Winery Wastewater Research to Practice Workshops



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

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Photographers: Hai Doan and Sonia Grocke

Description: These photographs were taken by Hai and Sonia during winery visits and regional workshops

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Abstract

The main objective of this project was to deliver training to the wine industry on the research on winery wastewater management and how that research can be adopted by the wine industry. A workshop structure was devised that consisted of modules that included existing information and research findings and how this information could be applied in the wine industry.

The report includes a copy of the training modules.

Workshops were conducted in 17 sites in wine-producing areas across Western Australia, South Australia, Victoria and New South Wales. Approximately 326 wine makers, operators, environmental managers participated in the learning and improved practice experience over the life of the project. By presenting seminars at special wastewater recycle and reuse workshops and conferences, the winery wastewater management related information was further disseminated to additional 390 people. The feedback from the workshops was very good, with most participants indicting that the workshops fulfilled their needs.

Acknowledgements

We would like to thank GWRDC for funding this project. Thanks are due to Keith Pekin, Lachlan Campbell for organising these workshops in WA and Victoria. The stars of the show have been the industry representatives who, despite their full-time work commitments and all that goes with it, are passionate about this topic and are willing to catalyse a change by sharing their knowledge and experiences with industry colleagues. We would like to thank Mr Mike Carson from JJC, Dr Cecil Camilleri and Mr John Ide from Yalumba, Mr Gary Lyons from Ryecroft, Mr Shane Phillips from Tachi, Dr Darrem Oemcke and Mr Karl Forsyth from Provisor who have made excellent contributions at these workshops. Local EPA and NRM representatives have also been actively involved in these workshops in their regions.

Executive summary

Environmentally and economically sustainable management of winery waste and wastewater is a high priority for the industry. Each winery generates wastewater with a unique quality, quantity and seasonal variation pattern. Winery wastewater is often of high strength and is highly variable in quantity and quality making it a difficult effluent to manage. The diversity of practices in wineries results in a diversity of effluents. For example water usage per tonne of crush ranged from 0.4 – 8.0 kL/tonne. There are similar wide ranges of values for diatomaceous earth, DE usage (0 – 8.2 kg/tonne of crush) and caustic, NaOH usage (0 – 2.2 kg/tonne).

The challenge of handling winery wastewater has been studied in Australia by several GWRDC funded projects including work by Chapman *et al*. (1995a and b), Frost *et al*. (2007), Kumar *et al.* (2006) and Kumar *et al*. (2009a and b).

The overall aim of the project was to develop a training program on winery wastewater management techniques and to increase the industry's awareness and knowledge on matters of regulation and good practice for effective and informed stakeholder engagement. This was to be achieved largely by conducting workshops in wine-producing regions. These workshops addressed the needs and interests of the local wine industry on issues such as:

- How to reduce the amount of wastewater;
- What are the key winery wastewater quality characteristics;
- Limitations and advantages of the treatment processes that are currently used in Australia;
- Regulatory frameworks and guidelines for winery wastewater re-use;
- Options for winery wastewater re-use;
- Salt management options associated with winery wastewater irrigation; and
- Risk assessment approach to manage wastewater management related issues.

A set of training modules was developed which included input from background knowledge, previous and current research as well as information about regulations which was obtained from websites and regulators. A copy of the modules is provided as a supplement to this report.

In all, 17 regional workshops were held across southern mainland Australia, with some 326 attendees overall. Feedback from the workshops was very positive, and the majority of participants considered that the workshops met their needs. In addition to the direct training, the workshops provided networking opportunities amongst wine producers and also allowed feedback from the wine producers to the researchers. The information on winery wastewater management was further disseminated to approximately 400 additional people through presentations at special workshops/seminars on wastewater management and reuse.

From the industry survey and process auditing we developed several software tools to assist winery managers. Full details and the spreadsheet tools will be available to be downloaded from the CSIRO/GWRDC website.

1. Two models have been developed so that wineries can compare the components of the winery wastewater quality in terms of COD (chemical oxygen demand), EC (electrical conductivity, pH, salt loads (Na and K loads) and volumes of the winery wastewater generated by each unit operation.
2. A tool to give an assessment of the environmental impact of a winery. The general approach is to produce an index that indicates the environmental efficiency of a winery based on winery wastewater management. It is assumed that the crush size is known, so the amount of environmental impact can be expressed on a per tonne basis. It is based on a range of key performance indicators (KPIs) within the winery.
3. A tool to assess costs of current wastewater treatment options. This tool can be used by winery managers to estimate the cost of treating winery wastewater. The analysis covers power costs, maintenance, depreciation, labour and capital costs.

Recommendations

The concept of small regional workshops was well received by local wine producers and should be used as a method of communication between research providers and research users. Field trips should be also included in the 1-2 day workshop programs. These field trips also provide opportunities of interaction between region-specific wine makers/winery operators representing small and large scale wineries, both during and (potentially) beyond the project.

GWRDC should consider whether communication between researchers and wine producers is most effectively achieved by researchers and/or by professional communicators.

There should be a national workshop involving researchers, key industry representatives and regulators to produce national regulations or guidelines, and that these guidelines should include implications of wastewater management on soil organic matter and salinity.

We would like to recommend following communication techniques at multi user levels to maximise impact and outcomes for utilising recycled water fit for a variety of uses.

- Handbook or a technical manual
- Regional workshops and field trips
- AWRI road shows
- Web-based modules
- Decision support tools
- Short videos demonstrating practices and their benefits
- Case study brochures and fact sheets

This research was co-funded by GWRDC and CSIRO and was conducted in collaboration with the regional wine industry representatives, state EPA and NRM representatives. The project team acknowledges the support of all experts who contributed significantly by sharing their knowledge and experiences at these workshops.

1 Background

Wine consumers are becoming increasing conscious of the environmental impact of the wine industry. For Australia to remain competitive Australian wine producers must take steps to be good environmental stewards (WFA 2009). Pip Marks Consulting, in the assessment of the environmental aspects of GWRDC 2002-07 R&D plan, highlighted an inadequate research into water conservation and wastewater management in wineries. The report notes that many wineries are concerned about the cost and effectiveness of wastewater treatment systems – a recent survey (Frost *et al*. 2009) estimated that the cost of wastewater disposal in some small wineries is approximately $37/tone of crush. It also notes that improving wastewater management is critical to protect local waterways and wetlands, as well as minimizing soil salinisation. It suggested that R&D needs to support the wine industry in demonstrating leadership in environmental management.

The gap analyses of priorities against GWRDC five year plan programs (undertaken by the GWRDC priorities reference group meeting) puts wastewater management as the 4th highest combined priority in Sustainable Production. Analysing the wine makers priorities alone, wastewater was ranked as the highest priority together with life-cycle analysis to measure ecological footprint of whole industry and guidelines for handling wine making by products. Both of these are also related to the wastewater issue.

The wastewater generated by wineries is often high strength due to its high biological oxygen demand (BOD), organic content, electrical conductivity and salinity and therefore needs careful management. Regulations for environmental discharges and for recycling/reuse schemes are becoming increasingly stringent. Waste management associated with wine processing is a critical issue due to issues such as potential contamination of soil, groundwater or surface water. In order to protect ecosystem health, regulatory authorities no longer permit discharge in waterways and consequently wastewater application on land is becoming more widespread. However, currently land application of winery wastewater for irrigation is often governed by “disposal” mentality without adequate attention to hydraulic, salt and organic carbon loading to soil. For the long-term sustainability of this practice, the wastewater reuse on land needs very careful management.

A summary of the current issues and opportunities for improving winery wastewater management is presented in Figure 1.1

CSIRO has ongoing research projects on the problems of winery wastewater (Kumar *et al*., 2007 and Kumar *et al*., 2009). There has been a lack of comprehensive information available on the issues related to winery wastewater management. This has been especially evident for the small wineries. This project aimed at developing at packaging and disseminating the existing knowledge as new knowledge.

To achieve dissemination of the current knowledge, this project developed a training program on wastewater management for the industry using the Research to Practice model. This program developed training support materials, coordinate input from researchers as well as other sources and develop the workshop-series. These workshops have been delivered in all major vine-growing regions of Australia.

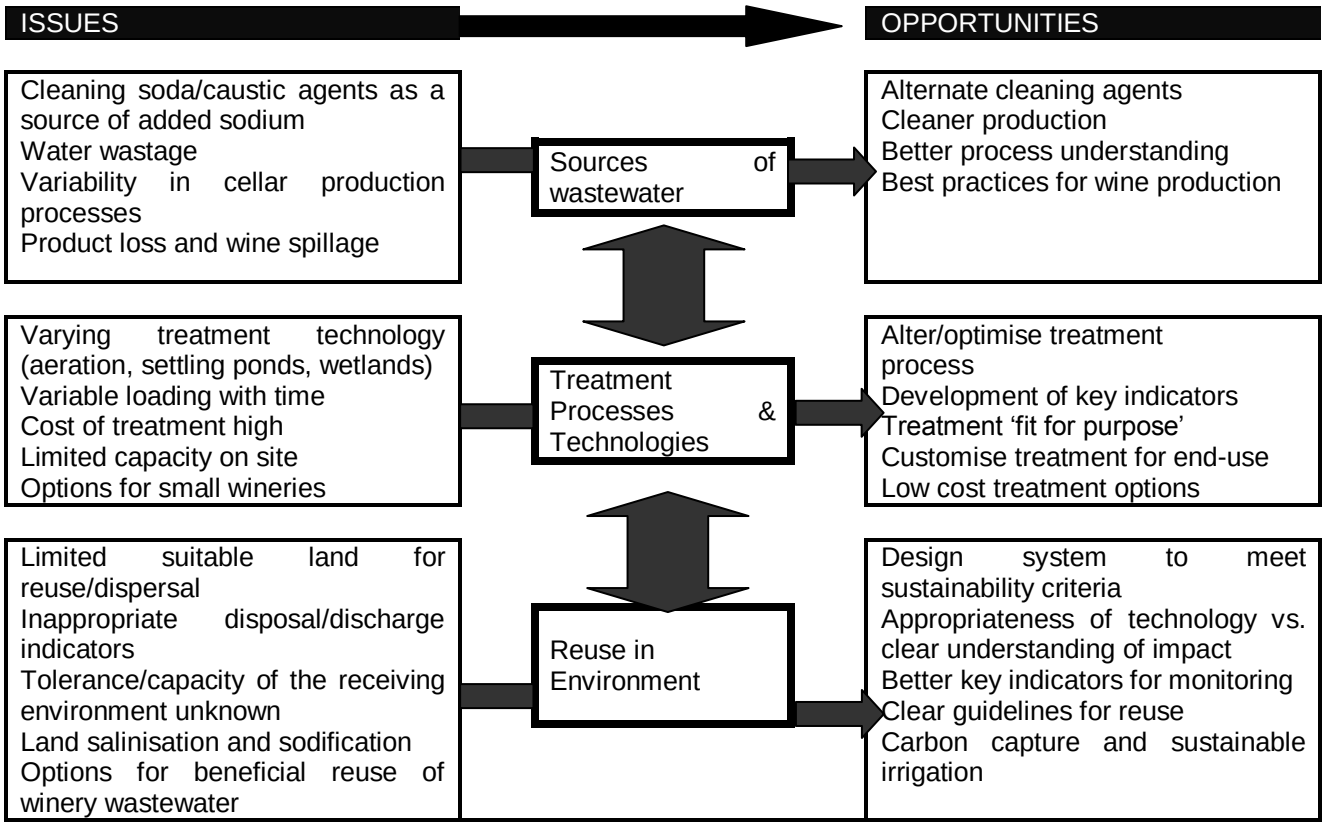


Figure 1.1 Current issues and opportunities for improving winery wastewater management

2 Project Aims and Performance targets

The overall aim of the project was to develop a training program on winery wastewater management know-how to increase the industry's awareness and knowledge on matters of regulation and good practice for effective and informed stakeholder engagement.
The specific objectives included:

- Use 'Research to Practice TM ' model to develop and deliver training that comprises complex research results on wastewater management know-how to practical options that can be adopted and practiced in the viticulture industry;
- Prepare carefully constructed modules or topics on the wastewater issues and their management for delivery;
- Collate existing information and research findings on wastewater topics in a handout booklet;
- Provide information in a form that is consistent with Best Practice Adult Learning Principles;
- Increase environmental awareness of wine-makers, consultants and other stakeholders through this training program; and
- Address regional-specific issues into training and education materials for use across the industry.

2.1 Performance targets in the original proposal

Outputs and Performance Targets 2005-06

Outputs	Performance Targets
• Up to date training materials and tools on winery wastewater management know-how.	1. Prepare first draft of manual and course modules by Dec 2005 2. 10 copies of manual and CD for dry run by Dec 2005. 3. Successful dry run of presentations by Jan 2006 4. Produce updated manual by March, 2006 (during vintage season)
• Regional delivery of winery wastewater management issues through workshops.	2.1 Run three pilot workshops on winery wastewater related issues in the following regions from April – June 2006. Barossa Valley, SA Riverina, NSW Adelaide Hills, SA

Outputs and Performance Targets 2006-07

Outputs	Performance Targets
1. Regional delivery of winery wastewater management issues through workshops.	**1.1** Run six more pilot workshops on winery wastewater related issues in the following regions from July 2006 – Jan 2007. 1. McLaren Vale, SA 2. Clare Valley, SA 3. Sunraysia, VIC 4. Hunter valley, NSW 5. Margaret River, WA 6. Riverland, SA **1.2** Update presentations, CD and manual based on pilot workshops by March 2007 (during vintage season) **1.1** Run six more workshops in other identified regions from April to June 2007. **1.2** Evaluation of participant and facilitator feedback for improvements to next year's program by June 2007. **1.3** Total 12 groups with up to 15 participants in each complete the program in 2006-2007.

Outputs and Performance Targets 2007-08

Outputs	Performance Targets
1. Correct, up-to-date information for the viticulture industry to increase their awareness of environmental issues related to wastewater management and provide the confidence to modify their current practices in a cost-effective and safe manner	1.1. Organise at least 12 workshops in different regions from June 2007-June 2008 1.2. 7 groups with up to 15 participants in each complete the program by Dec 2007. 1.3. Evaluation of participant and facilitator feedback for improvements to recommended future model by June 2008. 1.4. Additional information for manuals as required/developed through season
2. Trained consultants to run these workshops independently.	2.1. Organise five workshops in different regions involving five consultants interested in continuing these training workshops 2.2. 5 groups with up to 15 participants in each complete the program by May 2008.
3. Easily accessible information on the key winery wastewater management issues.	3.1. Use "**Vitinotes"** to disseminate information on key winery wastewater management issues 3.2. Write articles in regional magazines such as catchment board's newsletters, regional wine grower's newsletters.
4. Licensed course on winery wastewater management	4.1. Course modules, presentations to be licensed for consultants and regional associations by June 2008 for delivery after the completion of this project.

2.2 Variation in the performance targets

Revised Outputs and Performance Targets (1 March – 30 October 2009)

Outputs	Performance Targets	Delivery dates
1. Easily accessible information on the key winery wastewater management issues.	1.1 Use other forums through WFA and GWRDC to disseminate information on the following outputs as models/spread-sheets: A) Environment rating Index B) An audit model for small winery C) An audit model for a large winery D) Costing spread sheet on winery wastewater	June 2009
	1.2 Write articles in regional magazines and scientific journals on the research conducted in the GWRDC funded research project on winery wastewater management. A) Best practices to reduce both winery wastewater generation and contaminant load in different winery processes. (a magazine article)	Aug 2009
	B) Environmental rating of winery wastewater management practices (a journal article)	
	C) The application of Winery wastewater on soil should be governed by soil infiltration rate and not by BOD/COD (a journal article)	Aug 2009
	1.3 Develop fact sheets and flyers on the key issues of winery wastewater. A) Tackle the source not the symptom! B) What to measure and when to measure? C) Best fit Treatment Plant design D) Best Practices for Land-Based Wastewater Reuse	
2. Run regional workshops to disseminate information from the research project	2.1 Organise at least four workshops in different regions based on their needs and high impact.	
	2.2 Four groups with up to 15 participants in each complete the program by Oct 2009.	Sep 2009
4. 3 A fully developed course on winery wastewater management	3.1 Course modules, presentations to be available to GWRDC for delivery after the completion of this project.	Oct 2009
	3.2 Submit Final project Report	
5. Discuss future options of extending this program to the wine regions by involving key experts form CSIRO and the wine industry.	4.1 Future of the workshop program to be discussed with GWRDC after the completion of this project in Oct 2009.	Oct 2009

3 Methods

3.1 Current knowledge

Summarise current knowledge and to package it into modules that could be presented at workshops.
The knowledge was obtained from a variety of sources. These are listed below.

Studies of regulations

Each state currently has its own regulations for controlling winery waste. In some cases much of the responsibility has been delegated to local government. Information is available concerning the regulation from state government websites

(see for example http://www.epa.sa.gov.au/xstd_files/Industry/Guideline/guide_wineries.pdf for South Australia).

The project had the cooperation of many local regulators. A list of the regulators who participated in the workshops is given in Table 3.1.

Table 3.1 List of regulators who participated in the workshops

Regulator	Affiliation
Dr Nenita Sison	SA EPA
Mr Tony Sliuzas	SA EPA
Ms Amy Russel	WFA
Ms Donna-Lee Edwards	Dept. Water, Land and Biodiversity Conservation & Adelaide & Mt Lofty Natural Resources Management Board
Dr Genevieve Hanran-Smith	Cape to Cape catchment group outlining the Improved industry capacity for winery wastewater treatment and monitoring project (SWCC & Curtin University)
Mr Keith Pekin	Sustainable production officer, Swan Catchment Council
Dr Scott Pigdon	Bendigo office, VIC EPA

Background knowledge
The presentation team has a broad scientific knowledge and this provided input into the presentations.

One module of the course was devoted to sampling. Details of this can be seen in the addendum. The input for this module used statistical theory but incorporated the large sampling experience of the team.

Another module of the course considered the sodium absorption ratio (SAR). A knowledge of SAR is vital to the understanding of the effect effluent may have on soil.

Previous studies
Some members of the team have been actively researching properties of winery waste for several years. For example, the team were able to draw on data from previous projects (e.g. Chapman et al. 1995a and b, and Kumar *et al.,* 2006).

Current research
The findings from current research projects was incorporated into the course material. A rich source of information was the survey of wineries that has been described in Kumar et al. (2009a). Amongst other information this survey provided quantitative information on water usage as well as the amount of chemicals and efforts being made by some wineries to reduce the concentration of sodium in the effluent.

Useful information on the cost of treating effluent was also obtained from the survey. For example the survey included an estimate that the cost of treatment was $37 per tonne of crush in small wineries.

A second more detailed audit also provides very useful information on performance of various processes in a winery.

A further example was a study of the relative effects of sodium and potassium on soil structure: this new knowledge augments knowledge obtained from classical soil science.

Feedback from workshops
The workshops provided useful feedback that was incorporated in the material and in one (Shane Philips) offered a new avenue for research.

3.2 Best technologies

The project sought out leading industry experts who are consultants to the wine industry to assist with the presentations. A list of the consultants is given in Table 3.2. Where feasible a local consultant was used as he was more familiar with the local conditions. One of those consultants was present at every workshop.

Table 3.2 List of consultants who contributed to the workshops

Consultant	Affiliation
Mr Mike Carson	John Constadine Consulting
Dr Darren Oemcke	DO Consultants (Provisor)
Mr Paul Savage	Aquasol
Mr Doug Hall	Industry Development Officer, Irrigation Association of Western Australia
Mr Tony Johanson	WA Consultant

In addition to the presenters, the project cooperated closely with leaders of the wine industry. Some of those who assisted are listed in Table 3.3.

Table 3.3 Wine industry representatives who collaborated with the project

Industry representative	Affiliation
Ms Amy Russel	WFA
Mr Tim Smyth	Industry Development Officer, Riverland Wine Industry Development Council
Mr Peter Leske	Wine SA
Mr Lachlan Campbell	Australian Alpine Valleys Agribusiness Forum
Dr Cecil Camilleri	SA Wine EC

3.3 Presentation of workshops

The workshops were planned in conjunction with a local wine producers' group. Once the requirement for a workshop was established a venue was typically chosen by a local coordinator. A flyer (Table 3.4) was used to distribute information concerning the workshops. Depending on the client audience, the workshops might run for one or two days. Typical programs are shown in and Table 3.6. Further details of the course are given in the next section.

3.4 Other methods of communication

Other methods of communicating research findings to winemakers were used in addition to the workshops.

Radio interviews
Dr Kumar was interviewed by ABC radio. In one case it was a regional station and in another case the interview was broadcast nationally.

Media coverage:
As part of its communication, the project published articles in media commonly read by wine producers. Articles were published in Wine Business, Grape Grower's Magazine and GWRDC R&D at work.

Table 3.4 Flyer used to advertise workshops

NAME:	Winery Wastewater Management - Research to Practice®
DESCRIPTION:	A workshop to assist wineries to develop and maintain environmentally sustainable wastewater treatment practices.
COST:	$80 per day or $140 for both days (cost recovery basis)
DATE	26-27 September 2007 (Wednesday - Thursday)
COURSE LENGTH:	Two day workshop (10:00 am – 3:30 pm) Morning tea, lunch, and afternoon drinks/nibbles will be provided each day
VENUE:	Bentleys Hotel, Main North Rd Clare SA
RESOURCES AND METHOD OF DELIVERY:	Participants receive a course manual. This course is delivered using indoor instructions and group discussions. Hands on exercises regarding calculations and risk assessments relevant to winery wastewater management are also included.
COURSE AIMS:	Increased wine production has increased the need for robust tools, technologies and practical guidelines for the management of winery wastewater. Development of a sustainable wastewater management strategy is important for the Australian industry as it has the potential to reduce the costs of wine production, and it will demonstrate leadership in environmental responsibility that is very important in international markets. The key objective of this workshop is to increase the Industry's awareness and knowledge on sustainable winery wastewater management by addressing the needs and interests of the local wine industry on issues such as: cleaner production and technologies key winery wastewater quality characteristics regulatory frameworks and guidelines for winery waste re-use better options for winery wastewater minimisation and re-use environmental issues associated with winery wastewater irrigation current thinking on salt management options associated with winery wastewater irrigation
Learning outcomes	The key speakers at the workshop will be engineers, regulators and researchers from the wine industry, government, and CSIRO. Contact Dr Anu Kumar (08 8303 8597) or Dr Jeanne Young (08 8303 8598) for further information. Or E-mail: Jeanne.E.Young@csiro.au Current treatment technologies in use What monitoring data is useful (What to measure? When to measure?) Best practices for winery wastewater minimisation and management Soil health issues and their management Current research outcomes on the winery wastewater related issues
Course program/structure:	Why do we need smart and cleaner practices for winery wastewater management? Can we implement Smart Practices through Smart Regulations? Wastewater: Tackle the sources, not the symptom Current treatment processes used in Australia: limitations and advantages Treatment options for small wineries Winery wastewater characteristics: what really matters? Group Discussion session: Case studies: small, medium and large winery Soil monitoring program Problem ions in wastewaters and soil health implications? Tree plantation irrigation: Is it sustainable? Risk assessment approach to manage wastewater management related issues Group discussion: An exercise to assess the risks

Table 3.5 Typical agenda for a two-day workshop

First day	
Time	Agenda item
10:00 – 10:10	Arrival and morning tea
10:10 – 10:30	Welcome and opening remarks: objectives for the day and background information
10.30 – 11:00	Wastewater: Tackle the source, not the symptom
11:00 – 11:25	Current Treatment processes in the Australian wine industry
11:25 – 11:45	Winery wastewater characteristics: What really matters?
11:45 – 12.10	Treatment options for small wineries
12:10 – 12:30	Discussion: Issues from small/medium winery perspective
12:30 – 12:45	Water Allocations in the Clare Valley: NRM perspective
12:45 – 1:45	Lunch
1:45 – 2:15	Smart practices through smart regulations?
2:15 – 2:30	Winery wastewater management plan
2:30 – 3:00	Exercises/calculations- SAR
3:00 – 3:30	Drinks
NEXT DAY	10:00 – 15:30
10:00 – 10:10	Arrival and morning tea
10:10 – 10:20	Winery wastewater reuse and disposal- an introduction
10:20 - 10:40	Cleaner production initiatives: a local case study
10:40 – 11:05	Soil and groundwater monitoring program
11:05 – 11:15	Winery Wastewater issues from reuse perspective
11:15 – 11: 45	Land irrigation: Is it sustainable?
11:45 -12:00	Use of organic matter for cropping: A case study
12:00 – 12:30	Group discussion: Issues and concerns-soil health
12:30 – 1:30	Lunch
1:30 – 1: 45	Problem ions in wastewater: current status
1:45 – 2:00	Best management practices
2:00 – 2:25	Risk assessment approach: An exercise
2:25 – 3:00	Drinks and closing remarks

Table 3.6 Typical agenda for a one-day workshop

20th January 2010		
Time	Agenda item	
9:00 - 9:15 am	Welcome and opening remarks	
9:15 - 9:30 am	Introductions and discussion on the key issues	
9:30 - 10:00 am	CSIRO	Winery wastewater characteristics: what really matters?
10:00 - 10:30 am	CSIRO	Wastewater: Tackle the source, not the symptom
10:30 – 10:45 am	Morning tea	
10.45 - 11:30 am	CSIRO/Provisor	Stage 2 Audit
11:30 - 12:00 pm	Mike Carson JJC	The best fit winery wastewater treatment plant design
12:00-12:30 pm	Mike Carson JJC	Treatment options for small wineries
12:30-12-45pm	CSIRO/JJC	Group discussion: issues and concerns-treatment options
12:45 – 1:30 pm	Lunch	
1:30- 2:00 pm	Vic EPA	Regulatory Framework
2:00 - 2:45 pm	CSIRO	Land irrigation and wetlands: Is it sustainable?
2:45 - 3:15 pm	Group discussion	Winery wastewater reuse and disposal: Key issues
3:15 – 3:35 pm	Afternoon Tea	
3:35 – 3:50pm	CSIRO	Trial run on models and environment rating index
3:50 - 4:30 pm	CSIRO	Risk assessment approach: An exercise to assess risks at your winery
4:30 pm	Close workshop, drinks and nibbles.	

4 Workshop content

This section of the report outlines some of the key points made in the workshops. The exact material used in any one workshop varied depending on the participants. A full set of notes that was used in the Geelong workshop is provided as a supplement to this report.

4.1 Introductions and discussion on the key issues

These sessions served several purposes.

- Allowed workshop leaders to become acquainted with the participants;
- Facilitated networking among the participants; and
- Provided feedback to the workshop leaders as to the perceived problems being faced by the participants.

4.2 Winery wastewater characteristics: what really matters?

This session typically started with illustrations of some of the adverse effects that can result from poor handling of winery wastewater. These effects included overflows from the system, malodour, waterlogging and soil structure degradation, both onsite and downstream. Plants can also be adversely affected by excess nutrients or by salinity.

Generalisations are difficult to make as no two wineries are the same and consequently no two effluent streams are the same. This is further complicated by large seasonal variations in both quality and quantity of the wastewater.

The aim of the workshops were to promote the sustainable development of

- Vineyard;
- Organisation;
- Community; and
- Environment.

An understanding of the complete process is required to achieve these aims.

4.3 Wastewater: Tackle the source, not the symptom

The first part of this component is to identify quantify the sources of winery waste.
Emphasis was placed on

- Reduce;
- Reuse; and
- Recycle.

A case study where these measure reduced water usage by 30% over two years.

Data from the second audit presented in Frost et al. (2009) were used to highlight more details of water usage. Discussion were also presented on the methods of reducing chemical usage and best practices that can be easily implemented in the wineries. Some of the key points from this presentation are as follows:

- Reduce water use where possible at the source;
- Reuse chemicals until spent;
- No water is used only once (all water has a secondary purpose);
- All water is treated to a point for sustainable reuse; and
- Recycled water can be used to reduce mains/supply requirements.

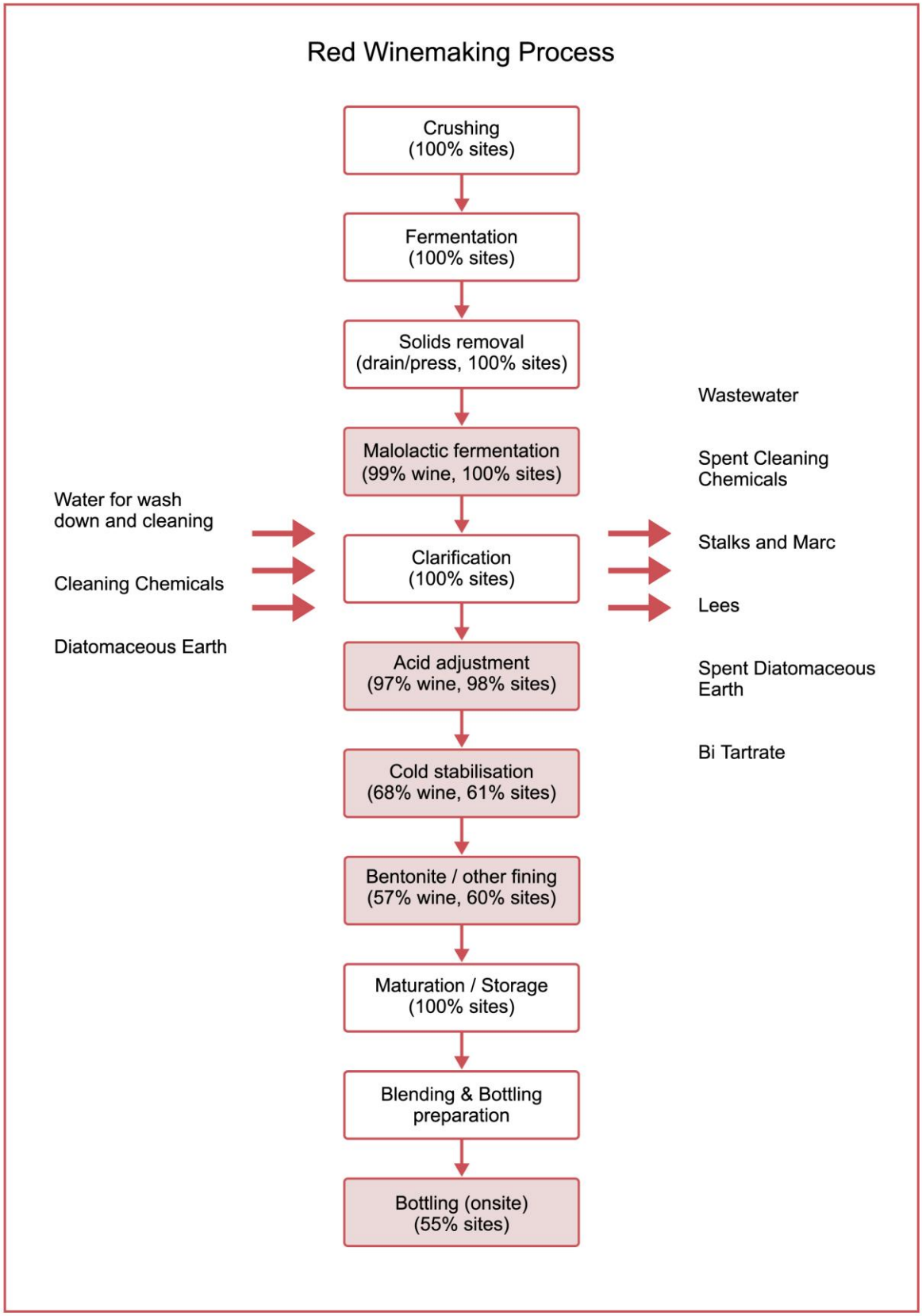


Figure 4.2 Schematic of processes involved in red wine making and potential waste stream sources. (percentages refer to total amount of wine produced by wineries in the survey and sites refers to the number of wineries in the survey)

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4.4 The best fit winery wastewater treatment plant design

The choice of winery wastewater system depends on many components including

- Are you near a river or residents;
- How much space is available;
- Depth to groundwater;
- Current waste and waste reduction potential;
- Whether waste streams can be segregated; and
- Where will the wastewater go.

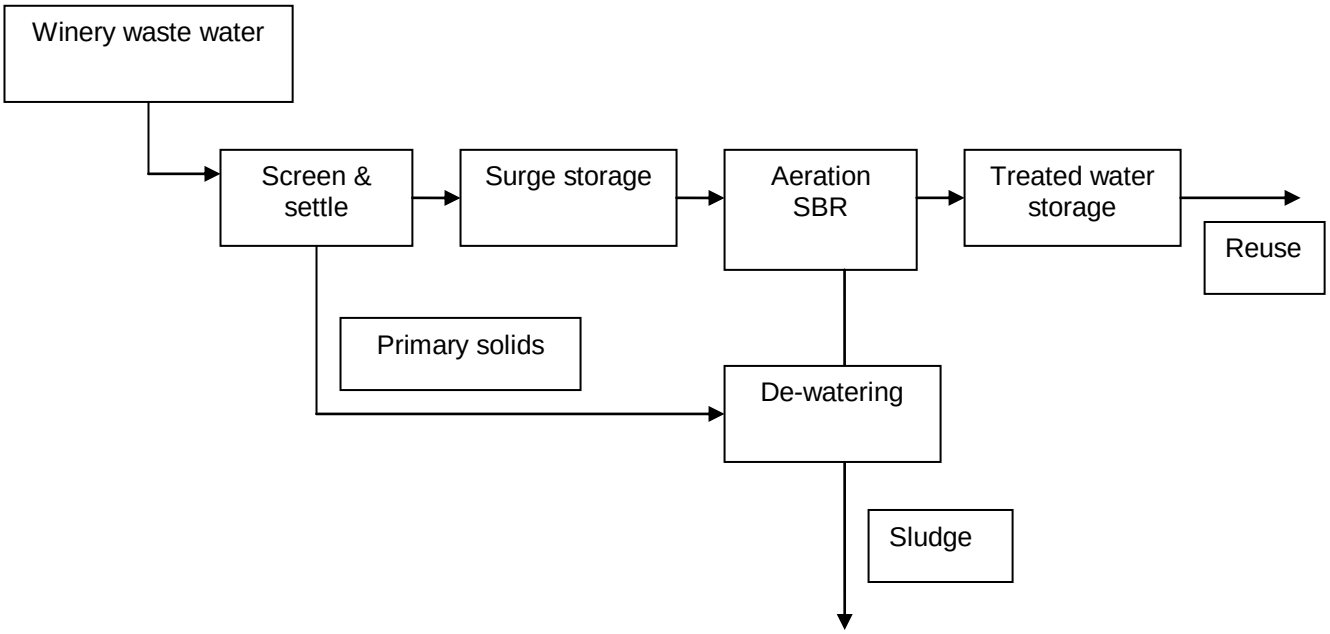


Figure 4.3 Schematic representation of a wastewater treatment plant

Ways to increase the efficiency of the treatment plants are considered, for example whether it is cost effective to include an anaerobic treatment plant in the treatment train. The problem of how to compromise between capital expenditure yet having a plant of sufficient capacity are considered.

Typically the workshop included an on-site inspection of the wastewater treatment plant of a local winery.

4.5 Treatment options for small wineries

Small wineries can have a phased approach to developing a wastewater treatment plant.

The sequence of installation would be

- Screening and settlement (Followed by irrigation if possible or trucking offsite);
- Aeration process;
- Surge tank; and
- Dewatering facility.

It is indicated that very useful monitoring of the waste stream can be achieved using a simple water quality meter that measures EC, pH and dissolved oxygen.

4.6 Regulatory Framework

Regulations have been found to be the most common reason for upgrading treatment plants.

Typically a regulator from the state EPA would make a presentation.

4.7 Land irrigation and wetlands: Is it sustainable?

Historically disposal of wastewater was to streams whereas now the streams are protected. There is therefore only a short history of the effect of irrigation of with treated effluent.

Trials have shown that BOD from winery waste appears to increase soil health provided there is no water logging nor adverse effect on soil structure.

Monitoring of soils has indicated that there is an accumulation of monovalent ions (Na+ and K+). The accumulation can be controlled by having an appropriate leaching fraction, but that poses a threat to the groundwater.

4.8 Rapid wastewater reuse and disposal

A case study is presented where wastewater is screened and then used for irrigation of pasture. Blockages in the system are minimised by spreading the water using a water cannon, which has jets approximately 10 mm in diameter. Such a system is relatively cheap to install and uses considerably less energy while at the same time it accumulated soil organic matter.

Monitoring of the soil (which is very sandy) found that there was an accumulation of organic matter and potassium. Sodium appeared to be lost from the system, presumably from leaching.

Key to the success of the system is the availability of large areas that are accessible to an irrigation system, and sandy soil.

4.9 Soil and groundwater monitoring program

The objective of the soil monitoring is to collect information concerning the rates of change. All the data collected should be useful in decision making.

Critical questions addressed are

- The choice of control sites
- How samples should be taken;
- Where samples should be taken;
- Frequency of sampling;
- How many samples should be taken;
- What depth intervals should be sampled; and
- What chemical analyses should be requested?

Critical to any long term monitoring is effective archiving of information.

4.10 Risk assessment approach

The risk assessment considered the potential of a range of potential hazards to onsite and offsite assets as showing Table 4.7. The risk assessment tool shown included in the supplement was used to assess the risks. This exercise was used to assist the participants to consider a broad range of potential impacts that can arise from the operation of a winery.

Table 4.7 Range of risk assessment scenarios considered by workshop participants

	Environmental Element				
		On-Site Impacts		Off-Site Impacts	
Pollution Types	**Air**	**Soil**	**Water**	**Landscape**	**Stakeholder Issues**
	emission to air	Degradation	releases to water	down-stream	including employees
	Dust *Inorganic Particulate Matter*	Breakdown Products	Breakdown Residues	Atmospheric *Including acid rain*	Archaeological & Historic relics
	Gaseous Emission • *Greenhouse*[2] • *Ozone depleting*[3] • *Acid Rain*[4] • *Hazardous substances*[5] • *Dangerous substances*[6]	Effluent Disposal	Ground Water use	Ecology of Flora	Contractors and Suppliers
	Heat	Industrial Chemicals	Nutrient Leaching	Ecology of Fauna	Environmental Health *Including the effect of alcohol consumption*
	Odour	Laboratory Chemicals	Industrial Chemicals	Effluent Disposal *Liquid Waste*	Food Preservatives
	Noise & Vibration	Liquid Hydrocarbons	Inorganic Matter Non-Biological Solids	Ground Water	International Community
	Pesticide Aerosols	Nutrient Surplus	Laboratory Chemicals	Noise & vibration	Local Community
	Plant Disease Spores	Pesticide Residues	Liquid Hydrocarbons	Odour	Natural Heritage, *Eg. conservation & recreation parks*
	Pollen	Risk of Pesticide Spill / Leakage	Organic Matter Biosolids	Soil Erosion	Pesticides ~ MRLs
	Radiation *electromagnetic, ionising particles or rays*	Salt & Heavy Metal Deposits	Pesticides Residues	Soil & Salinity	Wine Industry
		Solid Waste	Risk of Pesticide Spill / Leakage	Solid Waste Disposal	

4.11 Trial run on models and environment rating index

Participants were asked to apply data from their own winery into the Environmental Impact Index that has been developed by CSIRO. This index highlights where the winery is having a large impact and by manipulating the parameters users can find where they can make the largest impact. The feedback on the use of the Index was incorporated into later versions.

Two models have been developed so that wineries can compare the components of the winery wastewater quality in terms of COD (chemical oxygen demand), EC (electrical conductivity, pH, salt loads (Na and K loads) and volumes of the winery wastewater generated by each unit operation. These models were also trialled by the workshop participants.

5 Results/Discussion

5.1 Workshop presentations

Workshops and special seminars were presented in 20 locations as shown in Figure 5.4. There was a wide spread of localities covering many of the wine-growing areas in Australia. The number of attendees varied from 12-38 at the workshops and 120-150 at the special seminars (Table 5.8). Overall there were approximately 715 attendees.

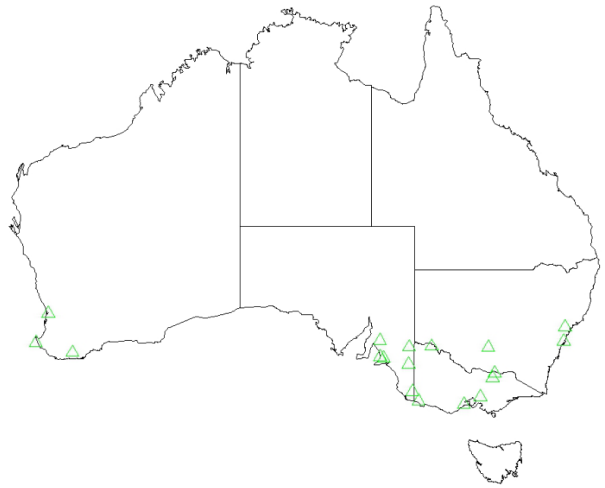


Figure 5.4 Map of Australia indicating locations where workshops were held.

Table 5.8 Summary of location of workshops and number of attendees.

Location		Date	Number of Delegates
AVSO seminar, Nuriootpa	SA	June-08	120
Barossa Valley	SA	Feb-06	15
Barossa Valley	SA	Oct-07	13
Berri	SA	Oct-07	120
Clare Valley	SA	Sep-07	13
Coonawarra	SA	Sep-08	15
Adelaide, Environment Institute	SA	Oct-08	30
Geelong	Vic	Jan-10	14
Great Southern	WA	Dec-07	22
Griffith	NSW	Jan-08	18
Margaret River	WA	Dec-07	36
McLaren Vale	SA	Jul-07	13
Mildura	Vic	Aug-09	12
Rutherglen	Vic	Sep-08	15
Swan valley	WA	Dec-07	15
Sydney, AWA conference	NSW	Nov-07	150
Wangaratta	Vic	Sep-08	19
Adelaide, 13th Winetech Conference	SA	Aug-07	38
Riverland	SA	Jan-07	14
Yarra Valley	Vic	Oct-06	24

Response to workshops

A questionnaire was distributed to the attendees of some workshops to both assess the reaction of the attendees and also to use that feedback to improve the presentations. A diagrammatic summary of the responses is given in Figure 5.5 as box plots. From these it can be seen that there was only a single score of less than three on any questions.

The responses were anonymous and the response rate from attendees was typically 80%, so there was little if any non-response bias.

Typically the structure of the workshop was rated 4/5, but a quarter of the responders gave a rating of 3/5.

The presenters' delivery was consistently rated at 4/5, and talk duration was rated 4/5 by most responders but up to a quarter rated this aspect as 3/5. The overall rating for the workshops was 4/5, with outliers at 3/5 and 5/5. The presenters' knowledge was rated very high with over 50% scoring it as 5/5 and most of the remainder as 4/5.

Over 50% gave a rating 4/5 rating for the workshop meeting their needs and the remainder gave a rating of at least three. Overall the workshop was given a very consistent 4/5 rating.

The results of the survey indicate that the workshops addressed problems that were considered important by the attendees and that the presentations were of high quality.

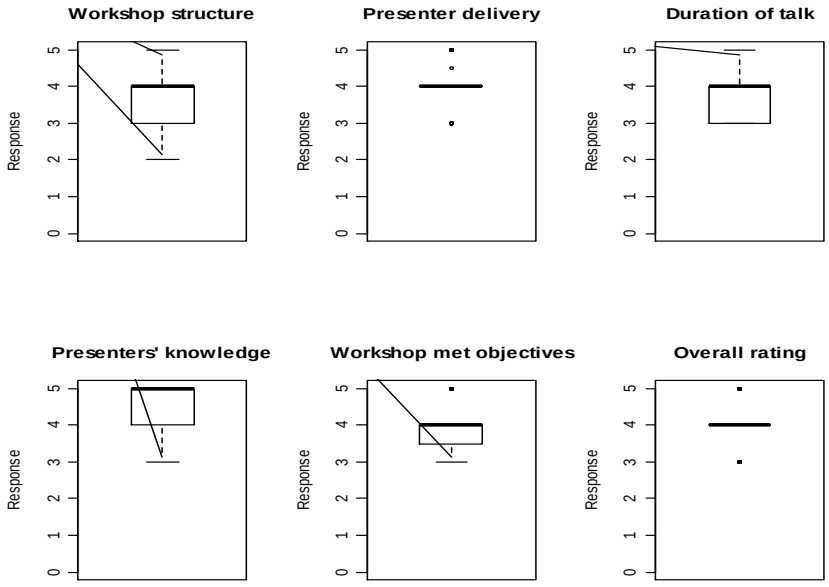


Figure 5.5 Diagrammatic summary of responses to questionnaire

Table 5.9 Summary of responses of delegates to workshop presentations

Workshop		Question							
Location	Date	Number of Delegates	Number of Responses	Overall rating	Workshop meets objectives	Workshop structure	Presenter delivery	Duration of talk	Presenter's knowledge overall
McLaren Vale	Jul-07	13	11	4.2	3.9	3.6	4.0	3.8	4.4
Winetech	Aug-07	38	2	4.0	3.5	4.0	4.0	4.5	4.0
Clare Valley	Sep-07	13	11	3.9	4.0	3.7	3.6	3.7	4.4
Barossa Valley	Oct-07	13	7	4.3	4.4	4.0	4.4	4.0	4.8
Margaret River	Dec-07	36	13	4.3	4.1	3.8	4.3	4.2	4.4
Great Southern	Dec-07	22	10	4.0	3.6	4.0	3.7	3.5	4.6
Swan valley	Dec-07	15	9	3.7	3.9	3.2	3.7	3.4	4.3
Mildura	Aug-09	12	8	4.4	4.3	4.0	4.4	4.3	4.9
Geelong	Jan-10	14	8	4.0	4.0	3.9	4.1	4.0	4.4
Overall result for sample		176	79	4.1	4.0	3.8	4.0	3.9	4.5

6 Outcome/Conclusion

6.1 Networking

The workshops provided excellent opportunities for networking at several levels as described below.

Among wine producers
One of the outcomes of the workshop was increasing networking among wine producers within a region.

Between wine producers and researchers
The workshops enabled much closer relationships between researchers and wine producers. The wine producers were much more aware of the role research is playing in supporting their industry. The interaction also enabled researchers to obtain information from wine producers. An example was the extensive use made of rapid irrigation with untreated wastewater.

Between researchers and regulators
There were interesting interactions between researchers and regulators. An important aspect of this was the effect of BOD on soil. Regulations place limits on the concentration of BOD that is allowed in irrigation water. Research presented in the workshops has shown that BOD is beneficial to soil. These findings have been accepted by SA EPA. As a result EPA SA is considering modifying its regulations.

6.2 Diversity of the wine industry

The diversity of processes in the wine industry is well established, and as a consequence of that there is a great diversity of winery waste water. This diversity makes it very difficult to make general statements or to give recommendations that are applicable to a diversity of situations. The approach used in this project has enabled small groups to be considered. The use of small groups from a single region meant that at least all attendees were under the same regulatory framework.

One observation made during the workshops was the range of knowledge of the wine producers. For example some participants appreciated the concept of SAR and how it is calculated. In other cases the wine producers had insufficient knowledge of chemistry to understand the calculations. Where the concept was well understood, the project could offer an Excel template for performing the calculations.

6.3 Links between research and industry

The strong link between research and research providers on the one hand and industry on the other hand was clearly appreciated by the workshop attendees. There were also benefits for the researchers who attended the sessions. The close liaison between research providers and industry is very appropriate because the research is funded in part by the industry.

The sample of wine producers may well be biased toward those who were more innovative.

The model used in this study – provision of workshops to small groups in their region – was clearly appreciated. What was also clear was the appreciation of the recipients of the knowledge of the presenters. While it is clear there remains a clear need for good interaction between industry and researchers, there is a significant cost involved. This cost should be considered an integral part of the research program and as such should be included in research budgets.

This poses the question as to the most efficient method of communication. One model is to have separate projects for communication as was exemplified by this project. An alternative model would be for researchers to brief communicators and for professional communicators to give workshops. A decision needs to be made as to whether the communication of the research should be by the researchers or whether it would be better to use professional communicators in this role.

6.4 Links between research and regulators

Throughout this project there was good collaboration between researchers and regulators. The regulations concerning the wine industry differ between the states. There is a case for a workshop between regulators of the wine industry with the researchers involved in winery waste water, with a view to being able to align current research with policy. Such research involves soil organic matter and so should be incorporated into

greenhouse gas considerations. There are therefore benefits in having national regulations concerning how winery waste should be handled.

6.5 Spreadsheets

From the industry survey and process auditing we developed several software tools to assist winery managers. Full details and the spreadsheet tools will be available to be downloaded from the CSIRO/GWRDC website.

1. Two models have been developed so that wineries can compare the components of the winery wastewater quality in terms of COD (chemical oxygen demand), EC (electrical conductivity, pH, salt loads (Na and K loads) and volumes of the winery wastewater generated by each unit operation.
2. A tool to give an assessment of the environmental impact of a winery. The general approach is to produce an index that indicates the environmental efficiency of a winery based on winery wastewater management. It is assumed that the crush size is known, so the amount of environmental impact can be expressed on a per tonne basis. It is based on a range of key performance indicators (KPIs) within the winery.
3. A tool to assess costs of current wastewater treatment options. This tool can be used by winery managers to estimate the cost of treating winery wastewater. The analysis covers power costs, maintenance, depreciation, labour and capital cots.

7 Recommendations

The concept of small regional workshops was well received by local wine producers and should be used as a method of communication between researcher providers and research users. Field trips should be also included in the 1-2 day workshop programs. These field trips also provide opportunities of interaction between region-specific wine makers/winery operators representing small and large scale wineries, both during and (potentially) beyond the project.

GWRDC should consider whether communication between researchers and wine producers is most effectively achieved by researchers and/or by professional communicators.

There should be a national workshop involving researchers, key industry representatives and regulators to produce national regulations or guidelines, and that these guidelines should include implications of wastewater management on soil organic matter and salinity.

The wine industry has a serious lack of communication in efficient winery wastewater reuse and wastewater treatment. We are continually seeing companies trying things that we know work or don't work from experience on other sites, or companies inefficiently developing things that have already been developed. Wineries are not sharing the innovations to improve the Australian wine industry overall. There is vast literature, studies and experience in the treatment of wastewater from a variety of sources rendering it fit for specific purposes. However, there are no specific handbooks for practical solutions to implement control measures and manage these systems for the wine and viticulture industry. By facilitating wineries in sharing their innovations in wastewater management, the demand for consulting in knowledge sharing will represent a significant saving to industry, both by expediting adoption and reducing costs of external help. In particular, smaller companies will benefit as they are often unable to access cost prohibitive wastewater and recycling best practice expert advice.

We would like to recommend following communication techniques at multi user levels to maximise impact and outcomes for utilising recycled water fit for a variety of uses.

- Handbook or a technical manual
- Regional workshops and field trips
- AWRI road shows
- Web-based modules and calculators
- Decision support tools
- Short videos demonstrating practices and their benefits
- Case study brochures and Fact sheets

8 Appendix 1: Communication

8.1 Journal Papers

1. Quayle, W.C., Christen, E., Jayawardane, N., Blackwell, J., Correll, R., and Fattore, A. (2006). Innovation in management of wastewater in the Australian wine industry. The Australian and New Zealand Grapegrower and Winemaker, 34th Annual Technical Issue (no. 509a): 41-49.
2. Frost, P., Kumar, A., Correll, R.L., Quayle, W., Kookana, R.S., Christen, E., and Oemcke, D. (2007). Current practices for winery wastewater management and its reuse: an Australian industry survey. The Australian and New Zealand Wine Industry Journal, 22 (no. 1): 40-48.
3. Arienzo, M., Christen, E., Quayle, W., and Kumar, A. (2008). A review of the fate of potassium in the soil-plant system after land application of wastewaters [in press]. Journal of Hazardous Materials, (doi:10.1016/j.jhazmat.2008.08.095).
4. Kumar A, Correll R and Kookana R (2008) Winery wastewater workshops translate research into practice Australian Wine Industry Journal 23 (6): 60-63.
5. Ray Correll And Anu Kumar A Tool for Assessing Environmental Impact of Winery Wastewater. To be submitted to Water Research

8.2 CLW Science Reports

1. Kumar A, Frost P, Correll R and Oemcke D (2009a) Winery wastewater generation, treatment and disposal: A survey of Australian practice.
2. Kumar A , Arienzo M, Quayle W, Christen E, Grocke S, Fattore A, Doan H, Gonzago D, Zandonna R, Bartrop K, Smith L, Correll R and Kookana R (2009) Developing a Systematic Approach to Winery Wastewater Management GWRDC Project CSL05/02

8.3 Conferences and workshops

1. M. Arienzo, E. Christen, W. C. Quayle, R. Kookana and A. Kumar. A review of land application of wastewaters and fate of potassium in soil-plant systems. Poster presentation, 13th Australian Wine Industry Technical Conference, Adelaide, 28th July -2nd August, 2007.
2. Anu Kumar, Evan W. Christen, Penny Frost, Wendy C. Quayle, Vincent O'Brien, Rai Kookana, Michele Arienzo and Ray Correll. Current Practises in Australian Wineries for Wastewater Minimisation and Treatment: their Advantages and Limitations. WEA Conference and Exhibition. Progress through Engineering 20/21 June, 2007, Mildura, VIC
3. Kumar A, Doan H, Grocke S, Kookana R and Correll R. 2007. An assessment of the efficiency of constructed wetland in treating high strength winery wastewater. Poster presentation. Proceedings of Thirteenth Australian Wine Industry Technical Conference 28th July – 2nd Aug 2007, Adelaide
4. Kumar A, Doan H, Grocke S, Kookana R and Correll R. 2007. Polymer use for treating winery wastewater: Environmental concerns. Poster presentation. Proceedings of Thirteenth Australian Wine Industry Technical Conference 28th July – 2nd Aug 2007, Adelaide.
5. Kumar A, Grocke S, Correll R, Doan H, Kookana R and. 20007. Winery wastewater quality differences across small, medium and large scale wineries. Poster presentation. Proceedings of Thirteenth Australian Wine Industry Technical Conference 28th July – 2nd Aug 2007, Adelaide.
6. Kookana R, Kumar A**,** Grocke G, Smith L, Doan H and Correll R. Impacts of winery wastewater discharge on soil health. 2007. Poster presentation. Proceedings of Thirteenth Australian Wine Industry Technical Conference 28th July – 2nd Aug 2007, Adelaide
7. Quayle, W.C., Christen, E., Jayawardane, N., Blackwell, J., Correll, R., and Fattore, A. (2006). Innovation in Management of Wastewater in the Australian Wine Industry. WEA Conference and Exhibition. Engineering for the Competitive Edge, 21/22 June, 2006, Morphetville Racecourse, SA.
8. Winery wastewater management and its role in wine industry sustainability. An oral presentation by Anu Kumar on invitation at the EP3 – The Third Wave of Environmental Practice organised by the Environment Institute of Australia and New Zealand. 11th October, 2007, Adelaide.

9. Current Practises in Australian Wineries for Wastewater Minimisation and Treatment. An oral presentation by Anu Kumar on invitation at the Wastewater Treatment and Re-use Forum, hosted by The South Australian Murray-Darling Basin Natural Resources Management Board, 30th October, 2007, Berri.
10. Current Practises in Australian Wineries for Wastewater Minimisation and Treatment. An oral presentation by Anu Kumar on invitation at the Two Day Specialty Seminar Worry Wastewaters II – ReUse, Recycle, Discharge organised by Australian Water Association, 7-8th November, 2007, Sydney.

8.4 Excel Spreadsheets

1. Audit model for a large winery
2. Audit model for a small winery
3. Environment rating index
4. Costing sheet to calculate treatment costs

8.5 News letters and factsheets

1. Study will assist those making waste treatment decisions. GWRDC R&D at work, April, 2007 edition p. 12 – 13
2. Winery Wastewater Management Project Flier – 2006
3. Winery Wastewater Odour Management Guidelines – 2009

8.6 Web-page

1. For winery wastewater management workshop updates
2. Project overview

8.7 Radio interviews

1. ABC Regional
2. ABC National Radio

8.8 International linkages

1. Sharon Melmon, Senior Associate Scientist, Kennedy/Jenks Consultants, USA
2. Prof Antonio Brito from the University of Minho, Portugal
3. Paul Jacobson and Philip Manson, Science and Innovations Manager, New Zealand Winegrowers
4. Jacques Rossouw, Wine and Spirit Board, South Africa

9 Appendix 2: Intellectual Property

This project created no intellectual property. In fact, the role of this project was to share research findings with the wine industry.

10 Appendix 3: References

1. Chapman JA, Correll RL and Ladd JN (1995a) Removal of soluble organic carbon from winery and distillery wastewaters by application to soil. Australian Journal of Grape and Wine Research 1:39-47.
2. Chapman JA, Correll RL and Ladd JN (1995b) The removal of soluble carbon from winery and distillery wastewaters by application to soil. Australian Journal of Grape and Wine Research 2:76-85.
3. Frost P, Kumar A, Correll R, Quayle W, Kookana R, Christen E, and Oemcke D (2007). Current practices for winery wastewater management and its reuse: an Australian industry survey. The Australian and New Zealand Wine Industry Journal, 22 (no. 1): 40-48.
4. Kumar A, Frost P, Correll R and Oemcke D (2009a) Winery wastewater generation, treatment and disposal: A survey of Australian practice.
5. GWRDC 2002-07 Five year R&D plan (2002 – 2007).
6. Kumar A , Arienzo M, Quayle W, Christen E, Grocke S, Fattore F, Doan H, Gonzago D, Zandonna R, Bartrop K, Smith L, Correll R and Kookana R (2009b) Developing a Systematic Approach to Winery Wastewater Management GWRDC Project CSL05/02
7. Kumar A, Saison C, Grocke S, Doan H, Correll R and Kookana R. (2006) Impact of winery wastewater on ecosystem health. Final report. GWRDC project CSL02/03.
8. WFA (2009) *Freshcare Environmental: Winery code of practice* Available at http://www.wfa.org.au/resources/4/PDF_Resources/FC_Environmental_Winery_Code.pdf

11 Appendix 4: Staff

List of all staff that have been engaged on the project

Name	Location
Dr Anu Kumar	CLW, Adelaide
Dr Ray Correll	CLW, Adelaide
Ms Sonia Grocke	CLW, Adelaide
Dr Jeanne Young	CLW Adelaide
Ms Debra Gonzago	CLW, Adelaide
Dr Rai Kookana	CLW, Adelaide
Mr Lester Smith	CLW, Adelaide
Mr Hai Doan	CLW, Adelaide

12 Appendix 5: Course materials

A set of course materials is provided in the supplement to this report.

13 Appendix 6: Budget reconciliation

END OF PROJECT FINANCIAL STATEMENT

Statement of Receipts and Expenditure

At the conclusion of each Project, the GWRDC requires a Statement of Receipts and Expenditure of GWRDC funds received in relation to the Project.

Project Title:	WINERY WASTEWATER MANAGEMENT: RESEARCH TO PRACTICE

GWRDC Project Number	Project Start Date	Project End Date
CSL 05/01	1 July 2005	30 April 2010

Financial Year (e.g. 2006/07)	(a) *Funds brought forward from previous year	(b) #Approved GWRDC Budget (full year)	(c) Total budget available (a)+(b)	(d) Actual expenditure ($)	(e) Difference ($) (c)-(d)
Year 1: 2005/06	-	121,816	121,816	28,948	
Year 2: 2006/07		128,715	128,715	68,353	
Year 3: 2007/08		132,887	132,887	122,957	
Year 4: 2008/09		0	0	128,557	
Year 5: 2009/10		0	0	48,153	
TOTAL		383,418		396,968	

* "Funds brought forward" refers to any unspent GWRDC funds from the previous year and approved by the GWRDC to be spent the following year (i.e. column (e) from previous year).
# "Approved GWRDC Budget" is the funding amount specified in the Project Agreement, including any approved Variations after Project commencement.

Was funding expended as approved in the Project Agreement? Yes X No ☐

*If **NO**, please provide reasons:*

Has the cash and/or in-kind funding from Contributing Agencies been received and applied to the Project as approved in the Project Agreement? Yes X No ☐

*If **NO**, please provide reasons:*

I hereby certify that this statement is true and accurate.

Signature of duly authorised representative .....

Bhagya Epasinghe *Name:*

Finance Manager, CSIRO Sustainable Ecosystems *Title:*

7 May 2010 *Date:* 10/5/10