MILESTONE 6

Project VPI4

Use of reclaimed effluent water in Australian Horticulture:

Stage 2 – Research required to ensure sustainable development of horticultural industries in Australia.

Funders and Collaborators

The National Program for Sustainable Irrigation focuses research on the development and adoption of sustainable irrigation practices in Australian agriculture. The aim is to address critical emerging environmental management issues, while generating long-term economic and social benefits that ensure irrigation has a viable future. The Program has 14 funding partners who are: Land & Water Australia (Managing Partner); Sunwater, Queensland; Horticulture Australia Limited; Goulburn-Murray Water, Victoria; Cotton Research and Development Corporation; Harvey Water, Western Australia; Lower Murray Water Authority, Victoria; Wimmera Mallee Water, Victoria; Ord Irrigation Cooperative, Western Australia; Australian Government Department of Agriculture, Fisheries and Forestry; Department of Natural Resources and Mines, Queensland; Department of Primary Industries and Resources South Australia; Department of Environment Water and Catchment, Western Australia; and Department of Agriculture, Western Australia.

Milestone 6 – Report

30th October, 2005

Principal Investigator: Dr Anne-Maree Boland, Department of Primary Industries, Victoria

Summary

Report on Milestone 5

Appendix 1 **Published materials.**

Appendix 2 **Agenda and minutes of Steering Committee meeting.**

Appendix 3a **Draft document "Using Recycled Water - A Growers Guide".**

Appendix 3b **Salinity conversion wheel and crop salt-tolerance wheels.**

Summary

General Issues:

The project is progressing well and is on schedule. The social research and policy guideline components have been completed, while the development of generic Best Management Practice packages and training and education components are underway.

The project team met in Melbourne on July 19th to discuss the recently completed social research, as well as food safety modelling and data collection from crops irrigated with recycled water, and education, training and extension activities.

The Steering Committee met in Adelaide on 9th/10th August 2005 to review both the National Program for Sustainable Irrigation (NPSI) and Coordinator Recycled Water Development Horticulture (CRWDH) (Horticulture Australia Limited) projects and to discuss future work programs. The meeting included tours of the Fosters Wine Estate Vineyard, the Virginia Pipeline Scheme, Mawson Lakes residential estate and the Parafield urban stormwater harvesting facility.

Highlights

Major products of the project since the last milestone (31st May 2005) are:

1) The "Guidelines for Developing Recycled Water Schemes in Horticulture" document for the federal Department of Agriculture, Fisheries and Forestry (DAFF) was released following ministerial approval. It has been distributed in hard copy and is available in electronic form on the DAFF website (www.daff.gov.au/content/publications.cfm).
2) Anne-Maree Boland presented an overview of VP14 research at the CRC for Irrigation Futures annual research forum (Mildura, 19th - 21st September), titled "The use of recycled water in Australian horticulture".
3) International (Singapore, United States and Mexico) and national (Virginia Pipeline Scheme and Parafield urban stormwater harvesting facility) study tours were conducted. Anne-Maree Boland and Daryl Stevens prepared a story on the international study tour that appears in the latest (August) issue of the ReWater Newsletter (http://www.reclaimedwater.com.au/documents/rewater_aug_2005.pdf).
4) Anne-Maree Boland was interviewed by ABC regional radio in Mildura where she promoted the use of recycled water in horticulture as well as the NPSI and CRWDH projects.
5) A reference group has been developed for the Victorian DPI ORL project on recycled water, which represents all the stakeholders identified in the NPSI project systems framework.
6) Blair Nancarrow presented her social research to Melbourne Water, the Victorian Department of Sustainability and Environment, the Victorian Environmental Protection Agency, the Victorian Department of Human Services and Southern Rural Water.

Summary (*cont*)

Progress of Components:

Component A – Development of generic integrated best management practices and monitoring packages for the use of recycled water in horticulture.

1. *Complete (see Report for Milestone 5)*
2. A draft of the Integrated Best Management Practice (IBMP) packages has been reviewed by the Steering Committee. Prototype decision-support tools have also been developed and reviewed. The tools are salinity conversion and crop salt-tolerance wheels for use in the field by growers.

3/4. The Werribee recycled-water trial site developed under DPI's "Our Rural Landscape" Initiative is now being used to grow horticultural produce that is being irrigated with recycled water. Soil samples were taken prior to planting and the soil is now being analysed to establish base-line data for future monitoring and data collection. A reference group was established and met for the first time in October.

Component B – Social research into stakeholder perceptions on the use of recycled water in horticulture.

5. Stakeholder perceptions and evaluation for the Virginia Pipeline Scheme (June Marks) is complete and the report has been released.
6. The consumer decision-making survey for the Werribee Irrigation District (Blair Nancarrow) is complete and the report has been released.

Component C – Training and education.

7. Discussions with training, extension and communication specialists have been extended to include the relevant registered training organisations as well as the deliverers of the Irrigation Management Course (Victoria and NSW) and the Irrigation Association of Australia. A workshop was also conducted at the recent project team meeting to identify key issues and clarify roles and objectives. The education and training packages will form part of wider irrigation training packages and build on training delivered to WID growers as part of requirements for customer site management plans. They will also utilise the newly developed tools and monitoring packages, which will be applicable to reuse schemes across the country.

Component D – Development of policy guidelines for the optimum use of recycled water.

8. The guidelines document has been officially released and is available in electronic format on the DAFF website at http://www.daff.gov.au/content/publications.cfm. A follow up information document 'Water recycling in Australian agriculture', which includes more detailed information for the general public, has also been developed. The document was reviewed by the Steering Committee in August.

Report on Milestone 4

The milestones and payment schedule as listed on Use of Reclaimed Effluent Water in Australian Horticulture Project No: VP14: Research Agreement between the Land and Water Resources Research and Development Corporation and State of Victoria through its Department of Primary Industries.

Annexure A – Project Schedule

Completion Date	Description of Stage	Amount
6/06/2003	**Signed Agreement Returned** **Achievement Criteria** - Agreement executed. - Tax invoice submitted. **Achieved**	$30,000
30/09/2003	**Financial Statement 2002/03** **Achievement Criteria** - Financial statement 2002/03 submitted to Land and Water Australia. **Achieved**	$7,500
01/10/2003	**Milestone 1:** 1. Generic deliverables. 2. Project Team in place with all the necessary skills. 3. Establishment of stakeholder coordination process. 4. Quantification of potential resources and development of systems framework. 5. At least one Steering Committee meeting held. 6. Logframe for evaluator signed off. **Achievement Criteria:** - Generic deliverables achieved. - Steering committee agree to process and endorse preliminary recommendations. - Preliminary identification of key stakeholders. - Quantification of reclaimed water resources. - Documentation of systems framework and completion of Decision Tree. - Identification of key components for systems framework and determination of packages to be analysed. - Preliminary recommendations for Stage 2 R&D. - 5/9/03, Brisbane, meeting of stakeholders and researchers for review of all draft reports and components in progress and discussion of draft recommendations. - Land and Water Australia approve milestone report. **Achieved**	$30,000
31/12/03	**Milestone 2:** 1. Generic deliverables. 2. Benefits and risks of key components identified and recommendations for Stage 2 R&D. 3. Attendance including presentation and poster display by Principal Investigator at annual Sustainable Irrigation Program Forum (October 2003). 4. Cost share achieved. 5. Summary fact sheet of the project completed. 6. Evaluation process specified.	$22,500

	7. Stage 1 results and Stage 2 proposal presented to the Steering Committee along with an independent review of Stage 1 results. 8. Steering Committee provide advice to the Sustainable Irrigation Management Committee whether the project is sufficiently robust and to proceed to Stage 2. 9. Sustainable Irrigation Committee confirm Stage 2. Achievement Criteria: - Generic deliverables achieved. - Documentation of benefits and risks of key components. - Presentation and poster display at annual forum. - Cost share achieved. - Endorsement by Steering Committee of recommendations and development of Stage 2 R&D. - Stage 1 report approved by LWA. **Achieved**	
30/01/2004	**Decision for Stage 2.** **Decision by Sustainable Irrigation whether to proceed with Stage 2.** **Approved**	$15,000
30/04/2004	**Milestone 3** 1. Generic Deliverables. 2. Case Studies identified with all priority stakeholders participating. 3. Sustainable Irrigation Projects receiving input as appropriate for their project. 4. Future Milestones including report confirmed by LWA. 5. Synergies with other reclaimed water activities in case study locations identified. **Achievement Criteria:** - Stage 2 proposal confirmed. - Generic deliverables achieved. - Successful interaction with Projects and Case Study. - Milestone approved by LWA. **Achieved**	$10,000
30/10/04	**Milestone 4** 1. Generic deliverables. 2. Case studies confirmed and workplans defined. 3. Sustainable irrigation projects receiving input as appropriate for their project. 4. At least one steering committee meeting. 5. Future milestones including report confirmed by LWA. 6. Progress towards initiation of additional R&D activities. 7. R&D outcomes communicated to HA Ltd project. 8. Review linkages of project with national guidelines for consistency issues. **Achievement Criteria:** - Content confirmed after milestone 2 completion. - Generic deliverables achieved. - Successful interaction with Projects and Case Studies. - Steering Committee endorses implementation of the work plan and case studies. - Milestone approved by LWA. **Achieved**	$60,000
31/05/05	**Milestone 5** 1. Generic Deliverables. 2. Case Study workplans reviewed. 3. Sustainable Irrigation Projects receiving input as appropriate for their	$200,000

	project. 4. Review funding achieved for additional project components. 5. Stakeholder and grower networks established and functioning reviewed. 6. At least one Steering Committee meeting. 7. Future Milestones including report confirmed by LWA. 8. Principal Investigator presents at annual Sustainable Irrigation Program Forum. 9. Scoping phase completed. 10. Questionnaire designed and undertaken to public consumers, growers and distributors designed and completed. 11. Data analysed. 12. Case study report formats agreed between DAFF and LWA. 13. Agreed detailed final report submitted. 14. Report of recommendations for future communication and education programs produced. 15. Hard copy and electronic versions of Guidelines documents delivered to DAFF. **Achievement Criteria:** - Content confirmed after milestone 4 completion. - Generic deliverables achieved. - Successful interaction with Projects and Case Studies. - Steering Committee endorses implementation of the work plan and case studies. - Presentation and poster display at annual forum. - Milestone approved by LWA.	
30/10/05	**Milestone 6** 1. Generic Deliverables 2. Case Study workplans reviewed 3. Sustainable Irrigation Projects receiving input as appropriate for their project 4. At least one Steering Committee meeting 5. Future Milestones including report confirmed by LWA 6. Draft BMP package, monitoring package and tools presented to growers and Steering Committee for evaluation (including consistency with national guidelines) **Achievement Criteria:** - Content confirmed after milestone 5 completion - Generic deliverables achieved - Successful interaction with Projects and Case Studies - Steering Committee endorses implementation of the work plan and case studies	$60,000

Deliverable 1. Generic deliverables.

All project reports and communications in electronic and hard copy formats as specified by LWA Communications.

- Milestone report 5 was submitted to LWA in electronic and hard copy formats.

Photographic record depicting project milestones in a digital format suitable for web and PowerPoint presentations.

- Photographic records are updated continuously and electronic copies of photos have been included in various PowerPoint presentations and in the project newsletter. See Appendix 1.

At least one media release and updates supplied to LWA Communications and copied to Program Coordinator

- A Ministerial press release titled "Victorian scientists lead the way to smarter water use" was submitted to various media outlets in October 2005. See Appendix 1.

What knowledge assets the project has generated in the milestone period (if any).

The project has generated a number of new knowledge assets in the milestone period:

- The "Guidelines for Developing Recycled Water Schemes in Horticulture" document for the federal Department of Agriculture, Fisheries and Forestry (DAFF), which has now been released following Ministerial sign-off.
- New issues of the project newsletter have been distributed to project team members, the Steering Committee and other interested parties (Appendix 1).
- A news story on the international recycled water study tour in ReWater (Appendix 1).
- A presentation by Anne-Maree Boland to the CRC for Irrigation Futures (Appendix 1).

APPENDIX 1 – PUBLISHED MATERIALS

Deliverable 2. Case study work-plans reviewed.

The case study work-plans were reviewed and endorsed at Steering Committee meeting 4 (March 2005) and progress against the work plans was reviewed at Steering Committee meeting 5 (August 2005). A draft Integrated Best Management Practice Guideline document and prototype decision-support tools (see Deliverable 6) have been produced and will be further developed by testing at the case study sites.

The first crop has now been planted at the Werribee trial site for the DPI food safety project following extensive soil sampling and analysis to establish baseline data for ground-truthing of models. The site will accelerate the development of monitoring tools for Component A of the project. The project has also established a reference group, whose composition was determined using the NPSI project's systems framework, to ensure representation by all relevant stakeholders.

Education and training will also be tested at both case study sites (the Werribee Irrigation District and the Virginia Pipeline Scheme) prior to being rolled out on a wider scale.

Deliverable 3. Sustainable irrigation projects receiving input as appropriate for their project.

Regular discussions have been undertaken with team members from other relevant NPSI projects such as:

1) Steven Falivene – Open Hydroponics: risks and opportunities (NPSI project DAN22)
2) Matthew Durack – Sustainable Root Zones, NPSI Project Proposal.

Deliverable 4. At least one steering committee meeting.

A Steering Committee meeting was held in Adelaide on the 9th and 10th August. See Appendix 3.

APPENDIX 2 – AGENDA AND MINUTES OF STEERING COMMITTEE MEETING.

Deliverable 5. Future Milestones including report confirmed by LWA.

All future milestones for Stage 2 of project VP14 (Research required to ensure sustainable development of horticultural industries in Australia), including the final report, have been agreed to by LWA.

Deliverable 6. Draft BMP package, monitoring package and tools presented to growers and Steering Committee for evaluation (including consistency with national guidelines).

A draft BMP package, “Using recycled water - a growers guide”, has been developed that specifically targets growers and will be applicable to reuse schemes across the country. The document was reviewed by the VP14 Steering Committee in August and by the ORL Recycled Water Reference Group in October. The document is a simple information resource that will direct growers to additional, more detailed information sources. The information contained within the document is consistent with the National Guidelines and has been developed through consultation with the authors of the National Guidelines. Prototypes of a salinity conversion wheel and crop salt-tolerance wheel were also reviewed by the Steering Committee and by technical experts. These simple decision-support tools are robust to allow regular in-field use and, like the BMP document, will have wide applicability.

APPENDIX 3a – DRAFT DOCUMENT “USING RECYCLED WATER - A GROWERS GUIDE”.
APPENDIX 3b – SALINITY CONVERSION WHEEL AND CROP SALT TOLERANCE WHEELS.

APPENDIX 1

NEWSLETTER

Volume 2, Issue 3

September 2005

Recycled Water

Fifth SC Meeting

Greetings, Recycled Water workers.

The fifth Steering Committee meeting was held in Adelaide on the 9th and 10th of August. The meeting included tours of:

1) The Fosters Wine Estate Vinyard, where Mike McCarthy talked the steering committee through his trials using recycled water on vines, as well as the analysis of the resultant wine.

2) Mawson Lakes residential estate, which uses recycled water from the Parafield urban stormwater harvesting facility.

3) Virginia Pipeline Scheme (VPS), which included vegetable production.

4) And after dinner speaker Mr Peter Hayes, chair of the CRC-IF.

At the Steering Committee meeting:

1) Anne-Maree Boland presented an overview of the NPSI project and progress against milestones. The team was congratulated by Murray Chapman for continuing to deliver milestones in a timely manner despite various external pressures.

2) Daryl Stevens gave a brief outline of recent activities within the CRWDH project, as well as highlights from the recent Overseas Study Tour (see page 2). Daryl also led discussions on both the 8-page DAFF National Guidelines document ("Guidelines for Developing Recycled Water Schemes in Horticulture"), which has now been released (http://www.daff.gov.au/content/publications.cfm), and the expanded 16-page information document for the general public ("Water recycling in Australian agriculture").

3) Som Jarwal presented the prototype of his salinity wheel (see below) and best-management practice guidelines for growers ("Growers guide for using recycled water").

4) In depth discussions were held around extension, training and education programs, the creation of a recycled-water R&D knowledge bank, and the future work program for the projects.

Many thanks Ted Gardner for chairing the meeting and to all those that attended an enjoyable and informative gathering. The next Steering Committee meeting will be held in March 2006, in either Tasmania or Queensland (Toowoomba), chaired by Blair Nancarrow.

Project Meeting

A joint LWA/HAL Project Meeting was also held recently (July 19th at the Hilton Hotel, Melbourne Airport). Discussions centred around:

1) Social research (June Marks and Katherine Boon on their study of stakeholder perceptions in the VPS and Blair Nancarrow on her study of consumer decision-making associated with the Werribee Irrigation District).

2) Food safety and modelling the risks involved in human consumption of produce irrigated with recycled water (Andrew Hamilton) and the new DPI trial site in Werribee (Melissa Wos).

3) Education, training and extension, including the recent CRWDH project activities (Daryl Stevens) and the development of training packages (Matt Rogerson, Arris Pty Ltd and Barry Dignam, DPI).

Recycled Water

Overseas Tour

Jim Kelly and Daryl Stevens organised an overseas recycled-water study tour (28th May to 11th June) that was attended by 22 water enthusiasts with diverse backgrounds (including NPSI project team member Anne-Maree Boland and NPSI Steering Committee member Barry Dennien...and Ted Gardner would have gone if he'd been allowed!). The tour began in Singapore where participants were taken through the NEWater facility, which produces water that is safe for potable uses, and were also given an insight into the world-leading communications strategies that have accompanied recycled water developments in that country. The next stop was Florida, where the group looked at urban and recreational use of recycled water, as well as rapid infiltration basins for groundwater recharge. The group then traveled to Mexico where recycled water uses were mainly industrial, although treated water was discharged into waterways and withdrawn downstream for irrigation of crops. The final stop on the tour was California, to look at agricultural use of recycled water, and participants had a culinary run-in with the infamous Californian Globe Artichoke.

According to Daryl, the study tour was a resounding success and highlighted the fact that Australian standards and procedures for recycled water, as well as our consideration of the issues surrounding recycled water, often exceed those in other parts of the world.

(Left) Daryl Stevens and Jim Kelly inspect lettuce crops in Monterey, California. (Centre) Tour participants at a recycled water facility in Monterrey, Mexico. (Right) Barry Dennien entertains the crowd at a St. Petersburg Bar, Florida, as his groupies look on in awe.

The Western Corridor Water Recycling Scheme

Continued population growth in the south-east corner of Queensland will see demand for water exceed supply in 2025 if no action is taken. However, a new initiative will address this looming problem with the development of the Western Corridor Water Recycling Scheme. The scheme will integrate the urban, industrial and agricultural water cycles within this region, reusing water from more than 500,000 urban residents.

The scheme will provide non-drinking water to:

- New residential areas in Brisbane and Ipswitch.
- Industrial precincts such as the Swandbank Power Station.
- Agricultural areas such as the Lockyer Valley, Bremer and Warril.

The scheme will reduce the demand for on potable water sources by as much as 90 ML/day, as well as reduce the strain on groundwater. The scheme will also help to reduce the level of nutrients discharged into receiving waters and increase environmental flows by replacing surface water extractions.

The scheme will be developed in a staged process to satisfy projected demand from the various market segments up to 2025. The initiative will be particularly important for the regions horticultural producers. Water for horticulture from ground- and surface-water sources is becoming increasingly scarce, but recycled water promises to provide a more secure water supply. It is anticipated that the availability of recycled water will prompt agricultural production in the region to almost double. **For further information, Contact Barry Dennien.**

Recycled Water

Steering Committee Tour

Above: The Steering Committee discuss irrigation with Virginia Pipeline Scheme growers in the Northern Adelaide Plains, as the recycled water flows behind them.

(Above Left) Mike McCarthy shows off his vines to Anne-Maree Boland and Som Jarwal.

(Above) The Fosters Wine Estate Vinyard.

(Left) The Steering Committee tours the Parafield reedbed lagoons with protective bird-nets overhead.

(Below Left) A carrot crop irrigated with recycled water in Virginia, South Australia.

(Below) Mark Purdie explains the aquifer recharge procedure at the Parafield urban stormwater harvesting facility.

PRESS RELEASE

Media release

From the Department of Primary Industries

Monday, 5 September 2005

Victorian scientists lead the way to smarter water use

The use of recycled water for agricultural irrigation is set to increase in the wake of a national research program led by the Victorian Department of Primary Industries (DPI).

With increasing restrictions on the availability of traditional water sources, the race is on to both use supplies more efficiently and to evaluate the capabilities and limitations of alternatives such as stormwater and recycled wastewater.

These alternatives may be pivotal to sustaining irrigation in some regions.

The national Recycled Water in Australian Horticulture (RWAH) program entails both research and communication activities, to address key knowledge gaps and disseminate information about using recycled water.

Senior DPI research scientist, Dr Anne-Maree Boland, who leads the RWAH program, said that introducing alternative water sources was not simply a matter of getting the quality right.

“A major innovation of this kind has social, environmental and economic implications,” she said.

“We have been learning about the issues facing recycled water use at both a national level and through drawing on international experience in Singapore, Mexico and the United States.”

Dr Boland said that the horticulture industry in Australia has been concerned about community perceptions relating to food safety and the long-term sustainability of recycled water schemes.

“For irrigation with recycled water to succeed, growers need to be convinced that it is a safe, economically viable alternative."

A lack of training and advice for growers had also been identified as a limiting factor in the use of recycled water.

“The RWAH program is addressing the management issues of using recycled water for horticultural crops, to complement existing irrigation management courses, and will provide valuable knowledge on using recycled water effectively and safely’” said Dr Boland.

“Irrigation with recycled water is likely to play a big part in the future of Australian horticulture, provided we can demonstrate that there are no environmental or food safety risks.”

“With the introduction of two major schemes in Victoria (Werribee and the Eastern Irrigation Scheme), the science that DPI is undertaking will boost confidence in the use of recycled water in horticulture.”

The National Program for Sustainable Irrigation is supporting RWAH as part of its focus on research to drive the development and adoption of sustainable irrigation practices in Australian agriculture. The Program has 14 funding partners, with Land & Water Australia as the managing partner.

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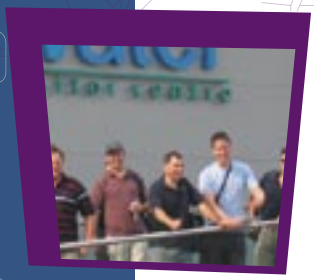
REWATER

rewater

farming with recycled water



Recycled Water Study Tour visits Singapore, Mexico, Florida and California

Dr Anne-Maree Boland - DPI Vic
Dr Daryl Stevens – Arris Pty Ltd

As part of the Horticulture Australia Limited project, Coordinator of Reclaimed Water Development in Horticulture, Arris Pty Ltd recently led a Recycled Water Study Tour to Singapore, Mexico and the USA. The tour was designed to explore the successful and sustainable development of recycled water use, both nationally and internationally. Participants studied agricultural/ horticultural, potable, industrial, domestic, municipal, recreational and environmental uses of recycled water. The water authorities and recycled water scheme operators at each site guided participants through their Wastewater Treatment Plants (often referred to as Water Reclamation Facilities) and recycled water schemes. They provided valuable insights into the development, commissioning, operation, management and communication programs associated with specific reuse schemes. Other areas of interest included wider public communication strategies and education, risk management for water authorities, regulatory issues and frameworks for the establishment of these schemes.

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edition August 2005

A product of the Coordinator Reclaimed Water Development Horticulture project. Funded by Horticulture Australia Limited. *Know-how for Horticulture™*

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Indirect potable reuse considered in San Diego. page 10

From the editor

ReWater has been developed in recognition of the growing interest in the use of reclaimed water in agriculture.

We would like ReWater to become a forum for you to communicate your thoughts about the beneficial use of reclaimed water.

If you would like to receive a copy of ReWater electronically, email us at rewater@reclaimedwater.com.au

If you have articles, ideas or would like to raise issues in the letters to the editor, submit them to the National Coordinator for Reclaimed Water Development, Horticulture.

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Below is a brief summary of each country and state visited.

Singapore

The NEWater water reclamation study was initiated in 1998 to determine the suitability of using NEWater as a source of raw water to supplement Singapore's water supply. NEWater is treated sewage water that has undergone a stringent purification and treatment process using dual-membrane (microfiltration and reverse osmosis) and ultraviolet technologies. NEWater can be mixed and blended with reservoir water and then undergo conventional water treatment to produce drinking water (ie. Indirect Potable Reuse). The tour included a visit to the NEWater visitor centre, which is a state of the art facility aiming to educate the community on the importance of water conservation and recycling. The tour also visited urban stormwater catchment facilities and a potable water treatment plant.

Key observations:

- The focus on communication and education was impressive, if not 'fantastic'.
- Consistent vision and leadership was important for the successful implementation of the NEWater scheme.

Study tour participants in front of NEWater visitor centre and water factory.

United States of America - Florida

The reuse of treated water (reclaimed water in Florida) has been occurring since the 1980s with the major driver being reduced outflows of effluent into the sea. Since that time the use of recycled water has rapidly increased to approximately 800 GL/y in 2003. Most of this water is used for landscape irrigation (45%) with other uses including industrial (16%), agriculture (16%), groundwater recharge (15%), and wetlands and other (8%). Many examples of urban irrigation, golf courses and parks were observed. In addition, a groundwater recharge facility, citrus orchard, nursery and industrial sites (cooling towers and electricity generation plant) were visited. A number of water reclamation facilities were visited to understand the treatment processes and regulatory frameworks that are employed.

continued page 3

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Key observations:

- The use of recycled water for agriculture is minimal and declining as the population increases and agricultural land is developed
- Orchard and irrigation management practices were variable as many owners waited for the land to be developed for residential uses
- Landscape irrigation is likely to increase as housing developments flourish
- Nursery producers were efficiently managing recycled water
- Water conservation is not apparent, rather the community focus is on using the recycled water resource, but not addressing the 'how efficiently' aspect
- Partnerships have been established to actively promote the use of recycled water
- Recycled water is perceived as a normal activity by the community
- Recycled water is never plumbed into the house for toilet flushing, etc as this is considered too high risk

United States of America - California

California has been a water recycling pioneer, beginning in the 1960s. The adoption of recycled water projects has probably been driven from a water conservation perspective with reduced discharge a secondary driver. Recycled water use in 2003 was approximately 700 GL with a capacity to reuse 2,000 GL/yr based on existing water reclamation plants. Agricultural production is a significant user of recycled water (47%) with landscape irrigation (21%), groundwater recharge (9%) and industrial use (5%) being lesser users. The tour included visits to reclamation facilities, and observations of end uses including the Groundwater Replenishment System in Orange County, the development of urban irrigation, golf courses and parks and the Monterey agricultural region. Alternative uses observed included car washes, aged care laundry facilities and government institutions (eg prisons).

Key observations:

- Agriculture has played an important part in the development and acceptance of recycled water schemes
- Experimental trials were undertaken for 5 years in Monterey at significant cost; this was prior to growers being asked to use recycled water
- Water is tending to move to those who can pay – eg affluent urban societies; the question is then raised - how does agriculture protect its recycled water resources?

Artichoke grown with recycled water from the MRWPCA Water Recycling Plant, Salinas Valley, California.

Mexico

Cities in Mexico are rapidly developing with considerable focus on the quality and quantity of its water resources. Industrial use of recycled water is the key focus of the Federal Government. Two key industrial sites were visited – an oil refinery that uses recycled water in its cooling towers and an electrical power plant that uses recycled water in the cooling towers and reverse osmosis treated water for steam generation water.

Key observations:

- There are many opportunities for use of recycled water in industry
- Industry generally has the ability to pay for the quality of water required for the end use as long as it is 'fit-for-purpose'
- At present, environmental considerations seem secondary to industrial development

More information on all the sites visited by the Study Tour will be available in the next ReWater edition.

continued page 4

Nursery and pot with dripper water system (insert); Hermann Engelmann Greenhouses – Apopka, Florida.

from page 3

Arris Pty Ltd would like to thank the 20 participants who attended this study tour for their enthusiastic participation and valued contribution to what will provide them, and Australia, with a valuable insight into recycled water projects in a range of countries around the world. These participants represented the key water management sectors in Australia including urban and rural water authorities, private water distribution companies, EPAs, and Government departments of Environment and Agriculture. We also recognise the invaluable contribution of a range of individuals from water industries in Singapore, Mexico, Florida and California, who gave our study tour participants the time to discuss and show us some of the most fascinating and innovative recycled water projects in the world.

This is a product of the Coordinator Reclaimed Water Development Horticulture project, funded by Horticulture Australia Limited. The delivery of research and development outcomes from this project to the horticultural industry is made possible by the Commonwealth Government's 50 % investment in all Horticulture Australia's research and development initiatives.

Large areas of lettuce, celery and artichoke in the Salinas Valley cropped with recycled water.

The Campaspe water reclamation scheme launched

www.earthtech.com.au/news.050520.htm

Treasurer and Minister for State and Regional Development The Hon. John Brumby, officially launched the $40 million Campaspe Water Reclamation Scheme in Echuca, Victoria (May 2005).

Coliban Water and Earth Tech worked together to deliver outstanding environmental and customer outcomes for the region. The Scheme provides additional wastewater treatment capacity to Echuca and surrounding townships and overcomes environmental problems experienced with the former lagoon-style treatment plants in Echuca.

Barry Norman, Earth Tech Managing Director, said the scheme is a milestone public-private partnership for Victoria. Earth Tech's successful delivery of the project demonstrates the effectiveness of this approach for maintaining vital community infrastructure.

Earth Tech designed and built the new high-tech Echuca treatment plant and the reclaimed water pipeline distribution network, which it will own and operate for 25 years in partnership with Coliban Water.

The scheme provides local farmers with 8 million litres (ML) per day of high quality Class B recycled water, which is fit-for-purpose for dairy pastures and crops including tomatoes and grape vines.

"By recycling water, we're helping sustain the land and providing additional water to local farms during a period of prolonged drought," said Mr Norman.

The scheme also provides long-term savings for the community, Coliban Water and local trade waste customers by introducing best practice waste minimisation and Environment Protection Authority Cleaner Production Strategies.

Gordon McKern, Coliban Water Chairman, said Coliban Water is leading the way using public-private partnerships to deliver projects to the North Central region.

"This process brings us cutting-edge innovation, world's best practice, great technical solutions and financial benefits," said Mr McKern. "I think it's an excellent way of doing projects that deliver real benefits to the local community".

As part of the implementation plan for the project, major trade waste customers have been active in implementing Cleaner Production Strategies with the support of the EPA and Coliban Water. Their trade waste has been minimised three-fold through: using cleaner production methods to reduce the amount of waste overall; employing water conservation in their production to reduce the volume of the waste; and installing trade waste pre-treatment equipment to reduce the load of trade waste before it goes to the Water Reclamation Plant.

8th International River Symposium

September 6-9, 2005. Brisbane, QLD.

The 8th International River Symposium will be held at Brisbane's Convention Centre from 6-9 September 2005. It's the place to be for water professionals, students, educators and conservationists. Other activities include Riverfire, Riverfeast and pre-symposium study tours. For further information, booking and registration details visit: www.riversymposium.com

20th Annual WateReuse Symposium

September 18-21, 2005. Denver, USA.

The 20th Annual WateReuse Symposium is fast approaching and is shaping up to perhaps be the biggest and best Symposium held to date. The hotel room block is filling up quickly, so book your room right away. The conference takes place at the Grand Hyatt Denver on September 18-21, 2005 with the theme, Water Reuse & Desalination: Mile High Opportunities.

The WateReuse Association is adding additional hotel room blocks for anyone unable to reserve a room at the Hyatt and will post this information on the Symposium web page at www.WateReuse.org/2005Symposium/ as soon as it is available.

The 2005 Symposium, which is co-sponsored by the American Water Works Association and the Water Environment Federation, features more than 110 papers, technical tours of nearby water reuse projects, and a new interactive session titled: Is Reclaimed Water Safe? The technical program, as well as registration and hotel information is available on the Symposium web page at www.WateReuse.org/2005Symposium/. A number of opportunities still exist for exhibitors and sponsors. An exhibitor prospectus and sponsorship flyer are available on the Symposium web page.

On-site '05 Conference

September 26-30, 2005. Armidale, NSW.

Theme "Performance Assessment for On-site Systems: regulation, operation and monitoring" to be held at the University of New England, Armidale NSW.

International keynote speaker Dr Richard Otis, from Ayres Associates, Wisconsin USA, will lead three other keynote speakers: Ted Gardner, Department Natural Resources and Mines, Queensland; John Lawrey, EWS Environmental in Melbourne, ex VicEPA; and Andrew Dakers, ecoEng Limited, Christchurch NZ.

Details of the conference and a printable brochure are available at: www.lanfaxlabs.com.au/onsite05 or by contacting the coordinator, Dr Robert Patterson: rob@lanfaxlabs.com.au

Reclaimed Water Conference to be held in Spain

October 19-20, 2005. Monterrey, Lloret de Mar (Girona), Spain.

The Consorci de la Costa Brava (CCB) is presenting a technical workshop in Spain called "The Integration of Reclaimed Water in Water Resource Management: The Fostering Role of the Territorial Region." The goal of the workshop is to analyse the progress and the future perspectives that the integrated management of reclaimed water can provide in different areas of Spain, while fostering the role of users, planners, and funding partners. The workshop will be held October 19-20 in the Guitart Gran Hotel Monterrey, in the municipality of Lloret de Mar (Girona). For more information, visit www.ccbgi.org/jornades2005/english/index.htm

International Conference on Water Resources Issues

December 26-28, 2005. Alexandria, Egypt.

The Egyptian Water Resources Association (EWRA) has issued a call for papers for the First International Conference on Water Resources in the 21st Century. The conference topics include water reuse, water supply and demands, river basin management, and more. The conference will present the more recent technological and scientific developments associated with the management of surface and subsurface water resources.

The meeting will be held December 26-28 in Alexandria, Egypt in partnership with Bibliotheca Alexandrina, Egypt; Wessex Institute of Technology, UK; Desert Research Institute, USA; Disaster Control Research Centre, Japan; and the Water Research Centre, Egypt. For more information, visit www.ewra.com/pages/2005/contents.htm

Australia

Advancing water recycling in Australia

www.aph.gov.au/library/pubs/rb/index.htm

Federal Parliamentary Library Research Brief by Dr Sophia Dimitriadis has been released. Titled, 'Issues encountered in advancing Australia's water recycling schemes', the paper seeks to provide a commentary on some challenges, opportunities and benefits of water recycling schemes in Australia. In parts suggesting that, 'Only selected agricultural industries could afford to pay the costs involved in treated water'. Quoting "The gross margins for selected crops with regard to the ability to pay for water are a major issue in relation to treated water. By and large, we believe we can treat the water for about $300 per megalitre … So you do have a problem with what you can pay. Generally speaking, it is wine grapes, apples and other intensive agriculture that can afford recycled water."

(from www.aph.gov.au/house/committee/primind/waterinq/report.htm)

Alice Springs water reuse scheme - environmental assessment report

From LAWLEX Water Newsfeed 12/8/05

www.lpe.nt.gov.au/enviro/ASWRS_2005.pdf

The Department of Planning and Infrastructure (DPI) has released, online, an Environmental Assessment Report and Recommendations (June 2005) on a proposal by Power and Water to develop a water recycling scheme for Alice Springs. The scheme aims to support up to 1,800 megalitres of wastewater per year for reuse in irrigation. The DPI said the Soil Aquifer Treatment and Horticulture schemes can be managed in an environmentally acceptable manner, subject to conditions.

New heights for Mt Hotham (Victoria) with recycling project

From LAWLEX Water Newsfeed 5/8/05

www.dpc.vic.gov.au/domino/Web_Notes/newmedia.nsf/8fc6e140ef55837cca256c8c00183cdc/b2f348ec7ac9dee5ca257050000248d2?OpenDocument

In a partnership between the State Government, the Mt Hotham Ski Company and the Mt Hotham Resort Management Board, the ski resort will use Class A treated wastewater for snow making from 2008 onwards. Water Minister John Thwaites said this would reduce the amount of fresh water taken from Swindlers Creek for use at Mt Hotham by 80 to 110 million litres a year. The Victorian Water Trust will contribute $4.18 million to the $8.36 million scheme.

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EPA advice on managed aquifer recharge using treated wastewater

From LAWLEX Water Newsfeed 5/8/05
www.epa.wa.gov.au/docs/2072_MAR%20section%2016e%20advice%20DRAFT%2025705.pdf

The Environmental Protection Authority (EPA) has released Draft Strategic Advice on Managed Aquifer Recharge using Treated Wastewater on the Swan Coastal Plain (25 July 2005). Comments on the draft report should be emailed to Melissa Bromly by 22 August 2005.

Agricultural wastewater treatment development

From LAWLEX Water Newsfeed 27/7/05
www.ebcrc.com.au/media/18July2005.htm

The Environmental Biotechnology Cooperative Research Centre (EBCRC) has announced that researchers have successfully developed technology that enables the environmentally friendly removal of high levels of nitrogen and phosphorus from agricultural wastewater.

Goulburn's water plan

From LAWLEX Water Newsfeed 21/7/05 and 9/6/05
www.goulburn.nsw.gov.au/roads/3014/3018.html

The Goulburn Mulwaree Council (NSW) has applied to the National Water Commission for funding of the Goulburn Mulwaree Council Sustainable Cities Project, as reported in last week's Water Newsfeed. This project involves indirect potable re-use: the Council is seeking $32 million to return reclaimed effluent to the Sooley Dam catchment.

Goulburn's useable water supply is dangerously low at 9.3 per cent capacity (week ending 29 May 2005).

Toowoomba seeks federal funding for water plan

From LAWLEX Water Newsfeed 21/7/05
www.toowoombawater.com.au/images/stories/briefing_paper_1july.pdf
www.toowoombawater.com.au/

Toowoomba City Council has also lodged a submission for funding with the National Water Commission "for a project that will help secure a safe supply of water to meet the future needs of Toowoomba and the region". The $68 million project includes installing additional bores and building a water reclamation plant.

For further information on the project please refer to Toowoomba City Council's Briefing Paper (1 July 2005) and the new Water Futures - Toowoomba website.

Like Goulburn, "Toowoomba's plan involves indirect potable re-use". Roughly 5,000 million litres of wastewater will reportedly be purified to six-star quality, pumped to Cooby Dam, and piped to residents.

Desalination plant powered by wind

From LAWLEX Water Newsfeed 21/7/05
www.theaustralian.news.com.au/common/story_page/0,5744,15934574%255E30417,00.html

The Australian reports that Griffin Energy and Queensland's Stanwell Corporation are tipped to win a $30 million contract to build facilities that will provide wind-powered energy for Western Australia's $380 million Kwinana desalination plant. The companies will reportedly erect 50 wind turbines at Emu Downs, about 200 kilometres north of Perth.

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Australia

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Australian water and other social trends

From LAWLEX Water Newsfeed 21/7/05
www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/Lookup/D3D7FAA735DDA645CA25703B00774A0B/$File/41020_2005.pdf

The Australian Bureau of Statistics (ABS) has released a new report on Australian Social Trends (12 July 2005). The report presents information on "contemporary social issues" such as household water use and conservation. The report reveals that in 2004, 90% of households reported conserving water by using a water saving device and/or by undertaking a water conservation practice.

Irrigators praised for water management

From LAWLEX Water Newsfeed 14/7/05
www.clw.csiro.au/publications/general.html

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has released research findings that "water management practices employed by the Murray and Murrumbidgee basins' $3.1 billion irrigation industry have substantially improved over the past decade".

Implications of potential climate change for Melbourne's water resources

From AWA Water News for week ending 10 July 2005
www.melbournewater.com.au/content/library/news/whats_new/Climate_Change_Study.pdf

A new CSIRO Report commissioned in 2003 has found that increases in temperature could cause up to a 35% fall in water flowing to its reservoirs by 2050 and demands more drastic measures be introduced for saving water including desalination and more wastewater reuse.

Trends in agriculture report

From AWA Water News for week ending 10 July 2005
www.pc.gov.au/research/crp/agriculture/index.html

The Productivity Commission has released a long awaited report, 'Trends in Agriculture', but there is little mention of the effects of drought and water shortages on the profitability or sustainability of agricultural production in the long term.

One billion dollar recycled water scheme

From AWA Water News for week ending 10 July 2005
www.gippswater.com.au/ Downloads at base of page

Melbourne Water & Gippsland Water have begun a feasibility study into a proposed $1 billion water recycling scheme to pipe treated sewage more than 135 kms from Melbourne's Eastern Treatment Plant to the Latrobe Valley, potentially reducing sewage discharge into Gunnamatta Bay by about 80%.

Werribee water recycling projects announced

From LAWLEX Water Newsfeed 7/7/05
www.dpc.vic.gov.au/domino/Web_Notes/newmedia.nsf/8fc6e140ef55837cca256c8c00183cdc/0c2422bb7bd1a92cca2570300004aade?OpenDocument

Acting Premier of Victoria, John Thwaites, has announced the completion of a $160 million upgrade of the Western Treatment Plant in Werribee (Vic). The Plant processes over half of Melbourne's wastewater. Mr Thwaites has also opened a new water recycling treatment plant at the same site to complement the upgrade.

Mr Thwaites also announced that "these developments will initially lead to the supply of Class A recycled water to 10,500 households at Manor Lakes, Bluestone Green and Werribee Fields".

Water appliance labeling scheme begins

From AWA Water News for week ending 3 July 2005
www.deh.gov.au/minister/env/2005/mr01jul305.html

The voluntary Appliance Labeling Scheme (Water Efficiency Labelling and Standards – WELS), one of a comprehensive raft of measures to save water under the $2 billion Australian Water Fund, began on 1 July. It follows the launch of the Commonwealth $200 million Community Water Grants.

Recycling made easy for Canberrans

From LAWLEX Water Newsfeed 30/6/05
www.perpetualwater.com.au/

Canberra's City News reports that Perpetual Water-Home™ - a "revolutionary new water system that turns grey water blue" - has been released for installation in new and existing Canberra homes. Perpetual Water reportedly treats water to Class A standard, "providing a never-ending source of water for gardens, lawns, laundry, toilets, and more". Managing Director John Grimes reportedly predicts that "within five years all houses built in Australia will have on-site water recycling".

Wastewater treatment report for Northern Territory

From LAWLEX Water Newsfeed 17/6/05
www.powerwater.com.au/powerwater/docs/wastewater/wastewater_treatment_reuse_discharge_04.pdf

Power and Water has released its first public report on wastewater treatment and reuse throughout the Northern Territory, entitled Wastewater Treatment, Reuse and Discharge 2004.

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MidCoast water re-use scheme hailed a success

From LAWLEX Water Newsfeed 30/6/05
http://taree.yourguide.com.au/detail.asp?class=news&subclass=local&category=general%20news&story_id=402589&y=2005&m=6

The Manning River Times reports that the "Taree area's re-use of treated water has been used as an example to other water-starved regions, during a national conference in Canberra". MidCoast Water, the local water and sewerage authority, had reportedly achieved 95 to 100% re-use for three of its sewerage treatment plants. MidCoast Water's General Manager Neil Hanington reportedly told the conference about "another scheme that, within 12 months, will allow us to reclaim 1000 megalitres a year for agricultural land".

Recycled water system for Mawson Lakes

From LAWLEX Water Newsfeed 24/6/05
www.premier.sa.gov.au/MediaSearch.asp?Action=Search&choice=News&id=2788

Launching the Mawson Lakes Recycled Water System in Adelaide's north, Environment Minister John Hill said the $16 million system is "the first of its kind in an Australian inner urban development in the way it delivers recycled water". Mr Hill said it "delivers a mixture of highly treated wastewater from SA Water's Bolivar Waste Water Treatment Plant and stormwater harvested in Salisbury that has been cleansed and treated, through a series of engineered wetlands to the Mawson Lakes development site". The system is projected to halve potable water use at Mawson Lakes, and save 800 megalitres per annum from being drawn from the River Murray.

New software measures water

From LAWLEX Water Newsfeed 7/6/05
www.abc.net.au/news/newsitems/200506/s1384139.htm

ABC News reports that new software has been developed to measure on-farm water use as well as seepage and evaporation.

Gold Coast reclaimed water scheme launched

From LAWLEX Water Newsfeed 7/6/05
http://statements.cabinet.qld.gov.au/cgi-bin/display-statement.pl?id=6975&db=media
www.goldcoast.qld.gov.au/t_news_item.asp?PID=4826

Environment Minister Desley Boyle has announced the launch of a $30 million Gold Coast reclaimed water scheme, which would give local agricultural irrigators access to recycled water, and ultimately reduce wastewater run-off to the Albert River. Ms Boyle said five cane farmers and one local palm grower have signed up to the scheme, which forms part of Gold Coast City Council's Northern Wastewater Strategy.

New water treatment plant

From LAWLEX Water Newsfeed 2/6/05
www.dpc.vic.gov.au/domino/Web_Notes/newmedia.nsf/8fc6e140ef55837cca256c8c00183cdc/73da6d8b8e3526ccca2570110005a48c?OpenDocument

State and Regional Development Minister John Brumby has commissioned a new $2 million water treatment plant. Mr Brumby said the plant "will convert around 30 per cent of Hamilton's wastewater into recycled water", to be used at Iluka's new Mineral Separation Plant in Hamilton.

Ballarat North water reclamation project

From LAWLEX Water Newsfeed 27/5/05
www.chw.net.au/smartcycle/update.html

Central Highlands Water (CHW) plans to develop a water reclamation plant at the Ballarat North Wastewater Treatment Plant "that will provide reclaimed water at a quality suitable for a range of potential reuse applications, including urban, public and agricultural applications". Following the Treasurer's approval, they have formally released the Expression of Interest Brief (20 May 2005). The period for lodging an Expression of Interest closed on 1 June 2005.

Support for large-scale water recycling – Sydney, NSW

From LAWLEX Water Newsfeed 12/5/05
www.deh.gov.au/minister/ps/2005/psmr05may05.html

Parliamentary Secretary for the Environment Greg Hunt supports Services Sydney's proposal, which involves accessing Sydney Water's sewers and pipelines to divert a proportion of the city's waste to a recycling plant. Mr Hunt called for Sydney to "invest in sewage treatment plants that can recycle this waste and produce usable water for industry and agriculture".

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Federal funding for recycled water pipeline – Darling Downs, Qld

From LAWLEX Water Newsfeed 12/5/05
http://fw.farmonline.com.au/news_daily.asp?ag_id=25913&s=17134

Farmonline has announced federal funding of $506,000 for a feasibility study on the proposed Brisbane to Darling Downs recycled water pipeline. Federal Member for Maranoa, Bruce Scott reportedly said the project "has the potential to deliver 85,000 megalitres into the Condamine and Balonne River system every year, to assist existing and future agricultural industry developments".

Federal funding sought for recycled water pipeline

From LAWLEX Water Newsfeed 14/7/05
www.abc.net.au/news/newsitems/200507/s1408964.htm

ABC News reports that proponents of a proposed Brisbane to Darling Downs recycled water pipeline are seeking funding under the Federal National Water Initiative after failing to garner Queensland Government support.

Overseas

Foundations laid for Singapore's largest NEWater factory (producing potable recycled water)

www.pub.gov.sg/NEWater

The foundation for the construction of Singapore's largest NEWater factory laid. Earlier this year, KIE was awarded the 20-year Design-Build-Own-Operate (DBOO) contract by PUB.

When completed in end 2006, the factory will be able to produce 116,000 m3/day of NEWater and 46,000m3/day of Industrial Water to meet the demand from the industrial and commercial sectors in the western and central regions of Singapore.

Although the quality of NEWater to be produced will meet international standards for potable or drinking water, it will largely be for industrial use in Singapore with a small amount flowing into reservoirs for indirect potable use.

Florida DEP publishes reuse inventory

From Reuse News 29/7/05
www.dep.state.fl.us/water/reuse/inventory.htm

The Florida Department of Environmental Protection has released its Annual Reuse Inventory Report. The report includes summary data on reuse facilities, reuse activities, capacity and flow ratios, and more. The report shows that Florida has had a steady increase in water reuse over the past 18 years. For example, from 2003 to 2004, there was a 13.6% increase in the number of residences irrigated, a 3.7% increase in the number of golf courses irrigated, a 4.5% increase in the number of parks irrigated, and a 5.6% increase in the number of schools irrigated. The full report is available online.

Indirect potable reuse considered in San Diego

From Reuse News 29/7/05
www.signonsandiego.com/news/metro/20050715-9999-1n15tap.html

Community leaders in San Diego have endorsed a plan to recycle treated wastewater for eventual use in local homes, according to the San Diego Union-Tribune. The plan advocates piping highly treated wastewater into the San Vincente Reservoir where it would be mixed with water from the Colorado River or Northern California, and then treated again for home delivery. This review is part of a $900,000 study that the City Council commissioned last year. If approved, this proposal would cost the city $210 million to implement. The matter has now moved to the City Council's Natural Resources Committee.

Websites

DAFF guidelines on planning and implementing recycled water schemes

www.maff.gov.au/releases/05/05015pm.html

New guidelines have been produced under the Water Savings Project funded by the Natural Heritage Trust. Their purpose is to help proponents of recycled water schemes for horticulture to adopt, together with other stakeholders, a holistic and inclusive framework in which to plan and implement such schemes.

We trust you find the guidelines useful.
They can be downloaded at:
http://www.daff.gov.au/waterguidelines_hort
or you can request further copies by telephoning 02 6272 5120.

Water Savings Project
Natural Resource Management Division
Australian Government Department of Agriculture, Fisheries and Forestry

WERF report on Endocrine Disrupting Compounds (EDCs)

WERF has created a four-page fact sheet on EDCs from a recent technical brief. Composed in Q&A format, this quick guide answers common questions concerning EDCs. Treatment facilities should find it useful in educating staff members, as well as concerned members of the community. The Technical Brief supports the conclusions of the fact sheet and provides references. Both documents were prepared in response to concerns over the potential for EDCs to enter the environment in treated wastewater discharges and from the land application of biosolids. A PDF version of the Technical Brief can be downloaded from www.werf.org/downloads/pdfs/04WEM6.pdf and is free to WERF subscribers.

A PDF version of the Fact Sheet is available at www.werf.org/pdf/04WEM6a.pdf

Guidelines for the safe use of wastewater in agriculture.

The draft 'WHO Guidelines for the safe use of wastewater in agriculture', Water, Sanitation and Health Protection of the Human Environment Department, World Health Organization, Geneva can be found at: www.iwahq.org.uk/documents/reuse/WHOAGRIGuideDraft.pdf

Other good reads

Water Reuse News

Water Reuse News: The latest news on water reuse and desalination
www.watereuse.org/news/wrnews_081805.htm
www.watereuse.org/news/wrnews_072905.htm
www.watereuse.org/news/wrnews_062205.htm

Water news

Horticulture Australia's Water Initiative - Ensuring Ongoing Access to Water for Horticulture', Water News, has been updated for July 2005. Please refer to the Water Initiative web pages at:
www.rmcg.com.au/HAL1.html

Contaminants of concern in water - Proceedings

CDROM Proceedings from AWA Specialty Conference Contaminants of Concern in Water are available at:
bookshop@awa.asn.au

Water recycling conference, Brisbane, 2003 - Proceedings

CDROM Proceedings from the 1st and 2nd Water Recycling Conference, 2003 in Brisbane are available as 2 CDs at: bookshop@awa.asn.au.

The delivery of research and development outcomes from this project to the horticultural industry is made possible by the Commonwealth Government's 50 % investment in all Horticulture Australia's research and development initiatives.

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CRC-IF
PRESENTATION

DEPARTMENT OF PRIMARY INDUSTRIES

The Use of Recycled Water in Australian Horticulture

30/10/2005

Dr Anne-Maree Boland

DEPARTMENT OF PRIMARY INDUSTRIES

Investors and Collaborators

Lead Agency: Department of Primary Industries Victoria

The National Program for Sustainable Irrigation funds research that will substantially improve the environmental and productive performance of irrigated agriculture and horticulture in Australia. The program brings together 14 funding partners from across Australia representing private and public sectors, including irrigators, water authorities, research organisations, commodity groups, Australian and state government agencies.

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Recycled water worldwide

- Developing and developed countries
- Cost of wastewater disposal is increasing
- Conventional water supplies are dwindling
- Recycled water is an additional resource

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Recycled water - options

- Urban
- Recreational
- Industrial
- Agricultural
- Potable - indirect & direct

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Recycled water in Australia

- An alternative water source
- Generally has high nutrients & salts
- Specific guidelines on use - EPA & DHS
- Can treat water for end user requirements

- Potential exists to use water for horticulture - schemes established
- What are the benefits and barriers for all involved?
- How have we addressed these barriers through a Research & Development program?

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Recycled water - a potential resource

Total Australian Water Use 24,909 GL

Agriculture Water Use 16,660 GL 67%

Increased pressure from environmental & urban sectors for good quality water

Total Recycled Water Use 517 GL (4% of Total Supply)

Agriculture Recycled Water Use 423 GL

	Total Water Use	Recycled	
Production horticulture (vegetables, fruit and grapes)	2,085 GL	51 GL	2.4%
Amenity Horticulture (golf courses and sporting grounds)	395 GL	36 GL	8.2%

Source: ABS 2004 (2000-2001 data)

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Benefits of recycled water use for horticulture

Growers
- Secure supply of water
- Consistent and known quality
- Supply of nutrients

Public
- Environmental benefits - reduce pressure on less sustainable water resources (eg ground water, rivers)
- Water resource management - substitution of drinking quality water ie fit-for-purpose
- Economic benefits - productive use located near source

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Barriers to use of recycled water

Institutional:
Clear standards and regulations (health, environment & water resource management)

Environmental:
Scheme - externalities eg greenhouse gas emissions
Farm - management of salinity/sodicity, nutrients, on-farm storage

Social:
Food safety and public health concerns, consumer perceptions

Economic:
Scheme - benefit:cost analysis, pricing - polluter, beneficiary or public pays?
Farm - maintaining market access, quality and price

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Research and development program.....

(1) Strategic View
- opportunities for use of recycled water
- drivers and barriers to adoption
- guidelines

Social Research	Biophysical Research
(2) Stakeholder Perceptions - general stakeholders (VPS) - consumers (WID)	**(3) Sustainable Practices** - environment and food safety - empirical studies - modelling & decision support systems

(4) Knowledge Management
- extension
- training
- communication activities

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With a focus on .....

- Guidelines and standards for implementation of schemes
- Consumer perceptions associated with food safety and understanding broader stakeholder perceptions
- Long term environmental sustainability
- Communication

Two major case study sites:
Virginia Pipeline Scheme (VPS)
Werribee Irrigation District (WID)

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1. Guidelines and standards for implementation of schemes

Part 1 - Guidelines for developing recycled water schemes in horticulture
- designed for proponents of new schemes
- key issues considered - planning and communication strategies, stakeholder engagement, managing risk, regulations (environmental & health)
- available on DAFF website

Part 2 - Water recycling in Australian agriculture
- information source
- understanding the resource potential
- benefits and risks of using recycled water
- case studies

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2. Consumer perceptions associated with food safety - Blair Nancarrow and Murni Po

The Community & Water Reuse

What drives decisions to accept or reject?

Scientifically sound reuse schemes frequently fail throughout the world ..... why?

Poor community perceptions and acceptance?
Unlikely - wastewater reuse is strongly supported by the community as a concept

"Doing it" is the problem
When faced with the actual behaviour, people lose support for the projects

We don't know why

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- In the past, public acceptance has been viewed as an "obstacle" to implementing reuse projects
  - therefore the emphasis was on persuasion
- Now generally accepted that social marketing & persuasion are ineffective
  - but virtually no research on the different factors that might influence public perceptions

We do know that

- The closer the water comes to personal contact – the less acceptable the reuse option - the 'yuk' factor

Greatest concern to growers is maintenance of markets - continued access and price

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How do people decide?

- The literature suggested the following factors ***might*** influence behavioural acceptability of water reuse
  - Emotion - "yuck!!"
  - perceived risks and benefits
  - Specific uses
  - Choice
  - Trust
  - Knowledge
  - Environmental attitudes
  - Environmental justice issues
  - Cost
  - Socio-demographic factors

Theory of Planned Behaviour - Ajzen's (1985)
Developed and adapted model
Tested the model - two surveys

Indirect potable, Perth (Managed Aquifer Recharge - MAR)
(400 random sample)
Horticultural irrigation, Melbourne (Werribee)
(400 random sample)

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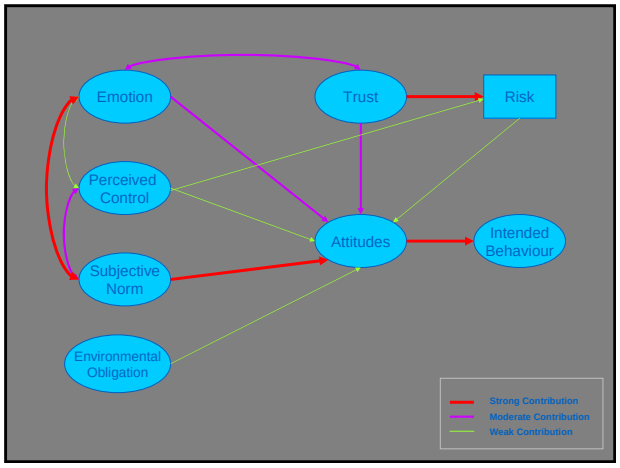
Consumption of vegetables from WID……

- Would you buy vegetables that have been grown in Werribee with recycled wastewater?
  - Yes 35%
  - Not sure 56%
  - No 10%

Yes - support the use of recycled water; trust the authorities to do the right thing

Not sure - if the water is treated properly; if safety is guaranteed

No - don't like the idea of using recycled water



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Key Findings

- Attitudes (behaviour beliefs and outcome evaluations) are the major predictor of intended behaviour
- Subjective norms (opinions and influence of others), emotions (ie yuk factor) and trust are the big contributors to attitudes and so to the behavioural decision
- Trust and subjective norms are the main influences on emotions
  - schemes managers must work to increase trust in authorities
  - increase influence of subjective norms
- Risk perceptions have only a weak contribution to the behavioural decision.
- Moderate effect of environmental obligation - saving water resource
- Knowledge has **no influence** on decision making
  - it may be a "lag variable" that only time will show
  - however open information (knowledge) is related to trust

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3. Stakeholder perceptions of an established scheme - June Marks and Katherine Boon

A social appraisal of the South Australian Virginia Pipeline Scheme: Five years' experience

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

VPS has been in operation for 5 years
Investigate stakeholder perceptions of VPS
Case study design
Multiple data sources, verification
Face-to-face interviews
Historical, current, future outlook

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PRIMARY INDUSTRIES

Key Findings

- Class A recycled water has generally been accepted
  - Initial communication strategy allayed concerns
- Water provided
  - Viable, alternative water source
  - Enables security, expansion
  - Wider environmental benefit
- Issues
  - arrangements and conditions of scheme eg pricing
  - on-farm management eg salinity
  - on-going education, information and training tailored for different ethnic groups
  - confirmation on market and consumer acceptance

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DEPARTMENT OF
PRIMARY INDUSTRIES

4. Long term environmental sustainability

Decision support systems for growers irrigating with recycled water
- managing salinity, nutrients and on-farm storage
- understanding regulatory requirements - EPA, DHS

Linking in
- QA and food safety (HACCP)
- OH&S
- environmental assurance

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DEPARTMENT OF
PRIMARY INDUSTRIES

Experimental site established in Werribee to quantify impacts of practices on soil and produce

Growing lettuce and broccoli

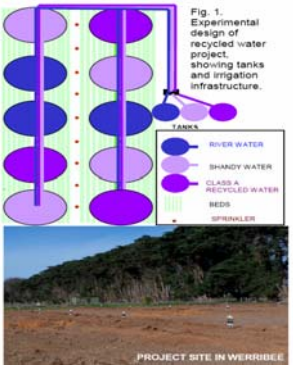

Fig. 1. Experimental design of recycled water project, showing tanks and irrigation infrastructure.

DEPARTMENT OF
PRIMARY INDUSTRIES

Tools for management

Salinity reckoner

Nutrient balance

Guide to using recycled water

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DEPARTMENT OF
PRIMARY INDUSTRIES

5. Communication

Coordinator for recycled water development in horticulture

Providing an information service to all relevant stakeholders associated with recycled water
- Government Departments
- Growers
- Suppliers
- Packers & merchandiser
- Wholesalers & Retailers
- Industry associations
- QA programs & auditors
- Mass media & general public

www.recycledwater.com.au

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DEPARTMENT OF
PRIMARY INDUSTRIES

Conclusions

Recycled water is a valuable resource which offers benefits for horticulture
- secure supply
- known quality

Matching quality of water to end user - "designer water" or "fit-for-purpose"

Agriculture often initial use - then moves to higher value use

Water resource management - should be about substitution rather than expansion

DEPARTMENT OF
PRIMARY INDUSTRIES

Conclusions

Schemes must be safe, economically sensible, environmentally sustainable and socially acceptable

Technical challenges - we are addressing but will require extension and training for adoption of best practice

Communication is important but ……. Ensuring public participation in decision making and gaining public confidence and trust in future water recycling initiatives is absolutely essential to the greater use of water recycling in Australia

Radcliffe 2004

APPENDIX 2

SC MEETING
AGENDA

Use of Reclaimed Effluent Water in Australian Horticulture: Stage 2
LWA – National Program for Sustainable Irrigation
AND
Coordinator of Reclaimed Water Development in Horticulture
Horticulture Australia

Joint Steering Committee Meeting No 5
9th -10th August 2005
Adelaide
Lirra Lirra Complex, Waite Campus

MEETING AGENDA - Tuesday 9th August

Chair: Ted Gardner

	ITEM	ACTION REQUIRED	
	Arrive Adelaide		
10:30 am	**Land and Water Australia: Use of reclaimed effluent water in Australian Horticulture** – Summary of Milestone 5 – **Paper 1** *Milestone CD previously distributed*	Information Update	Anne-Maree Boland
11:00 am	**Horticulture Australia: Coordinator of Reclaimed Water Development in Horticulture** – Milestone Report – **Paper 2**	Information Update	Daryl Stevens & Jim Kelly
11:30 am	Best Management Practices and Monitoring Packages Biophysical research and models – Summary documents – **Paper 3**	Information update and SC advice	Som Jarwal

12:15 pm	**Lunch**		
1:00 pm	Training and education programs Irrigating with reclaimed water. Focus – growers. Advising reclaimed water users. Focus – DPI, EPA, DHS, QA auditors. – Summary documents – **Paper 4**	 Information update and SC advice	Anne-Maree and Daryl
	Guidelines DAFF 8 pager printed and ready for release *Published document to be distributed* 16 Pager for general public – Draft document – **Paper 5** National reclaimed water guidelines	 Information update and distribution Review and SC advice Information update	 Daryl and Anne-Maree
2:30 – 4:00 pm	Future work program - Where to next - Gap Analysis - Biophysical and social research - Future funding opportunities - Extension to programs Summary of project team meeting and key issues – **Paper 6**	 General discussion and SC recommendations	
4:00 pm	**Meeting Finish**		
4:30 – 6:00 pm	**Travel to McClaren Vale by bus**		
7:00 pm	**Dinner at McClarens on the Lake**	After dinner speaker (confirmed)	Peter Hayes (Board of CRC Irrigation Futures/Fosters Wine Estate)

FIELD TOUR AGENDA – Wednesday 10th August 2005

8.30 am	**Willunga reclaimed water reticulations system. Including pump station, storage lagoon and telemetry.**	Confirmed	Glen Templeton
9:30 –10.30 am	**End user – viticulture. 5 years of research**	Confirmed	Dr Mike McCarthy – PIRSA
2 hours	**Lunch on the bus while travelling to North Adelaide**		
12:30 pm	**Mawson Lakes, Urban reuse scheme**		Richard Marks
2:00 pm	**Parafield Storm Water Interception scheme. Harvesting stormwater for recycling.**		Salisbury Council
3:00 pm	**Water Reticulations Service Viginia** **End user – vegetables.**		Tony White (Earthtech) and grower
	Bolivar Sewage Treatment Plant. (if time)		
4:00 leave for airport			SA Water
5.00 pm	**Drop off at Adelaide airport**		

SC MEETING
MINUTES

Use of Reclaimed Effluent Water in Australian Horticulture: Stage 2

LWA – National Program for Sustainable Irrigation
AND
Coordinator of Reclaimed Water Development in Horticulture
Horticulture Australia

Joint Steering Committee Meeting No 5
9th / 10th August 2005

Lirra Lirra, Waite Campus, Adelaide

MINUTES

Attendees
Daryl Stevens, Blair Nancarrow, Alison Turnbull, Jim Kelly, Ted Gardner, Murray Chapman, Tony White (proxy for Graeme Hill), Som Jarwal, Peter Hancock, Jim Northey, Rob Faggian, Anne-Maree Boland, Tad Bagdon, David Cunliffe, Barry Dennien

Minutes: Rob Faggian and Anne-Maree Boland

Apologies
Jane Lovell, Deborah Corrigan, Leigh Sparrow (represented by Alison Turnbull)

1. Anne-Maree Boland. <u>Overview of project and summary of milestone 5</u>.

AMB gave an overview of the project and RF provided a brief summary of progress against milestones.

Key Comments:

- There is greater acceptance of RW overseas, particularly those already using it, with a tendency to ask 'why aren't we using it' rather than 'why should we be using it'. However, no recycled water in houses and very strict measures are in place to minimise the risk of cross-connections. RW in agriculture frequently provides the first use in a region with movement of RW to higher value uses eg industrial.
- Ted Gardner mentioned the imminent first example of indirect potable reuse in QLD (Toowoomba). Toowoomba is in a very dire situation re water with so there is no real choice in this case. This prompted a discussion of Blair's research.
- Blair Nanacarrow gave a brief overview of consumer decision-making model and results of the Werribee study. Trust and subjective norms are critically important to peoples decision-making and there is a strong need to understand more about risk and refine the model over time. Also, the delivery of information and key messages is very important, as is the choice of deliverer.
- Murray Chapman congratulated the team on delivering milestone report 5 in the face of various external influences/difficulties.

  Note: Over 10% of Sydney population boil tap water before drinking!

2. Daryl Stevens. <u>Overview of CRWDH and OS Tour.</u>

DS gave a brief outline of progress against milestones in the CRWDH project, an overview of the recent study tour to Singapore, the U.S. and Mexico, and also led discussions on the National Guidelines.

OS Tour:

- Some interesting observations about trust and cultural difference between the countries visited. For example, the Singapore system worked very well at all levels, but population is more trusting/accepting of government decisions and government leadership. Excellent communication strategy in Singapore that targets multiple levels.
- Florida: treatment level and public access to water not up to Australian standards/expectations. RW done more by stealth. Mostly recreational use, etc. - example, Disney Land and baseball stadiums (RW in radiator-like coolers with no air contact and therefore no risk of aerosols). Also, sand infiltration rate in Florida of up to 30 inches per day.Indirect potable reuse through acquifer recharge but this is not explicit.
- Mexico: Mostly industrial use. Agricultural reuse consists of treatment and discharge into rivers, for later use by irrigators.
- California: Seemed to be over regulated, but people still had ample opportunity to come into contact with RW (e.g. they could canoe in RW water lakes and eat fish caught from RW recreational lakes, etc).
- The OS study tour worked well but it was difficult to avoid being shown anything other than the success stories. The tour put Australian experience in context and demonstrated that Australian standards and procedures are very good. Often agriculture was the 'foot in the door' for RW, before going to higher-value uses.
- Australia assesses the RW situation very well…for example, pumping up hill and greenhouse issues, urban sources and location of agricultural enterprises, etc.

National Guidelines:

- All eventual risk assessments in the national guidelines were carried out on agricultural, fire control, municipal non-potable, residential and environmental use of RW.
- Environmental aspects were difficult to assess because the background scientific info is either very complex or not adequate.
- SC Comment: Distinction needs to be made between 'environmental flows' (volume only) and 'water for the environment' (volume and quality).
- Risk assessment framework is quite complex but it is essentially just a plan-do-check-review cycle
- Key hazards
    - Boron
    - Cadmium
    - Chlorine disinfection residuals
    - Hydraulic loading
    - Nitrogen
    - Sodium
    - Chloride
    - Salinity
    - Phosphorus
- Proposing a change in wording to the organic standard

3. Som Jarwal. <u>Environmental and Agronomic Research.</u>

SJ gave an overview of the development of decision-support tools and best management practice documents.

Comments by SC on salinity wheel and BMP

- JK commented that Maas & Hoffman calculations need to be considered in light of cultural practices. SC suggested that Murray Chapman takes the comment on board and consider a project on the relevance of Maas & Hoffman to Australian vegetable production.
- Need to ensure national relevance (eg. references to Vic food act need to be changed)
- BOD very important for wine industry
- Check list could be expanded to include additional questions or more information
- Will salinity wheel be tested with growers? Yes…using SC from ORL project.

- Language needs to be refined to ensure document is as user-friendly as possible, e.g. scientific references are not useful to growers, referral to growers and consultants, etc
- Remove references to 'wastewater' and 'effluent' (eg. from first paragraph), as these are contradictory to the message that RW is a valuable asset.
- Remove decimal point and round-off
- Must make it explicit that the salinity wheel provides a guide only, not exact figures
- Include a disclaimer that the conversion values are affected by soil type, varietal differences, etc (Daryl Stevens offered to send a suitable disclaimer through to Som).

*** ACTION 1: SJ to send electronic version of BMP to SC following initial modifications***

4. Daryl Stevens.

Overview of DAFF Guidelines (8 pager)
"Guidelines for Developing Recycled Water Schemes in Horticulture"
Guidelines have been accepted by DAFF and have been printed. Awaiting sign off my Minister McGauran.

*** ACTION 2: DS to send hard copies of guidelines to SC when approved by Minister McGauran***

Information Document (16 pager)
"Water recycling in Australian agriculture"

SC Comments:

- Some typos scattered throughout document.
- Need to make it clear that HACCP is common place.
- Use of the term 'recycled' could be confusing and may need to consider all forms, i.e. water re-used from one on-farm process to another…DS pointed out that the focus of the document is on reclaimed water rather than recycled.
- Be careful of wording in the firefighting section and also note the difference in acceptance of rural and urban firefighters…urban firefighters don't accept some of the assumptions made to determine risk. Also, the documentation is contradictory in places (eg. RW is a risk in the household kitchen, but is OK for firefighters). The word 'safe' is currently the issue with regard to firefighting. However, another comment was that RW use for firefighting is an occupational issue, not a public issue, and may not be required in the document
- Section on endocrine disruptors is not sufficient to allay public fears on this issue at the moment, should be expanded regardless of scientific realities. The document is for the public and therefore public perception is the most important concern
- Document could be out of date very soon because new guidelines will not include classes A, B, C, etc.
- AMB: Is another SC review of the document required?
- Where appropriate, back-up statements in document with a line saying that 'The National Guidelines say it is not an issue', etc.
- Modify 'removing the flow could impact on the environment' etc to reflect public sensitivities (eg. downstream of Toowoomba)
- Why was an image of a child used on the front of the document?
- Should guidelines focus on agricultural use? Perhaps yes, although need to provide some context.
- After document is revised, it may be quite close to the release date of the national guidelines and it could therefore be modified to ensure both documents are complimentary.
- Target public libraries (?) for dissemination.
- Change title to "Recycled water in Agriculture"
- Audiences: DPI's, urban water bodies, LWA, etc.

*** ACTION 3: DS to send an electronic version of the DAFF document to SC ***
*** ACTION 4: SC to provide feedback on DAFF information document ***

5. **Training and Education. Anne-Maree Boland.**
    - RW is just another water source (with different quality parameters) so the training package competencies currently available for irrigation management are a good fit, acknowledging the need to develop a few new competencies that specifically cover the unique/different aspects of RW.
    - EPA requirement that growers in Werribee receive training in the use of RW, project is required to deliver training to Werribee growers.
    - Many linkages and possible overlaps with broader irrigation courses, eg. IAA training packages.
    - Training competency-based with recognition of prior learning, delivered by RTO.

6. **Future Work Program and Key Issues. Anne-Maree Boland.**

- Review of project
    - Bahman Shiekh recommended by SC. Also Troy Hartley in U.S has reviewed the CSIRO work.
    - URS Review…Evaluation.

    *** ACTION 5: AMB and MC to discuss review by Bahman and URS evaluation***

- R&D Knowledge bank
    - NPSI (will likely play a role), CRWDH (a knowledge bank for guidelines, etc. but not necessarily R&D info). Also check CRCWT and CRCIF.
    - Generating ISBN's may be a means of capturing the information in the long term.
    - NPSI to continue for another term…looking for other organisations to assist with information management…there is commitment from NPSI to ensure that the information from this project is captured and made accessible.
    - This is basically a question of information management…

    *** ACTION 6: AMB and MC to discuss information management issues further ***

- Business case – HAL water advisory committee
    - Any parallels with other industries and the analyses they do (eg. shoe and textile industry?)
    - Is there a forecasting capacity within HAL? They are in the process of appointing an analyst after acknowledging that there is demand for this. HAL held a globalisation overview to industry at their last forum (May).
    - Need to separate drivers and cost discharge to sea, and the cost of mitigating those discharges.
    - Economic sustainability of the positive end-use of RW…for example, see 'Sugar Cost' model
    - If horticulture falls over, another agricultural industry/enterprise may move in, or, the land could be used for residential purposes with access to third pipe.
    - Some regional development corporations carry out analyses like these.

    *** ACTION 7: Project team to prepare a recommendation to HAL for scenario planning/globalisation issues and viability of schemes ***

- Training & Extension – Ongoing

- R&D
    - Social research
        - What is acceptable risk? How is it perceived? Hasn't been measured properly. Trust
        - Changing of decision-making variables over time needs to be examined. Does emphasis change? Choice, context specific.
        - What are the drivers and how do you influence them?
        - Historical context…is our planning reactionary? Institutional issues.

    - On-farm management – HAL
        - How do we encourage growers to adopt certain management practices or technological changes?

- Is there an opportunity to develop projects for particular commodity groups? The structure of HAL still allows for cross-commodity projects…deadline looming (next week). Industry focus.
- How do we manage nutrients?
- Better Management skills
- Modify supply, designer water, nutrient balance

- Environmental impacts – NPSI (Solute transport) (decision on Aug 26th)
    - Ground/surface water interactions
        - Is there an opportunity to develop a project in this area with NPSI? July 2006 is the next round where this could be considered, but MC stressed that discussions need to take place first.

- Public relations for project…logic is we want to make RW-use the norm
    - People need to be ready to accept the information
    - On-going 'drip-feeding' of small snippets of information
    - Target key decision points…ie. where/who makes the decisions

SUMMARY OF ACTION ITEMS

ACTION 1: SJ to send electronic version of BMP to SC following initial modifications.
ACTION 2: DS to send hard copies of guidelines to SC when approved by Minister McGauran.
ACTION 3: DS to send an electronic version of the information document to SC.
ACTION 4: SC to provide feedback on DAFF information document.
ACTION 5: AMB and MC to discuss review by Bahman and URS evaluation.
ACTION 6: AMB and MC to discuss information management issues further.
ACTION 7: Project team to prepare a recommendation to HAL for scenario planning/globalisation issues and viability of schemes.

Next meeting will be chaired by Blair Nancarrow
Date: March 2006
Location to be determined. Toowoomba or Tasmania?
Format: Meeting on first day and tour on second day.

APPENDIX 3a

DRAFT DOCUMENT:
USING RECYCLED WATER
– A GROWERS GUIDE

Using Recycled Water

A Growers Guide

State Government Victoria Department of Primary Industries

HAL Know-how for Horticulture™

National Program for Sustainable Irrigation

Acknowledgements

Editors

Photographs

Logos

Authorised by the Victorian Government, 1 Spring Street, Melbourne

ISBN X XXXXX XXX X

CONTENTS

Will be automatic once we've completed.

INTRODUCTION

RECYCLED WATER

Recycled water is the water that has been recovered and treated for potable (drinking) or non-potable use. The source of this water may be human or animal waste, stormwater, industrial, or any other source of water unusable in its existing state. When treated, as required, this water can become suitable for a range of purposes. These can include irrigating pasture and field crops, in horticulture, industrial processing, in new suburbs as part of water-sensitive urban design, and to keep our public and recreational spaces green. Recycled water is a valuable resource. It improves the reliability of our water supplies, frees up water for the environment or growth, and reduces the amount of treated effluent discharged into our bays and oceans.

ABOUT THIS GUIDE

Recycled water is just another water source! However, there are special issues that may need to be considered when using recycled water. Like any water source you will need to ensure that the water quality and its management meet the requirements of the specific QA scheme that you are using. You may also need to meet some specific regulatory requirements for use of recycled water on horticultural crops. From a management perspective there may need to be some changes made as the quality of recycled water is often different from the usual water sources eg higher in salts and nutrients.

This guide outlines some best management practices (BMPs) that relate to the use of recycled water in horticultural production and pre-market handling of produce. The guide considered the requirements of popular quality assurance (QA) schemes, codes of practices and guidelines from regulatory bodies (eg. environment and human service authorities) were considered, along with published scientific evidence.

The BMPs are presented in the form of questions that address issues to be considered when using recycled water in horticulture. Guidance on the issue is provided with reference to additional useful information. A checklist is also provided which indicates if the issue is relevant, has been dealt with or needs to be followed up and can be applied when using or planning to use recycled water.

This guide is targeted towards the horticultural industry, including service providers and growers.

1. QUALITY ASSURANCE SCHEMES AND GUIDELINES

Traditionally most Quality Assurance schemes have been based on the application of a process rather than dealing with specific issues, such as recycled water quality. Most schemes do however focus on the customers' requirements and compliance with legislation, for example regulatory requirements related to a particular product. In other schemes water quality is commonly addressed through risk analysis, for example Hazard Analysis Critical Control Points (HACCP) based systems.

Question/Issue	Guidance/Comment	Your Checklist
Are you aware of the QA schemes, guidelines and codes of practice that are relevant to your horticultural production?	A number of QA schemes cover many aspects of horticultural production and preparation of produce for marketing. Some are industry driven, others are driven by the buyers. There are a number of guidelines and codes of practice covering environmental and human aspects. For example, HACCP is an internationally recognised and recommended approach to food safety that can help anticipate and prevent hazards associated with the use of recycled water. The HACCP plan is based on seven principles identified in the Codex Guidelines for the Application of Hazard System.	☐ NA (Not Applicable) ☐ Strategy in place ☐ Need to follow up
Are you aware of the requirements of relevant QA schemes and guidelines specific to recycled water use in horticultural enterprises?	Few QA schemes specifically refer to the use of recycled water in horticulture, while others refer only to the quality of water. Some popular QA schemes/systems are given in Table 1. *Refer to LWA (2005) in the Further Information section for details of the QA schemes. [Need to ensure final document has been accepted and loaded onto LWA website]*	☐ NA ☐ Strategy in place ☐ Need to follow up

Table 1: Popular QA schemes and guidelines covering recycled water use in horticulture

Schemes (process and performance based)		Guidelines (principle based)
National	**International**	**National**
Freshcare Code of Practice 2nd Edition October 2004 Freshcare Limited, Sydney markets	AS/NZS ISO 9001:2000 Quality Management Systems – Requirements International Organisation of Standardisation, Geneva Switzerland	Guidelines for On-Farm Food Safety for Fresh Produce 2004, Second edition. Department of Agriculture, Fisheries and Forestry, Australian Government
Woolworths Quality Assurance Standard Version 1 1st December 2003 Woolworths Limited,	Hazard Analysis and Critical Control Points System and Guidelines for its Application Annex to CAC/RCP 1-1969, Rev 3 1997 Codex Alimentarius Commission	Guidelines for the Management of Microbial Food Safety in Fruit Packing Houses Bulletin 4567 November 2004 Department of Agriculture, Western Australia
Australian Certified Organic – Organic Standard Version 6. 2003 Australian Certified Organic Pty Limited	AS/NZS ISO 14001:1996 Environmental Management Systems – General Guidelines on principles, systems and supporting techniques International Organisation of Standardisation, Geneva Switzerland	Safe Vegetable Production A Microbiological food Safety Guide for the Australian Vegetable Industry 2002
Standards for Organic Agricultural Production November 2003 The National Association for Sustainable Agriculture Australia Ltd.	British Retail Consortium Global Standard Food Issue 3 March 2003 British Retail Consortium, UK	Guidelines for Environmental Assurance in Australian Horticulture 2005 Horticulture Australia Limited
Processing and Preparation Standards for Certified Food and Fibre April 2003 The National Association for Sustainable Agriculture Australia Ltd.	EurepGAP General Regulations Version 2.1 – Jan 2004 EUREPGAP Secretariat Cologne, Germany	National Integrated Fruit Production Guidelines for Pome Fruit Final Report 2000
National standard for Organic and Bio-dynamic Produce 3rd Edition December 2002 Australian Quarantine and Inspection service	SQF 2000 Code 4th Edition – Amended February 2005 Food Marketing Institute, Washington DC	Enviroveg Program March 2001 AUSVEG: Australian Vegetable and Potato Growers Federation
	SQF 1000 Code 3rd Edition – Amended February 2005 Food Marketing Institute, Washington DC	NIASA Best Practice Guidelines Nursery Industry Accreditation Scheme Australia 2nd Edition 1997

2. PLANNING TO USE RECYCLED WATER

This section covers general issues associated with the use of recycled water. These include the suitability of the recycled water, infrastructure requirements, market acceptance of produce, health and safety issues and general compliance.

Question/Issue	Guidance/Comment	Your Checklist
Market Requirements		
Will the produce grown with recycled water be accepted by organic markets?	In Australia, recycled water can be used for growing organic produce if it is treated appropriately and has re-entered a natural public waterway system. There may however, be other requirements that need to be met in your specific situation and this should be checked with your auditor. The Australian Organic and Bio-dynamic program is managed by the Australian Quarantine and Inspection Service (AQIS). It is responsible for the management of organic and bio-dynamic produce via a co-regulatory arrangement with AQIS approved certifying organisations. More information and a list of approved certifying organisations can be found at: Www.affa.gov.au/content/output.cfm?ObjectID=43E732B6-D4AF-43EE-8F71C0E5E1F50550	☐ NA ☐ Strategy in place ☐ Need to follow up
Will my buyers accept the produce grown with recycled water?	Check with your buyers and prospective customers. The majority of QA schemes accept the use of recycled water in horticultural production provided the water meets certain minimum quality criteria and auditing/certification requirements. Auditors can request evidence of the quality of water used in crop production and post harvest handling.	☐ NA ☐ Strategy in place ☐ Need to follow up

Regulatory Requirements		
Has the recycled water been approved by relevant state authorities (eg. EPA, DHS) for the intended use? Is it fit-for-purpose?	Generally new recycled water schemes in Australia obtain a "fit-for-purpose" approval from state regulatory authorities like the Environment Protection Authority and/or Department of Human Services, however, this varies from state to state. Depending on the level of treatment, recycled water is generally categorised into four classes in Australia: A,B, C and D, with Class A being treated to highest standard and hence of highest quality. The quality criteria for different classes of water and the permitted uses vary from state to state. From a human health perspective, Class A recycled water generally has no restrictions on the method of irrigation or crops grown. *Refer to state guidelines – see section Further Infromation*	☐ NA ☐ Strategy in place ☐ Need to follow up
Can recycled water be used for post-harvest produce washing and processing?	Guidelines vary from state to state in relation to final washing of the produce with recycled water. Recycled water is not to be used in any processing (peeling, slicing) or cooking where it falls under the regulation of the Food Act. The interpretation of what is 'on-farm' washing and what is 'food processing' is very critical. For example the Victorian Food Act states that only potable water (water you can drink) can be used for food processing. DHS advice to farmers is that recycled water (Class A) can be used for on-farm washing of produce before packing and marketing. However if the food is chopped or packaged (eg. salad mixes) for direct consumption then this is deemed food processing and falls under the Victorian Food Act which states that potable water must be used during this process. Class A recycled water is not considered potable and therefore cannot be used. Your QA auditor will be able to advise you what is acceptable.	☐ NA ☐ Strategy in place ☐ Need to follow up

Do you have an agreement in place for the use of recycled water with the provider and do you understand the conditions of supply?	Generally the water suppliers will require you to enter into an agreement. Make sure you understand the terms and conditions and your rights and responsibilities. Consult your water supplier if in doubt.	☐ NA ☐ Strategy in place ☐ Need to follow up
Have you attended the relevant workshops or training on the use of recycled water?	For some new recycled water schemes it is a condition of water supply that you attend a workshop or training on the use of recycled water. Even if it is not a requirement it is good practice to understand the nature and use of recycled water. *Refer to the section Further Information for additional sources.*	☐ NA ☐ Strategy in place ☐ Need to follow up
Are you aware of any compliance and monitoring requirements?	Generally, the agreement covering recycled water supply will spell out if there are any compliance and monitoring requirements. As the supply of recycled water is linked to environment and human service authorities it is important that you understand the compliance and monitoring requirements.	☐ NA ☐ Strategy in place ☐ Need to follow up

Management Requirements		
Do you have a map or schematic layout of your property with prominent features marked?	It is a good practice to have property maps showing irrigated areas, property boundaries, buildings and water storage facilities, water supply pipes, drainage points, soil types etc. Your recycled water supplier should tell you if there any specific requirements relating to identification of prominent features on a map/sketch.	☐ NA ☐ Strategy in place ☐ Need to follow up
Do you have appropriate signage where recycled water is being or will be used?	You can check with the supplier about any specific signage requirements, for example lilac painting of recycled water pipes and taps. Many schemes require strategic and prominent signage where recycled water is used (Australian Standard 1319 – Safety Signs for the Occupational Environment). Even if there are no specific requirements it is considered good practice to have the appropriate signage.	☐ NA ☐ Strategy in place ☐ Need to follow up
Have you advised your family members and employees about the use of recycled water on the property?	Recycled water users need to ensure all family members, employees and other people entering the property are made aware of the use of recycled water on-site. Users must ensure they are complying with Occupational Health and Safety requirements. They must also ensure employees, family members and others concerned are aware that this water is not suitable for drinking. Check with your supplier if there are any specific requirements for handling recycled water.	☐ NA ☐ Strategy in place ☐ Need to follow up
Are you aware of your first point of contact in case of any concerns or incidents in relation to recycled water use?	In most cases, your water supplier will be the first point of contact if there are any concerns or incidents. For example: contamination of potable water supply by recycled water; significant leaks or overflows from the recycled water storage dams; discharges of recycled water to rivers or creeks; and soil salinity, sodicity or acidity problems caused by the use of recycled water.	☐ NA ☐ Strategy in place ☐ Need to follow up

Do any of your management practices need to be changed because you are using recycled water?	The use of recycled water should not require you to make any significant changes to existing management practices. If they are required the scheme operator should make you aware of them.	☐ NA ☐ Strategy in place ☐ Need to follow up
Do you have an on farm storage facility for recycled water?	If you need to store recycled water make sure you have appropriate controls in place to prevent leaks or overflows.	☐ NA ☐ Strategy in place ☐ Need to follow up
Do you have an algal management plan in place?	Algae are free floating plant like organisms that may grow rapidly under ideal conditions of warmth, sunlight, high nutrients and stable water to form blooms or surface scums. Blue-green algae (BGA) are of primary concern because some species can produce toxins. Although toxin-producing BGA are very rare, any algal outbreak should be treated with caution. Algal outbreaks may be prevented or reduced by controlling the environment and avoiding conditions that they grow best in. Any suspected algal bloom should be treated and contact with the water source should be avoided.	☐ NA ☐ Strategy in place ☐ Need to follow up
Are you aware of where you can find further information?	Every recycled water scheme will have communication strategies and information sources available to its users. Your water supplier and government agencies should be able to provide you all the information you need or advise you where to find it. *See section Further Information for some information sources.*	☐ NA ☐ Strategy in place ☐ Need to follow up

3. QUALITY OF RECYCLED WATER

The recycled water supplied at the farm gate should have met pre-determined standards that ensure it is fit for the intended purpose. It is important to understand the different quality issues associated with recycled water that will help the user make informed management decisions on farm.

Question/Issue	Guidance/Comment	Your Checklist
Do you understand the issues associated with the quality of recycled water?	By nature the primary sources of recycled water (human or animal waste, stormwater, rainwater, industrial, or any other source of water unsuitable for intended purposes in its existing state) have different contaminants, pathogens and varying loads of salts and nutrients. While salts are generally harmful to plants, nutrients can be beneficial. The level of treatment will determine what, and how much remains in the recycled water at the point of supply.	☐ NA ☐ Strategy in place ☐ Need to follow up
What salts and nutrients are generally present in recycled water?	Generally the most common salt in recycled waters is sodium chloride or table salt. Magnesium, calcium and potassium salts are also present in significant quantities and there may be small amounts of other salts. The proportion of various salts will largely depend on the whether the source of recycled water is industrial or domestic (or business) and the nature of treatment. Ironically the constituents of most of the salts are also plant nutrients. For example, calcium, magnesium and potassium are all plant nutrients. In addition nitrogen and phosphorus are also present in significant quantities. Recycled water also has most of the micronutrients, eg. iron, manganese, zinc, copper, molybdenum, boron, chlorine, nickel and cobalt in varying quantities.	☐ NA ☐ Strategy in place ☐ Need to follow up

	The presence of nutrients in recycled waters can reduce the amount of fertilisers or manures. But if the nutrient content of recycled waters is more than crop requirement then it could lead to adverse effects on crop growth or excessive build up in soil or discharge to ground water which could have adverse environmental consequences. Excessive amounts should be managed to ensure that these harmful effects don't occur. See also the section "Fertilise and Nutrient Management".	
What other contaminants are present in recycled water and are these of concern?	Generally there are three types of contaminants in recycled water: heavy metals (eg. cadmium, chromium, copper, lead and mercury), microorganisms (bacteria, viruses, protozoan parasites and nematodes) and organic contaminants like pesticides and other chemicals that can cause endocrine disruption. These contaminants are present in source waters either naturally or introduced through human actions. High levels of these contaminants can be harmful to plants, animals and the environment. Recycled water schemes should ensure through treatment, testing and monitoring that the levels of contaminants don't exceed guidelines from human health and environmental authorities.	☐ NA ☐ Strategy in place ☐ Need to follow up
Are the levels of pathogens in recycled water acceptable?	All recycled water schemes comply with their state guidelines in relation to acceptable levels of pathogens. These guidelines are based on national guidelines which are considered stringent in comparison to international standards. If the food crops grown with recycled water are to be eaten raw the World Health Organisation (WHO) guidelines specify that the number of faecal coliforms should not exceed 1000 per 100 millilitre, and that of intestinal nematodes should not exceed 1 per litre of recycled water. Your water supplier will be able to provide the microbiological assessment of the recycled water. *Refer to state and industry guidelines for more information in the section Further Information.*	☐ NA ☐ Strategy in place ☐ Need to follow up

Faecal coliforms (FC) are micro-organisms found in the faeces of warm blooded animals. Only a small proportion of FC are pathogens, but FC are a useful indicator of the likely level of pathogens in recycled water.

Is the level of biological oxygen demand (BOD) of recycled water acceptable?	The level of BOD in recycled water is an important consideration when it comes to storage. BOD is a measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. It can also be used as an indicator of degree of pollution of water, where the greater the BOD, the greater the degree of pollution. Excessive levels of BOD are also associated with odours. Recycled waters with high levels of BOD entering the ground water system could pollute the ground water. Agencies like EPA generally prescribe certain standards for the levels of BOD that must be followed.	☐ NA ☐ Strategy in place ☐ Need to follow up

4. SOIL SALINITY AND SODICITY

Soil salinity and sodicity are important considerations in any farming enterprise. Recycled water generally has a higher salinity level than drinking water. Therefore, it is important to check that the salinity of the recycled water is acceptable for the crops and soils where you will be irrigating.

Question/Issue	Guidance/Comment	Your Checklist
Do you understand how salinity effects your plant production?	Soil salinity refers to the presence of soluble salts in soils. Soil salinity mainly results from natural processes of landscape evolution; however human activity can contribute to the development and exacerbation of soil salinity. Salts can be brought in through the irrigation water. A common misconception about salinity is that it is just caused by sodium chloride (NaCl ie. table salt). While sodium chloride is generally the predominant salt, salinity can be made up of many other salts (eg. salts of calcium, magnesium, potassium etc.) which may even come from common fertilisers and manures (eg. ammonia, urea, ammonium sulphate, ammonium nitrate, urea, ammonium nitrate, chook manure etc.).	☐ NA ☐ Strategy in place ☐ Need to follow up
How is salinity assessed and what do the salinity levels mean for your enterprise?	There is a range of field and laboratory analyses that can be used to assess soil salinity. Generally electrical conductivity (EC) of soil–water suspension is a convenient method of estimating salt content of soil. In Australia a 1 part soil: 5 part water suspension method is used by most laboratories to determine EC. Other methods determine the amount of total dissolved salts (TDS) directly.	☐ NA ☐ Strategy in place ☐ Need to follow up

The international standard for the salinity unit is deci Siemen per metre (**dS/m**). Other units in use are:

Electrical conductivity

µS/cm – micro Siemen per centimetre
EC units – numerically same as µS/cm (EC unit =1 µS/cm)
µmho/cm – micro mho per cm (= µS/cm)
mmho/cm – milli mho per cm (= dS/m)
mS/cm – milli Siemen per cm (= dS/m)

Total dissolved salts

mg/L – milligram per litre of (TDS)
ppm – parts per million of TDS, same as mg/L

A calculator has been provided with this booklet that can be used to convert other units to dS/m.

A large amount of information on salinity is available that refers to EC_e. To use that information the salinity values expressed in $EC_{1:5}$ must be converted to EC_e. The following guide may be used for conversion from $EC_{1:5}$ to EC_e for different types of soil:

Soil type	Multiply by*
Sand	23
Sandy loam	14
Loam	10
Clay loam	9
Medium clay	8
Heavy clay	6

The above conversion factors are usually accurate enough as the values are just a guide and are influenced by site specific conditions. Soils can be rated based on salinity; eg. low, moderate, high, extreme etc. These ratings are relative therefore it is the underlying salinity level that counts. See further discussion on salinity under "Salt tolerance of crops".

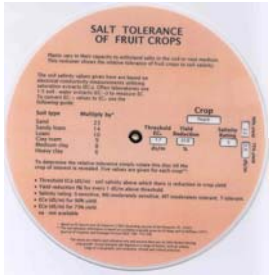
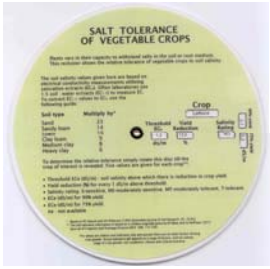
How does salinity affect horticultural production?	Soil salinity generally affects plant growth through an osmotic effect that makes it more difficult for the plants to absorb water from the soil. Excessive salt content of the solution taken up from the soil may also have a toxic effect on the plant where the salts actually damage the plant cells. Saline water, depending on the concentration of salts, applied through sprinkler irrigation can also cause direct damage to the leaves.	☐ NA ☐ Strategy in place ☐ Need to follow up
What can you do to deal with the effects of salinity?	Salinity can be effectively managed through reducing salt input by shandying with low salinity water, appropriate crop selection, leaching salt from the root zone and irrigation management. There is a huge variation in the tolerance of crops to salinity. For example turnip and carrots are among the most sensitive crops and can only tolerate soil salinities of about 1 dS/m before a yield decline may be experienced. Zucchini on the other hand, can tolerate soil salinity of up to 4.7 dS/m before a reduction in yield is recorded. Most vegetable crops and fruits fall into the sensitive to moderately sensitive range. Table 2 illustrates relative tolerance of some vegetable and fruit crops to soil salinity. The information given in Table 2 has also been transformed into an easy to use decision support tool (included with this guide) to help you compare the tolerance of various horticultural crops to soil salinity.   For a discussion on leaching and irrigation see the section "Irrigation Management".	☐ NA ☐ Strategy in place ☐ Need to follow up

Table 2: Salt tolerance of horticultural crops

Common name	Scientific name	Soil salinity (Ece) threshold[a], dS/m	Yield reduction[b] % per dS/m	90% yield[c]	75% yield	50% yield	Salinity rating[d]
				Soil salinity (Ece), dS/m			
VEGETABLES							
Artichoke	*Cynara scolymus*	6.1	11.5	7.0	8.3	10.4	MT
Asparagus	*Asparagus officinalis*	4.1	2.0	9.1	16.6	29.1	T
Bean	*Phaseolus vulgaris*	1.0	18.9	1.5	2.3	3.6	S
Broccoli	*Brassica oleracea*	2.8	9.1	3.9	5.5	8.3	MS
Cabbage	*Brassica oleracea capitata*	1.8	9.7	2.8	4.4	7.0	MS
Carrot	*Daucus carota*	1.0	14.1	1.7	2.8	4.5	S
Cauliflower	*Brassica oleracea botrytis*	2.5	na	na	na	na	MS
Celery	*Apium graveolens*	1.8	6.2	3.4	5.8	9.9	MS
Cucumber	*Cucumis sativus*	2.5	13.0	3.3	4.4	6.3	MS
Eggplant	*Solanum melongena*	1.1	6.9	2.5	4.7	8.3	MS
Garden beet	*Beta vulgaris*	4.0	9.0	5.1	6.8	9.6	MT
Garlic	*Allium sativum*	3.9	14.3	4.6	5.6	7.4	MS
Lettuce	*Lactuca sativa*	1.3	13.0	2.1	3.2	5.1	MS
Onion	*Allium cepa*	1.2	16.1	1.8	2.8	4.3	MS
Pea	*Pisum sativum*	3.4	10.6	4.3	5.8	8.1	MS
Pepper	*Capsicum annum*	1.5	14.1	2.2	3.3	5.0	MS
Potato	*Solanum tuberosum*	1.7	12.0	2.5	3.8	5.9	MS
Radish	*Raphanus sativus*	1.2	13.0	2.0	3.1	5.0	MS
Spinach	*Spinacia oleracea*	2.0	7.6	3.3	5.3	8.6	MS
Sweet potato	*Ipomoea batatas*	1.5	11.0	2.4	3.8	6.0	MS
Tomato	*Lycopersicon esculentum*	**2.3**	**18.9**	**2.8**	**3.6**	**4.9**	MS
Turnip	*Brassica rapa*	0.9	9.0	2.0	3.7	6.5	MS
Zucchini	*Cucurbita pepo melopepo*	4.7	9.4	5.8	7.4	10.0	MT

FRUIT							
Almond	*Prunus dulcis*	1.5	19.0	2.0	2.8	4.1	S
Apple	*Malus sylvestris*	1.0	18.0	1.6	2.4	3.8	S
Apricot	*Prunus armeniaca*	1.6	24.0	2.0	2.6	3.7	S
Avocado	*Persea americana*	1.3	21.0	1.8	2.5	3.7	S
Blackberry	*Rubus fruticosus*	1.5	22.0	2.0	2.6	3.8	S
Boysenberry	*Rubus ursinus*	1.5	22.0	2.0	2.6	3.8	S
Date palm	*Phoenix dactylifera*	4.0	3.6	6.8	10.9	17.9	T
Grape[e]	*Vitis spp.*	1.5	9.5	2.6	4.1	6.8	MS
Grapefruit	*Citrus paradisi*	1.8	16.1	2.4	3.4	4.9	S
Guava	*Psidium guajava*	4.7	9.8	5.7	7.3	9.8	MT
Lemon	*Citrus limon*	1.5	12.8	2.3	3.5	5.4	S
Macadamia	*Macadamia integrifolia*	3.6	na	na	na	na	MS
Olive	*Olea europaea*	4.0	na	na	na	na	MT
Orange	*Citrus sinensis*	**1.7**	**15.9**	2.3	3.3	4.8	S
Peach	*Prunus persica*	1.7	21.0	2.2	2.9	4.1	S
Pear	*Pyrus spp.*	1.0	na	na	na	na	S
Plum	*Prunus domestica*	**2.6**	**31.0**	2.9	3.4	4.2	MS
Prune	*Prunus domestica*	**2.6**	**31.0**	2.9	3.4	4.2	MS
Rockmelon	*Cucumis melo*	1.0	8.4	2.2	4.0	7.0	MS
Strawberry	*Fragaria x ananassa*	1.0	33.3	1.3	1.8	2.5	S

The data in this table serve only as a guideline to relative tolerances among crops. Actual tolerance will vary depending upon climate, soil conditions, cultivar/rootstock, stage of crop growth and cultural practices. The data is taken from published literature based on the plant salt tolerance scheme originally given by E.V. Maas and G.J. Hoffman (1977) Crop salt tolerance – current assessment. *Journal of the Irrigation and Drainage Division, American Society of Civil Engineers* **103,**115–130.

[a]Level of soil salinity above which there is reduction in crop yield. All the soil salinity data is in ECe

[b]Yield reduction (%) per unit of soil salinity (ECe) in excess of the threshold.

[c]Level of salinity up to which 90% yield can be achieved

[d]Salinity rating as given by relevant researchers (generally based on the yield reduction per unit of soil salinity in excess of the threshold); S – sensitive, MS – moderately sensitive, MT – moderately tolerant, T – tolerant

[e]Most crop cultivars show some variation in their ability to tolerate soil salinity, however, grape varieties and rootstocks show huge variation in their ability to tolerate soil salinity. For example, while most commercial varieties in Australia can only tolerate soil salinity up to 1.8 dS/m there are rootstocks that can tolerate up to 5.6 dS/m.

Question/Issue	Guidance/Comment	Your Checklist
What is sodicity?	Sodicity refers to a condition where too much exchangeable sodium is present in the soil compared with other cations. This has a negative impact on soil behaviour. Cation is an atom or group of atoms that have positive electric charge. Exchangeable sodium is different from sodium in the solution. It is held on the negatively charged clay particles in the soil by a bond. Sodium makes a weaker bond compared to calcium, magnesium or potassium. When such soils are wet sodium bond is easily broken and the clay particles disperse giving cloudy appearance.	☐ NA ☐ Strategy in place ☐ Need to follow up
How is sodicity measured? The following relationships between ESP and SAR are commonly used in Australia: For saturation extract – $ESP = SAR_e$ For 1:5 suspension – $ESP = 2SAR_{1:5}$	Australian soils are defined as sodic if the exchangeable sodium percentage (ESP) is greater than six. In other words, ESP is the extent of exchangeable sodium as compared with all the cations taken together. Another commonly used measure of sodicity is sodium adsorption ratio (SAR). This measure is also used for water. Like salinity, SAR for soils can be measured using either saturation extracts or 1:5 soil:water suspension. While ESP and SAR can only be determined through laboratory analysis, there are some surrogate methods that can be used by farmers to obtain first hand assessment of soils in relation to sodicity. One such method involves observing the behaviour of air dry soil aggregates in rain/distilled water. To do this assessment, drop about 8–10 small aggregates in a glass jar containing rain/distilled water and leave undisturbed for about two hours. If the water becomes cloudy (clay dispersed) then this is an indication of sodicity.	☐ NA ☐ Strategy in place ☐ Need to follow up

How does sodicity affect horticultural production?	In contrast to salinity, the effect of sodicity is via its adverse influence on soil structure. Sodic soils are hard setting with restricted infiltration of water, are prone to water logging and difficult to work with. Crops grown under such conditions suffer from poor root development and restricted nutrient and water uptake. Soil structure is the combination or arrangement of primary soil particles into aggregates or clumps. Sodicity affects the structural stability or the ability of the soil to resist adverse changes to the structural arrangement.	☐ NA ☐ Strategy in place ☐ Need to follow up

Question/issue	Guidance/comment	Your Checklist
What can you do to deal with the effects of sodicity?	Gypsum is the most commonly used material to ameliorate soil sodicity. The amount of gypsum to be applied will depend on the level of sodicity and the quality (purity) of gypsum. Gypsum contains calcium in the form of calcium sulphate. When gypsum is applied to the soil calcium displaces sodium. Calcium forms stronger bonds between clay particles resulting in reduced clay dispersion. The more calcium the better in the long-term. Gypsum is available as mined gypsum and as an industrial by-product commonly known as phospho-gypsum. Phospho-gypsum is generally of high purity but can be contaminated with cadmium (which could be a potential health risk to users). On the other hand, there is huge variation in the purity (quality) of the material sold as mined gypsum. The amount of gypsum to be applied may need to be adjusted upward depending on its purity. The information on the quality of gypsum is available from the suppliers. Lime (calcium carbonate) is another material that can be used in acidic soils. Lime supplies calcium and also reduces the acidity. Consult with your adviser to decide the amount of gypsum or lime that should be applied based on the level of sodicity and gypsum purity. Another way to manage the sodicity is to improve the organic matter content of soils. Organic matter helps maintain good soil structure as well as supplying essential plant nutrients as it breaks down in the soil.	☐ NA ☐ Strategy in place ☐ Need to follow up

5. IRRIGATION MANAGEMENT

The switch to recycled water may provide an opportune time to review your irrigation practices, including irrigation method and salinity management, to improve water use efficiency.

Question/Issue	Guidance/Comment	Your Checklist
Have you identified the best method for application of recycled water?	Ideally the use of recycled water should not require you to alter your current irrigation practices, however you should be aiming to optimise water use efficiency and minimise run-off and seepage to ground water and to creeks or rivers. Consider irrigation scheduling, along with methods like drip irrigation to minimise water loss and improve water use efficiency. If nutrients in recycled water promote algae growth in your storage facility you may need to install better filtration systems if using drip irrigation. Irrigation scheduling is the matching of crop demand for water with supply, ie. applying the right amount of water at the right time. Water use efficiency is a measure of dry matter or harvested portion of the crop produced per unit of water consumed.	☐ NA ☐ Strategy in place ☐ Need to follow up
How can you effectively irrigate with recycled water without increasing soil salinity?	To prevent salt from accumulating in the soil, excess water can be applied to deliberately cause a fraction of the water to flow through the root zone and flush away excess salts. This excess water used for leaching is called 'leaching requirement' and this practice has been used effectively in containing salt build up under saline water irrigation. However, unless the water table is very deep, or the lateral groundwater drainage is sufficiently rapid, the extra irrigation can cause a progressive rise of water table. Therefore, the amount of water applied must be optimised to allow leaching without water table rise.	☐ NA ☐ Strategy in place ☐ Need to follow up

If you are using a sprinkler irrigation system have you identified the best practice to minimise spray drift?	As a minimum requirement, no overhead spray should be directed towards a neighbouring property, public land or public roadways. Sprinklers at the boundary of properties should have adjustable spray heads or shields so irrigation can be directed within farm boundaries. Good irrigation practice would include avoiding irrigation during strong winds and using spray heads and pressures that prevent fine mist generation.	☐ NA ☐ Strategy in place ☐ Need to follow up
Do you have appropriate drainage and run-off controls?	If nitrogen and phosphorus are in high concentrations (relative to that in water bodies affected), or large amounts of fertilisers are being used, the run-off caused from irrigation presents a risk to neighbouring land and environmentally sensitive waterways by potential increased nutrient loads. To minimise run-off avoid irrigating prior to a storm event, postpone irrigation if heavy rainfall is experienced and avoid excessive irrigation that results in pooling of water on the soil surface. Reduced run-off can be achieved by irrigation scheduling and improving drainage characteristics such as maintaining good soil structure through adding organic matter or calcium based amendments.	☐ NA ☐ Strategy in place ☐ Need to follow up
Are you aware of any withholding periods needed after irrigating with recycled water?	Check with your buyers if there are any withholding period requirements between the irrigation application and marketing of the produce.	☐ NA ☐ Strategy in place ☐ Need to follow up

6. FERTILISATION AND NUTRIENT MANAGEMENT

It is important to get the nutrient balance right. This will ensure crop productivity is not affected by under-supply (deficiency) or oversupply (toxicity) of essential nutrients. A sound nutrient management plan can provide significant advantages in crop yield and quality. The use of recycled water adds another dimension to crop nutrient management plans as most recycled waters contain some nutrients – more than plant or fertilisation requirement in some cases. A comprehensive nutrient plan will consider soil fertility, crop requirement and removal, nutrient content of recycled water, crop rotation and potential losses through volatalisation, leaching or runoff.

Question/Issue	Guidance/Comment	Your Checklist
Do you have access to information on the nutrient content of recycled water?	Your supplier can provide you the water analysis results including the concentration of pant nutrients. Some schemes could be shandying recycled water with other water sources (eg. river, potable) to lower the salinity levels. Shandying would also affect the nutrient content so use caution when interpreting water analysis results.	☐ NA ☐ Strategy in place ☐ Need to follow up
Will the use of recycled water result in over-fertilisation?	Using recycled water during crop growth cycle may lead to an excessive supply of nutrients and subsequently affect the crop and soil. As plant requirements change the application of nutrients also needs to change. When using recycled water it is possible to dilute the water during periods when there is a demand for water but not for additional nutrients.	☐ NA ☐ Strategy in place ☐ Need to follow up

Have you developed a nutrient plan for your crops?	A nutrient plan contains information on when, how and what nutrients need to be applied. Application rates will depend on soil fertility status and crop requirement. Soil analysis is a valuable technical tool that provides information on the ability of the soil to supply nutrients to the crop and is invaluable in planning and assessment of fertilisation programs. The analysis will also provide information required for crop selection. The setting of realistic yield targets is important as it helps to define the total nutrient requirement of a crop. This is done in conjunction with gross margin analysis to identify highest profitability. While it is possible to achieve high yield it may come at significant costs. A nutrient plan will consider current soil nutrient status, all the inputs (eg. fertilisers, soil amendments, recycled water), removal (eg. crop uptake, losses through leaching and erosion) and the balance. Your adviser will be able to assist you in developing a crop nutrient plan. A nutrient balance tool will be provided with this guide to help you with doing a nutrient balance of your crops production program.	☐ NA ☐ Strategy in place ☐ Need to follow up

7. FURTHER INFORMATION

National recycled water guidelines

ANZECC & ARMCANZ, NHMRC (2000) Guidelines for sewerage systems: Use of reclaimed water. NWQMS.

www.deh.gov.au/water/quality/nwqms/index.html

New national guidelines for recycled water are being developed and should be available for public comment in the second half of 2005.

Guidelines for developing recycled water schemes in horticulture, Natural Heritage Trust (?)

http://www.daff.gov.au/corporate_docs/publications/pdf/nrm/water/water_use_recycling_hort_guidelines_june_05.pdf

Industry Guidelines

Guidelines for On-Farm Food safety for Fresh Produce 2004, Second edition. Department of Agriculture, Fisheries and Forestry, Australian Government

www.horticulture.com.au/

Guidelines for Environmental Assurance in Australian Horticulture 2005, Horticulture Australia Limited

www.horticulturefortomorrow.com.au/documents/GuidelinesFINAL_000.pdf

State recycled/reclaimed water use guidelines available on-line

NSW	http://www.environment.nsw.gov.au/water/effluent.htm
Qld	www.epa.qld.gov.au/register/p01212aa.doc
SA	www.environment.sa.gov.au/epa/pdfs/recycled.pdf
Tas	www.dpiwe.tas.gov.au/inter.nsf/WebPages/CDAT-5JV3TW?open
Vic	http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/PubDocsLU/464.2?OpenDocument

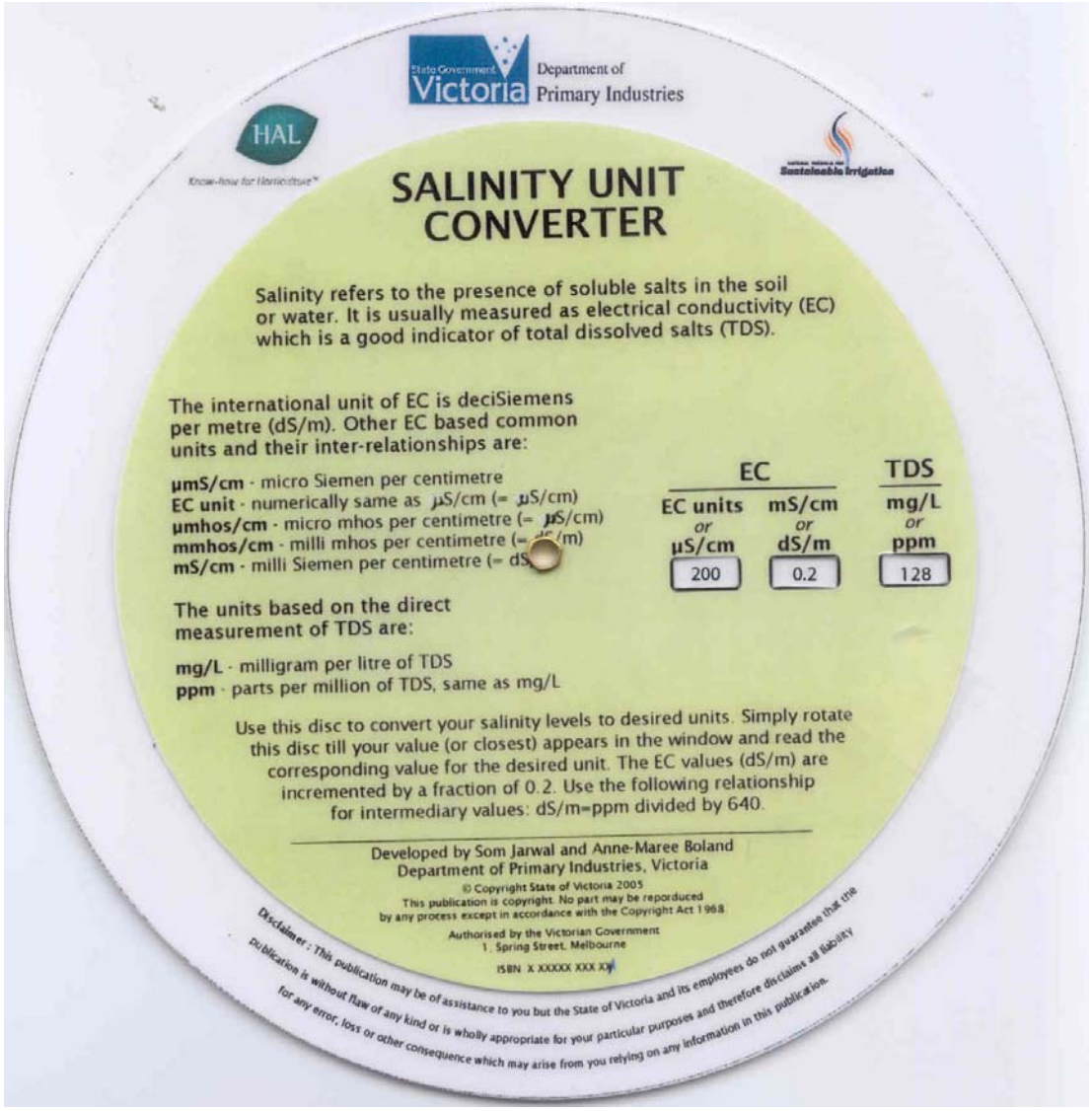
Quality Assurance schemes (LWA document)

Websites for more information on recycled water

Coordinator Recycled Water Development in Horticulture	www.recycledwater.com.au
CRC for Water Quality and Treatment	www.waterquality.crc.org.au/
Department of Environment and Heritage	www.deh.gov.au
Australian Heritage Commission	www.ahc.gov.au
Murray Darling Basin Commission	www.mdbc.gov.au
Department of Agriculture, Fisheries and Forestry	www.daff.gov.au
National Environmental Protection Council	www.ephc.gov.au/
ATSE Water Recycling Report	www.atse.org.au/index.php?sectionid=597

APPENDIX 3b

SALINITY CONVERSION
AND
SALT TOLERANCE
WHEELS


State Government Victoria
Department of Primary Industries
HAL
Know-how for Horticulture™
Sustainable Irrigation
SALINITY UNIT CONVERTER
Salinity refers to the presence of soluble salts in the soil or water. It is usually measured as electrical conductivity (EC) which is a good indicator of total dissolved salts (TDS).
The international unit of EC is deciSiemens per metre (dS/m). Other EC based common units and their inter-relationships are:
µmS/cm - micro Siemen per centimetre
EC unit - numerically same as µS/cm (= µS/cm)
µmhos/cm - micro mhos per centimetre (= µS/cm)
mmhos/cm - milli mhos per centimetre (= dS/m)
mS/cm - milli Siemen per centimetre (= dS
EC
EC units or µS/cm
mS/cm or dS/m
TDS
mg/L or ppm
200
0.2
128
The units based on the direct measurement of TDS are:
mg/L - milligram per litre of TDS
ppm - parts per million of TDS, same as mg/L
Use this disc to convert your salinity levels to desired units. Simply rotate this disc till your value (or closest) appears in the window and read the corresponding value for the desired unit. The EC values (dS/m) are incremented by a fraction of 0.2. Use the following relationship for intermediary values: dS/m=ppm divided by 640.
Developed by Som Jarwal and Anne-Maree Boland
Department of Primary Industries, Victoria
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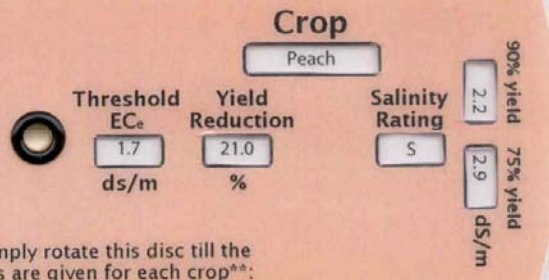
SALT TOLERANCE OF FRUIT CROPS

Plants vary in their capacity to withstand salts in the soil or root medium. This reckoner shows the relative tolerance of fruit crops to soil salinity.

The soil salinity values given here are based on electrical conductivity measurements utilising saturation extracts (EC_e). Often laboratories use 1:5 soil : water extracts ($EC_{1:5}$) to measure EC. To convert $EC_{1:5}$ values to EC_e use the following guide:

Soil type	Multiply by*
Sand	23
Sandy loam	14
Loam	10
Clay loam	9
Medium clay	8
Heavy clay	6



To determine the relative tolerance simply rotate this disc till the crop of interest is revealed. Five values are given for each crop**:

- Threshold ECe (dS/m) - soil salinity above which there is reduction in crop yield.
- Yield reduction (%) for every 1 dS/m above threshold.
- Salinity rating: S-sensitive, MS-moderately sensitive, MT-moderately tolerant, T-tolerant.
- ECe (dS/m) for 90% yield.
- ECe (dS/m) for 75% yield.

na - not available

* Based on PG Slavich and GH Petterson (1993) [Australian Journal of Soil Research: 31, 73-81].
** The salt tolerance information is based on a scheme originally given by EV Maas and GJ Hoffman (1977) [Journal of Irrigation and Drainage Division ASCE: 103, 115-134].

The values are relative and indicative only and assume there are no other factors limiting crop growth. Actual tolerance will depend on a range of factors, such as cultivar, stage of crop growth, soil conditions, climate and cultural practices.