Smart Water Fund

Milestone 5 / Final Report

Evaporative Cooler Pilot Study - 72M-7091

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Executive Summary

An industry perspective report on the installed stock of evaporative coolers prepared by AIRAH for the Department of Sustainability and Environment identified that there could be potential water wastage of three gigalitres per year associated with evaporative coolers. Very little evidence existed to confirm this estimation. The Evaporative Cooler Pilot Study was undertaken with funding from the Smart Water Fund to develop a methodology to better estimate water use efficiency based on actual field measurements. 50 residential and 50 non residential units from a variety of locations in Victoria were included in the study to obtain enough data for a statistically valid result while not making the project prohibitively expensive.

The site measurements and calculations confirmed that there is potential to greatly improve water efficiency in both residential and non residential evaporative coolers through retrocommissioning the water management systems on the units.

Three publications and complementary training for mechanical services plumbers were developed following the findings from the pilot study. The aim of the publications is to raise awareness for design engineers, home owners and non-residential end users about water conservation issues in evaporative coolers. The training for plumbers focuses on the retrocommissioning process for evaporative coolers to improve water efficiency. Ongoing communication is underway with a number of key stakeholders to maximise awareness raising activities for end users.

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Background

In 2009 AIRAH prepared a report, *Industry perspective of water inefficiencies in evaporative coolers,* for the Department of Sustainability and Environment (DSE) which considered the way installed evaporative coolers are used in Victoria. The report was based on discussion and input from a broad range of stakeholders involved with evaporative coolers.

Theoretical estimations of the overall water consumption of evaporative coolers and the steps that could be taken to ensure efficient use of water were included in the report. The report recommended that two field trials be undertaken to accurately calculate the water savings that could achieved in the commercial setting and with a cross-section of domestic users.

The key findings in the report were:

- There are approximately 550,000 residential evaporative coolers installed in Victoria.
- Evaporative coolers can last up to 20 years.
- Estimated overall water consumption associated with evaporative coolers in Victoria is about 15GL/yr.

- Estimated water excess associated with evaporative coolers in Victoria is 3GL/yr. (this figure is based on assumptions made on average water use efficiency in the coolers.)

AIRAH applied to the Smart Water Fund to undertake the recommended field trials for residential and non residential evaporative cooling systems.

Introduction

There is limited information on the water use and water use efficiency of evaporative coolers available. This Smart Water Fund project determined the actual operating efficiencies of existing units in the residential and non residential sector. This was difficult to calculate theoretically as there are many variables: the type and size of unit, the age of the unit, the frequency of the maintenance over the period of operation, the water quality and the weather.

AIRAH developed a methodology based on water chemistry measurements to estimate the water efficiency of coolers based on information gathered during onsite visits. 50 residential and 50 non-residential sites from a range of geographic locations were included in the study.

Objectives/Goals

The aim of the Evaporative cooler pilot study was to test the theoretical calculations and industry anecdotal advice included in the DSE report and to establish possible ways to reduce water consumption in existing evaporative cooling systems without compromising effectiveness.

Once the field trials were conducted and water saving techniques established the aim of the project was to develop awareness raising material for end users (residential and non residential) and design engineers. To complement this awareness material AIRAH negotiated funding from the Plumbing Industry Commission to develop training for plumbers focusing on water conservation measures for evaporative coolers.

Literature Review

A number of reports were reviewed to develop the original DSE report to help calculate theoretical water use and water efficiency. None of the literature reivewed considered the water chemistry or water use efficiency:-

- Yarra Valley Water, *2003 and 2007 APPLIANCE STOCK AND USAGE PATTERNS SURVEY*
- Yarra Valley Water, *2004 Residential End Use Measurement Study*
- Infomark residential unit sales figures (note – non residential unit sales are not reported to informark
- 2005 Joint Project between Yarra Valley Water And Water Services Association of Australia, *Evaporative Air Conditioner Study*

Key Steps / Milestones

- Methodology – residential study

50 units from a variety of locations in Victoria were included in the study to obtain enough data for a statistically valid result while not making the project prohibitively expensive.
Water retailers throughout Victoria canvassed their staff to help find potential participants for the study.
40 participants were selected in the Melbourne metropolitan area, (northern, southern, eastern and western suburbs) and 10 in regional areas. All units reviewed were of the “direct” type that provide

cooling for the occupied space of a house (as opposed to the “indirect” type of cooler that provides cooling for a heat exchanger or as part of some other process).
Visits to sites were undertaken on hot days between 1:00 pm and 4:00pm during January and February, 2010. This ensured the units would be operating as they would normally be used. Householders were asked to make sure the units were running when site was visited. Homeowners were asked a series of questions about their evaporative coolers
Each unit was then inspected for the following:

- The design and functionality of the evaporator cooling unit
- Evaporative water usage
- Non-evaporative water usage
- Non-evaporative water loss
- Fixed factory operational settings
- Programmable settings and if they had been altered from factory settings by the home owner
- Make-up water conductivity (salinity, corrosion or scale forming tendencies)
- System water conductivity where possible. Water samples were taken from the evaporative cooler using a sterilised bottle and the water tested with a multi-range conductivity meter to determine TDS loading as an indication of the scaling and/or corrosion tendency of the water at that time. In some instances this was not possible due to safety considerations.
- Water use patterns during the past 12 months
- The internal configuration and condition of the units
- Maintenance type and frequency, together with warranty implications
- The implications for water savings and cooling efficiency and when equipment operation and maintenance is compared with best practice.

The results were then combined for analysis and comparison.

A summary report was provided to the unit owner to allow consideration regarding implementation of the recommendations for possible water and energy savings, improved cooling efficiency and longevity of the evaporative cooling equipment.

Methodology – non-residential study

Using existing contacts 51 non-residential evaporative coolers were audited to assess their water efficiency.
The sample size of 51 units allows for statistically relevant trends and relationships to be drawn and units were selected to represent a range of locations, types and uses.
Locations were split as follows:

- Melbourne CBD: 12%
- Melbourne metro: 63%
- Country locations: 25%

End use application was split as follows:

- Commercial: 16%
- Food: 18%
- Health care: 39%
- Manufacturing: 27%

There were three distinct types of evaporative coolers sampled:

- Small roof mounted residential-type coolers, typically used to cool spaces up to the size of a house.
- Large industrial roof mounted coolers, typically used to provide cooling to the occupied spaces of large open areas such as factories and warehouses or to provide indirect cooling for a heat exchanger or other process.
- Large "capillary" coolers typically used to provide cooling for a large space with high heat loads (such as kitchens). Their use is fairly uncommon.

The study measured the water chemistry on site to determine the levels of the total dissolved solids (TDS) are reaching before the water is refreshed. This was where it was assumed there was the greatest potential for water savings by recommissioning the bleed / dump controls to the appropriate levels for the local supply water quality. Measuring conductivity will gave a snapshot of efficiency.

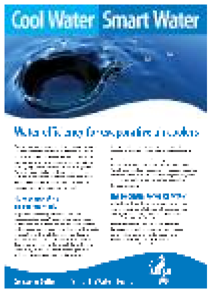
- Resources

Following the field trials two awareness documents, a detailed technical manaul and training for plumbers were developed in consultation with a range of technical, non technical stakeholders including regulators and water retailers.

- *DA29 – Evaporative air cooling systems* - detailed technical guide aimed at engineers. This manual covers the full life cycle of evaporative coolers from design, installation, commissioning, operation, maintenance to recommissioning. (Appendix 1)

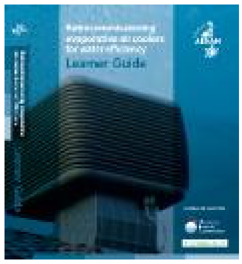
- *Non-residential evaporative air cooling systems - Water efficiency and conservation Best Practice Guidelines* – this guide is available for free download online and is aimed at the non residential end user. *(Appendix 2)*

- *Residential evaporative air cooling systems - Water efficiency and conservation Best Practice Guidelines* – this guide is available for free download online and is aimed at the residential user. (Appendix 3)



Both end user guides have been developed to focus on existing equipment to provide guidance and questions to ask about water efficient operation of evaporative coolers.

The training for plumbers aims at raising awareness about retrocommissioning existing systems to improve water efficiency in operation.



- **Timing**

The project commenced in the summer of 2009/2010 with the onsite field investigations of residential and non-residential units. The whole project (field trials, reports, best practice guides and training for plumbers) was completed in June 2011.

- **Financial Summary**

Funding Summary for Milestone 1 – project plan and design of field trials		
Source	**Amount**	
	$	**In kind**
Smart Water Fund	0	0
Grantee	0	0
Other AIRAH	0	$10,000

Funding Summary for Milestone 2 – field trials and reports		
Source	**Amount**	
	$	**In kind**
Smart Water Fund	52,000	
Grantee		
Other (DSE)	48,000	

Funding Summary for Milestone 3 – development of best practice guides		
Source	**Amount**	
	$	**In kind**
Smart Water Fund	$20,000	
Grantee		
Other (please name)		

Funding Summary for Milestone 4 – Training for plumbers		
Source	**Amount**	
	$	**In kind**
Smart Water Fund		
Grantee		
Plumbing Industry Commission	$35,000.00	

Funding Summary for Milestone 5 - Final evaluation report and recommendations		
Source	**Amount**	
	$	**In kind**
Smart Water Fund	$13,000	
Grantee		
Other (please name)		

Findings/Results/Outcomes –residential field trials.

Evaporation rates for modern evaporative units approximates between 60 and 100 litres per hour (L/hr) depending on typical seasonal variations in Victorian ambient air conditions and model characteristics.
Non-evaporative purge (bleed and/or dump) rates approximate between 5 and 30 L/hr depending on salinity control or water management equipment, and the factory/installer settings of the system. The average purge rate encountered in this study was approximately 20 L/hr.
Purge consumption rates amount to approximately 25% that of evaporation rates with current equipment settings.
Operating evaporative units without bleed but dumping the full system volume once per 24 operating hours during the summer months represents a non-evaporative water savings of around 95%, equating to around 2.5GL/year (17% of estimated overall water consumption associated with evaporative coolers in Victoria).
Water losses (leaks, splash outs, overflows) were not encountered in the 50 residential units reviewed. Undertaking regular maintenance to rectifying any such issues in units that do have these problems, however, would result in further water savings.

Findings/Results/Outcomes – non residential field trials.

In summary, it was found that many non residential systems operate inefficiently and there is the potential to save 1,800 ML of water each year if all non-residential evaporative coolers in Victoria were operated according to best practice.
Relationships between excess water consumption and various design or operational parameters were investigated to help target resources. Reduced water efficiency was noted when evaporative coolers were:

- In a country location
- Associated with the food industry
- Manually bled
- Under manual on/off control
- Observed to be leaking

No statistically valid relationship was observed between excess water usage and system size, manufacturer, dumping frequency, maintenance regime, water treatment and waste flow. Insufficient data was available to comment on efficiency relationships between system condition, system age and the fitted evaporative media.

Non water efficiency related Findings/Results/Outcomes

Whilst the focus of this project was water efficiency in evaporative coolers AIRAH was contacted for comment on issues relating to bushfire and evaporative coolers following recent bushfires in Western Australia. Initial feedback from homeowners pointed to ember attacks on their evaporative coolers as the reason their houses caught fire. As a result of this, information on ember protection screens was included in the end user guides and the technical manual.

Risk Management

The main risk identified at the development stage of this project related to potential inability to “recruit” sufficient householders to undertake the residential pilot study. With the help of the water corporations engaging their staff this issue was overcome with ease.

Discussion/Evaluation

Before the DSE and SWF projects were undertaken there was no understanding or consideration about water efficiency in the installed stock of evaporative coolers in Victoria. Evaporative cooler operation is based on very simple physics and the equipment life can be up to 20 years.

The nature of the equipment (roof mounted) often means that it is installed and very little thought is given to its ongoing operation or efficiency. The field trials have highlighted there is a large potential for water efficiency improvements in existing systems, mainly through the retrocommissioning of the systems’ water management controls. From the study it appears that installers leave the water management controls at the “factory setting/default” and don’t adjust them to suit the local make up water quality.

The end user and technical guides and training developed as part of the project provide useful awareness raising material for a range of stakeholders. The key to the advice being taken up is a strong communication campaign by water corporations and the government. AIRAH will continue to work with these stakeholders to promote the guides and courses.

A useful next step to this project would be to work closer with the equipment manufacturers and agents to address the water efficiency issue at equipment selection, installation and commissioning phase.

Return on Investment

No physical changes were made to systems as part of this project so no measured savings can be reported on.

The first part of this project was a pilot field study to assess how efficiently existing installed evaporative coolers use water and to determine the best methods for water efficiency improvements. Theoretical water saving potentials addressed as part of this project were based on stakeholder anecdotes and on review of available literature as part of the DSE report.

The second part of the project was to develop awareness material for end users to educate them to drive them to start considering water efficiency measures.

AIRAH will continue to seek avenues to raise awareness of water efficiency through its networks and will also track the downloads of the end user guides. Another measure of success will be the uptake of training by plumbers. AIRAH have granted fee free licence to the Master Plumbers and Mechanical Services Association of Australia (MPMSAA) to deliver the training. AIRAH will work with MPMSAA to promote the availability of the training.

Conclusion

The field studies confirmed industry stakeholder anecdotal feedback that there is a large potential for water savings in the installed stock of evaporative coolers in Victoria. The focus of the water efficiency improvements should be the retrocommissioning of water management controls in the evaporative coolers (bleed and dump settings).

The end user documents developed as a result of the field trial findings raise awareness of the reader to consider the issues and directs them on steps to take.

The training developed for plumbers complements the advice in the end user guidelines and will equip plumbers with the knowledge to improve water efficiency in existing evaporative coolers through retrocommissioning.

Despite the simple nature of the technology used in evaporative coolers this project highlights the large amount of water wasted though inefficient operation of the systems. The project has also highlighted the collaborative approach that is needed to address the issues of water efficiency improvements in installed evaporative coolers.

Recommendations – residential field trials

The findings in the residential field report should be verified by temporarily installing appropriate hardware and data logging equipment on suitable evaporative coolers.
Upon verification the proposed water management recommendations should be discussed with evaporative cooler manufacturers, installation and service companies. Servicing frequency and requirements as per Australian Standard AS/NZS 3666 and Handbook HB32 should form the minimum scope of works.
It is recommended to redevelopment the consumer residential air conditioning website www.fairair.com.au to include more detail about evaporative cooling options for home cooling and awareness raising about maintenance and water efficiency issues.

Recommendations – non residential field trials

Based on the audit results and extrapolated efficiency findings the following recommendations can be made:

- Reduced water efficiency was noted when coolers were in a country location, associated with the food industry, manually bled, under manual on/off control and/or observed to be leaking. It is recommended that resources be targeted to units meeting one or more of these criteria in the first instance.

- Automated control systems should be advocated for larger systems.

- A cost-benefit calculator should be developed and provided to allow owners and operators of evaporative coolers to understand the benefits of improved water efficiency.

It is recommended the efficacy of these recommendations is verified by temporarily installing appropriate hardware and data logging equipment on suitable evaporative coolers.
It is also recommended, upon verification of the above findings, that the proposed water management recommendations are discussed with evaporative cooler manufacturers, installers and service companies. Servicing frequency and the requirements of AS/NZS 3666 and HB32 should form the minimum scope of works.

Recommendations - general

It is proposed the findings of the study will be used to inform regulatory mechanisms involving water efficiency measures such as the Plumbing Code of Australia and Water Efficiency Labelling Schemes. AIRAH is actively engaged with the government departments involved in these areas.

Ongoing work is now required and should be encouraged to engage the water corporations, plumbing stakeholders etc to make sure the awareness levels of end users are raised. This requires effective communication by SWF/ DSE/ AIRAH and other stakeholders.

References

DSE report - *Industry perspective of water inefficiencies in evaporative coolers,* November 2009

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Plumbing Industry Commission (PIC)
Master Plumbers and Mechanical Services Association of Australia (MPMSAA_

Appendices

- **Appendix 1** - *DA29 – Evaporative air cooling systems* - detailed technical guide aimed at engineers. This manual covers the full life cycle of evaporative coolers from design, installation, commissioning, operation, maintenance to recommissioning.

- ***Appendix 2*** - *Non-residential evaporative air cooling systems - Water efficiency and conservation Best Practice Guidelines* – this guide is available for free download online and is aimed at the non residential end user.

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Document Status

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