

Exposure assessment for recycled and alternative water use

Joanne O'Toole – PhD Thesis Abstract

Department of Epidemiology and Preventive Medicine, Monash University
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Recent drought conditions in Australia have led to increasing attention on water recycling and the use of alternative water sources. Despite 'in-principle' acceptance by the Australian public, support for proposed recycling schemes is constrained by perception of possible adverse health effects from exposure to micro-organisms and chemical contaminants. Exposure assessment research to inform risk assessment is vital if water sustainability targets are to be met through the expanded use of recycled and alternative water sources. This thesis comprises a series of exposure assessment studies providing data that can be used to assist regulators to design appropriate regulations and to assure the public of the safe use of alternative water sources, including recycled water, for designated purposes. It also provides methodological information that may be used for future research.

The results of the water usage survey provide information about Australian household water use and the recycled water exposure profile of dual reticulation households. Both questionnaire and diary formats were used to measure exposure among dual reticulation residents. Comparison of results showed that direct extrapolation of water usage from residents in control versus dual reticulation areas is problematic, especially because of differences in water restrictions.

Outcomes from machine clothes washing experiments investigating the transfer efficiency of bacterial and viral enteric indicators and *Cryptosporidium parvum* from water to fabric, hands, environmental surfaces and air, and from washed fabric to hands provide data that may be used for Quantitative Microbial Risk Assessment (QMRA) evaluations. Furthermore, these studies showed that recycled water of Class A microbiological quality used for machine washing will not lead to the transmission of numbers of micro-organisms likely to cause enteric diseases.

Findings from turf irrigation experiments suggest that the currently prescribed 4 hour withholding period following turf-grass irrigation should be maintained despite statistically significant reductions in indicator organisms under some shorter withholding conditions. Significant reduction in microbial numbers on irrigated turf-grass is best achieved through the wastewater treatment process prior to irrigation.

The results of the first Australian endotoxin survey of a variety of water types show that the wastewater treatment processes where membrane filtration is employed may result in the production of finished water with endotoxin concentrations at least as low as those in existing drinking water supplies. Results also indicate that further investigation of the endotoxin assay as a means to monitor treatment train efficacy is warranted as this may provide a supplement, or substitute, for existing tests.

Experiments investigating aerosol and droplet production of water-efficient devices present a significant methodological advance compared with other studies and show that further work to achieve a greater understanding of aerosol exposure to water-users during typical domestic water-using activities relevant to an Australian context is required.

Overall, results show that water recycling for designated non-drinking purposes may be safely employed without the need for sophisticated wastewater treatment processes that are required for drinking water augmentation.