, re-using or recycling solid and liquid waste streams in Victorian dairy factories.
- The CTL Project encompasses:
  - 5 Research Organisations (as researchers and investors)
  - 14 Industry & Other Government Agency Investors
  - The project duration is 4 years and the budget is $4.4m.
- The project is governed by a Steering Committee
- The project team receives industry feedback through an Industry Advisory Committee and sub-project Reference Groups.

Closing the Loop: An holistic approach to the management of dairy processor waste streams

Four main project phases:

- Survey, industry workshops & gap analysis
- Lab feasibility trials and field site establishment
- Pilot scale implementation, factory trials & land application modelling
- Technology transfer

Major projects

- Evaluation of technologies for removal of salt from dairy processing wastewater streams
- Sustainable and cost effective alternatives for reuse of dairy processing organic wastes
- Sustainable application of dairy factory sludge on agricultural land
- Composting dairy processing organic wastes

Industry overview

- 24 dairy factories processed almost 6.7 billion litres of milk (>95% production)
- 82% of the total output comprised: milk powders; cream; cheese; drinking milk
- Sodium in wastewater is a key long-term sustainability issue
- Sodium in wastewater is predominantly derived from CIP chemicals and salt used in production processes
- 22 of 24 factories surveyed used >11,000 t/year of salt in manufacturing processes
- 19 re-used or reclaimed used CIP chemicals
- 24 factories discharge 10.3 billion litres of wastewater - 13% to surface streams; 44% to land; 43% to sewer

Closing the Loop: An holistic approach to the management of dairy processor waste streams

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Cost Overview

- Total direct waste treatment costs = $36 million
- CIP Chemicals = $16.7m
- On-site waste treatment = $6.9m
- Input water = $4.6m
- Waste treatment chemicals = $3.2m
- Wastewater discharge = $3.3m
- Solid waste disposal costs = $2.1m

Closing the Loop: Project Partners

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GARDINER FOUNDATION

State Government Victoria Department of Primary Industries

DAIRY AUSTRALIA

FOOD SCIENCE AUSTRALIA
A JOINT VENTURE OF CSIRO AND AFISC
CSIRO afisc Australian Food Industry Science Centre

Dairy Process Engineering Centre

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RMIT UNIVERSITY

VICTORIA UNIVERSITY OF TECHNOLOGY

WARRNAMBOOL CHEESE & BUTTER FACTORY Co LTD EST'D 1888

Dairy Farmers

BONLAC FOODS

Bulla DAIRY FOODS

TATURA MILK

Murray Goulburn Co-operative Co. Limited

SOUTH WEST WATER AUTHORITY

GOULBURN VALLEY WATER

ORICA CHEMICALS

COLLEX

ONYX

Other industrial water management projects

- New industrial cleaning practices – cleaner effluent
- Clean in Place – A Review of Current Technology and its Use in the Food and Beverage Industry
- Anaerobic treatment of effluents from the juice and fruit-processing industries
- Investigation of water and wastewater management options for the Warrnambool rendering plant
- Optimising integrated water recycling and waste heat recovery in rendering plants and abattoirs
- Pilot-scale investigation on the anaerobic reduction of organic waste for the production of renewable energy
- Integrated water management for carpet manufacturing process

Industry Partnership Model

- Multi-layered partnership between University – Water Authority - Industry
- Act as independent researcher without any commercial interest
- Commitment towards long-term partnership build upon mutual TRUST
- Stake holder engagement through out the project is essential
- Identify and engage local Champions
- Commitment from senior management of the industry
- Cost-benefit analysis based upon economic, environmental and social outcomes is important
- Being a Knowledge Partner and facilitator

Acknowledgement

สถาบันสิ่งแวดล้อมไทย
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Thank you.