On-site Domestic Greywater Reuse in Western Australia – Opportunities and limitations for landscape irrigation

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Abstract
Greywater recycling via treatment systems for urban irrigation has great potential to aid in the management of Western Australia's water supply issues. Unfortunately, wastewater is generally viewed in terms of health and disposal issues, rather than looked upon as a valuable resource. Greywater reuse on a domestic scale has the ability to contribute to the sustainable development of Western Australia. This paper examines the capacity of greywater treatment systems to contribute to water savings when included as part of a well-designed urban garden irrigation system. It will be demonstrated that further research needs to be undertaken into developing systems that will enable efficient irrigation of domestic gardens.

Keywords
Domestic irrigation systems, greywater treatment systems, wastewater recycling

INTRODUCTION

The approach to water supply and disposal in developed nations is generally governed by a centralised strategy, an unsustainable process. Worldwide, water is used at an unsustainable rate and is often disposed of in a wasteful and unsustainable manner. Conventional disposal methods combine all domestic wastewater for treatment and final disposal; however, great potential exists in the field of on-site wastewater separation and recycling.

Domestic greywater, as a water source for landscape irrigation, could significantly contribute to sustainable development. Apart from the obvious contribution to water conservation, a range of economic and social benefits will follow the adoption and use of small-scale reuse systems.

Domestic greywater refers to effluent from the bathroom, washbasin and laundry. Wastewater from the kitchen sink will not be considered as part of the greywater stream due to the problems with reuse of this highly contaminated stream via irrigation. A range of sustainable options exists for treatment and disposal of the blackwater (toilet) component. Blackwater can still go to the sewer (along with kitchen effluent), however, in unsewered areas the blackwater can be treated separately via dry composting toilets, such as the ‘Clivus Multrum’ or on-site Aerobic Treatment Units, for example, the 'Biomax'.

Integrated design needs to takes place with regards to greywater treatment and recycling systems and irrigation systems. The potential significant impacts on water and energy use might require greywater reuse to be coincidental with water-sensitive urban design, reduced lawn area, and urban agriculture.

BACKGROUND.

In recent years Western Australia (WA) has been facing a water shortage crisis, the State is currently threatened with significant problems in ensuring future generations have sufficient potable water resources. The 'water crisis' has become increasingly prominent in the public arena, as well as the political, and is becoming a contentious issue.

Problems with ensuring a sustainable water supply have come about through a number of factors. A combination of changes in domestic water use practices, reduced inflow to scheme storage infrastructure and future expectations that

water use will continue to increase while climate change will reduce supply ability has contributed to creating the problem that now exists.

Water use in the State doubled over the 15-year period between 1985 and 2000, with outdoor water use being the most significant change, increasing by around 50% within that period. Water consumption is further expected to double by around 2020 (WRC, 2000).

The importance of conservative water use is emphasized by the fact that the State has experienced a 25-year low (below average) rainfall trend, it is predicted that the low rainfall will continue. The annual average rainfall for the South-West of WA is expected to decrease by up to 20% by 2030 and 60% by 2070 (CSIRO, 2001). It can be seen from Figure 1 below that annual inflow to Perth's major reservoirs has not exceeded the long-term mean since 1975.

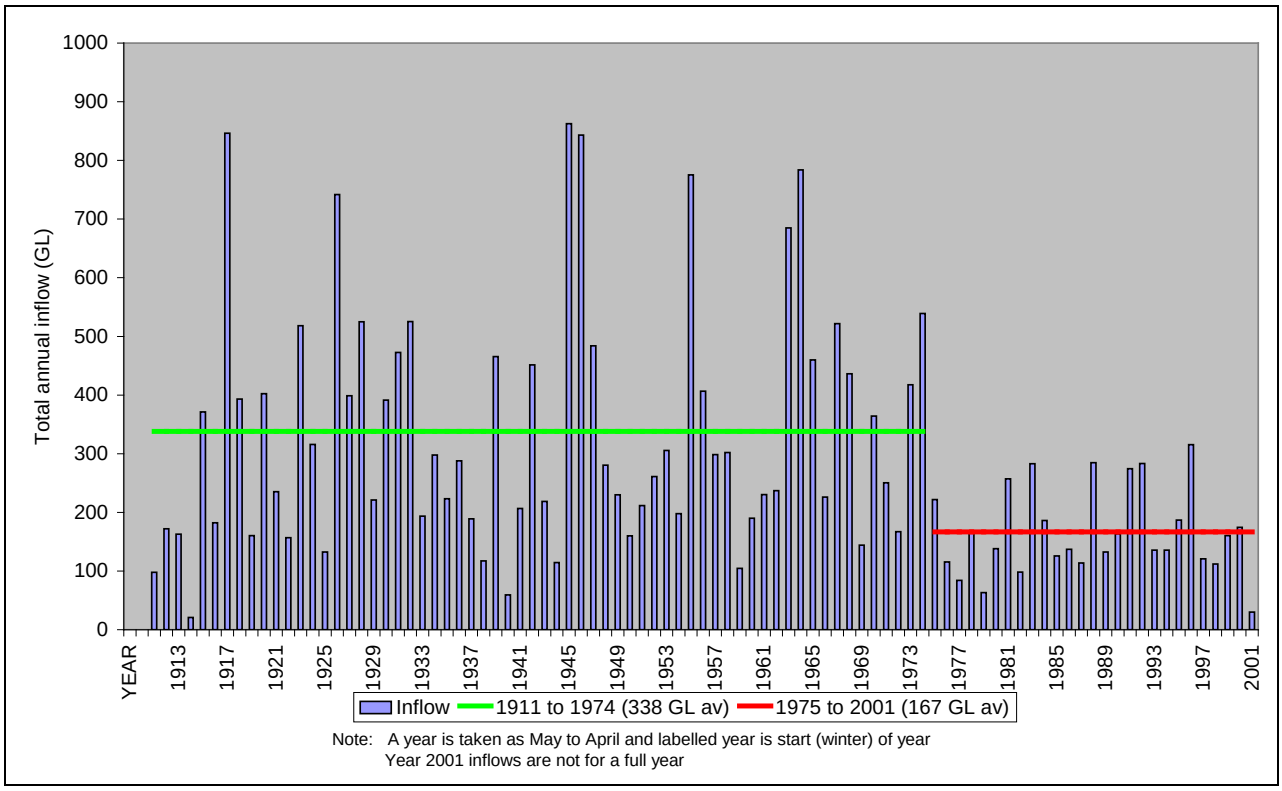

Figure 1: Annual Inflows to Major Perth Metropolitan Reserves (gL)
Source: Water Corporation, 2000

Current State of Play

Domestic greywater reuse, governed by State and Local Government Health Acts, is currently not permitted in Western Australia. It is acknowledged, however, that up to 20% or 100,000 Perth homes practice some form of water recycling (Lugg, 1994; Stone, 1996). As of the beginning of February 2002, the Western Australian Department of Health relaxed greywater regulations in order to allow for limited reuse. The decision to allow reuse, made in light of the severe water shortage, allowed for manual application to domestic gardens by bucket only, permitted only for the duration of the existing water restriction period (Department of Health, 2002).

In order to avoid public and environmental health issues related to unregulated reuse the Health Department of Western Australia and the Water and Rivers Commission have developed the Draft Guidelines for the Reuse of Greywater in Western Australia (Dept of Health WA, 2002).

The Draft Guidelines are prescriptive rather than performance based, however the release of the guidelines does allow for innovation, with the requirement that system design conform to the proposed Guidelines and Australian Standard 1547:2000 "*Onsite Domestic Wastewater Management*".

The current water shortages have prompted the establishment of a State Water Conservation Strategy by the State government and its agencies, with wastewater recycling of various scales addressed. The reuse of greywater on a domestic scale is one of the methods that could be employed to help meet the States future needs.

Recycling wastewater for landscape irrigation is not a new practice in the State, treated effluent from lagoons is used on municipal ovals, parks and golf courses in many country towns of WA, with around 80 reuse schemes currently approved across the State (Mathew & Ho, 1993).

In WA there is immense community support for reuse of wastewaters (WAWA, 1994), this attitude is also shared elsewhere in Australia, with surveys in Melbourne indicating that people are interested in the reuse of bathroom and laundry greywater (Cristova-Boal *et al*., 1994). At present, the implementation of domestic greywater reuse in Western Australia looks to be a promising prospect to aid in water conservation.

Role of Greywater Reuse in Urban Irrigation

Of the potable water supplied for domestic use in Perth, between twenty and forty percent is discharged as "greywater" from laundries and bathrooms. This amounts to around 300 litres per household, per day, for transport, treatment and disposal via the sewerage system. This equals around 110 kilolitres annually per household and some 45 gigalitres per year for Perth.

Water shortages in Western Australia have resulted in the introduction of urban irrigation scheme water restrictions during summer, further resulting in a record increase in the number of domestic wells (not currently subject to restrictions) being drilled in the South West of the State. The use of groundwater for garden irrigation aids in the conservation of scheme water supplies, however, at the same time groundwater resources, particularly on the Coastal Plain on which Perth is located, are under considerable pressure from increasing use.

Domestic garden irrigation often constitutes a considerable proportion of the total urban scheme water demand. In Perth, landscape irrigation accounts for up to 55% of all scheme water used for domestic purposes (Coughlin and Higgs, 2000), this equates to around 500L daily per household (Water Corporation, 2002). Despite this considerable usage, there appears to be limited research undertaken on the use of alternative water sources for domestic irrigation.

A number of methods of reuse on a domestic scale are available. The method of reuse can depend upon the greywater output volume, but most importantly, upon the regulations and the performance criteria for treatment. Where reuse is carried out via irrigation, the specific method of irrigation is dependant upon the level of treatment of the greywater (Dept of Health, 2002).

The Draft Guidelines identify two levels of treatment of greywater for reuse. Where no treatment occurs, simple bucketing is permitted.

1. Primary treatment systems enable reuse of greywater that has been coarse screened in order to remove solid particles such as lint and hair.
2. Secondary treatment systems enable the reuse of greywater that has been treated to a level equivalent to that of secondary wastewater effluent (typically 20mg/L BOD_5, 30 mg/L SS and 10cfu thermotolerant coliforms/100mL).

The Draft Guidelines stipulate that a minimum of secondary treatment must occur for sub-surface irrigation via drip, due to the potential for blockages caused by solids and system faults. Further disinfection must take place if surface sprays are to be employed in an irrigation system. Unfortunately, only trench "irrigation" is permitted for reuse of primary treated effluent, though the effectiveness of a trench disposal field for plant irrigation is questionable.

Holistic Design for Greywater Reuse

Many concerns have been raised in relation to widespread implementation of greywater reuse without proper management or maintenance: reduced sewer flows, higher concentrations at treatment plants, public health risks, groundwater contamination, mosquito breeding in constructed wetlands, flooding during winter rainfall, sludge build-up and blockages. However, there is another issue for concern that may lead to some of these problems and others indirectly: poor design (or no design). Not just the design of the system itself but the manner by which the system is integrated into the landscape. The Draft Guidelines and AS 1547 do, for example, specify minimum setbacks from houses and lot boundaries, provide ways of avoiding inundation and give design criteria for terraced disposal fields on slopes.

There are very few practical design methodologies that may serve the case of placement of a greywater recycling system in the house yard or community landscape. Two examples are:
* *hydroscaping* (Colwill, 1996) for sustainable garden aesthetic design; and
* *permaculture* (Mollison, 1988) for sustainable food production system design.

Hydrozoning will allow the placement of the greywater system in accordance with a garden layout designed for aesthetics and plant groupings of similar water needs.

Permaculture draws on a wider range of design tools including *zoning* for energy efficiency and *sector analysis* of the natural elements affecting the site (sun, wind, fire, view). Zones 1 to 5 in permaculture refer to areas of planting types (intensive salad beds, low maintenance orchards, through to natural bushland) placed in relation to house or settlement according to frequency of visits. Design with sectors allows the appropriate placement of windbreaks, shade trees, water tanks, zones and other elements in the landscape.

The use of a design approach prior to installation enables placement of the greywater system in a landscape with respect to the vegetation type that it will support and its position in relation to other elements and natural influences on the site. If such considerations are ignored with a focus merely on the technical design of the system itself then improper management and maintenance and poor performance may still be the longer-term outcome.

Opportunities and Limitations

The greatest impact of greywater reuse is the water savings generated. Table 1 below gives figures for potential savings at differing levels of domestic implementation and reuse in the city of Perth, Western Australia. Although reuse volumes at the bottom end of the scale are low, the reuse effectively increases the water resources available in the State. Although the community may support reuse, system installation is likely to be limited by the financial implications for the householders. Initial capital outlay for installation of systems is likely to be the greatest barrier to implementing domestic greywater reuse, therefore householders need to be informed of the wide range of benefits including water savings and the subsequent reduction in household water service expenses.

Table 1: Potential Annual Water Savings in Perth, Western Australia

Proportion of Perth households undertaking Greywater reuse (%)	75% of greywater reused (gL)	100% of Greywater reused (gL)
5	1.7	2.3
10	3.4	4.5
20	6.8	9.0
50	16.9	22.5
95	33	43

Stuart Henry of the Master Plumbers Association believes that with substantial promotion and education, uptake of greywater reuse technologies could be of the magnitude to provide annual reuse volumes of up to 40GL.

The Draft Greywater Guidelines provide information on how to correctly calculate greywater output volumes, which determines system sizing and subsequent sizing of the irrigation area. A possible shortcoming of greywater reuse systems is their ability to provide sufficient water to irrigate a domestic garden (or part of). If effluent output is insufficient, due to low household use, a supplementary water source may be required. A balance must therefore be found between the expense of installing a dual system and the likely benefits. Conversely, in instances where land availability or irrigation opportunities are limited, greywater volumes may be too great, requiring diversion to sewers or alternative systems, another financial burden for the householder.

Diversion of excess greywater may also be required during the wet months of the year when plant water needs are provided by rainfall. Problems that may eventuate include 'drowning' of plants and waterlogging of soils, potentially resulting in ponding of water, further presenting health risks via human contact. One method of avoiding these problems is through the use of a soil moisture sensor that regulates irrigation scheduling.

Great potential exists for greywater reuse in arid regions. Contrary to the circumstances in urban areas, the cost of implementing greywater reuse schemes can be competitive with the cost of other water supply options especially when low yield or unsustainable sources are used. Plans have been made to construct greywater reuse trenches at Goodabinya, a remote Aboriginal community in Western Australia. The trenches, planted with fruit and native tree

species will employ evapo-transpiration to reuse the greywater while providing nutritional food and windbreaks (Salter, 2002, pers.comm.).

It can be seen that there exists a need for further research into integrating greywater treatment and irrigation systems. Systems are required that are capable of effective irrigation, while also protecting human and environmental health. Implementation of systems that are not able to fully satisfy those requirements create the risk that another water source could be wasted and confidence in the reuse of wastewater could be damaged.

The Way Forward

Due to the large expense involved in implementing domestic greywater reuse in existing homes, the future of reuse lies in encouraging the installation of systems in:
1) New private housing.
2) Retrofit programs (during house resale)
3) Public housing- State Government leading by example.

The provision of financial incentives by the State Government, to encourage use of sustainable water systems, would aid in reducing the financial burden on householders. This could be implemented through programs that target the first two sectors above. Indeed, one recommendation within the State Water Conservation Strategy (2002) is the use of a rebate scheme for efficiency projects that reduce demand on scheme water, such as wastewater reuse systems.

Employing command and control devices as a disincentive to those that continue to irrigate in an unsustainable manner, provide an option to help regulate water use. Similar to the water restrictions previously employed within the State, regulations on urban irrigation schedules could be implemented. An example of this can be found in the State Water Conservation Strategy (2002) with the development of 'minimum performance standards' for water use fixtures such as irrigation system, and penalties for irrigating during specific periods, for example, during winter and drought periods.

Most importantly, the need exists to promote domestic reuse through increasing public awareness through education programs, promotional opportunities exist in the creation of 'display homes' that employ reuse and allow public viewing. A shift in attitude needs to occur, specifically towards water use practices and the manner in which wastewater is perceived. Education further needs to address safety considerations and health requirements to ensure that reuse is carried out in a controlled environment.

CONCLUSION

Implementation of domestic greywater reuse via irrigation has great potential to contribute to water conservation in Western Australia. Greywater reuse can contribute to the sustainable development of the state through water conservation, reduced financial costs of water use and treatment and also by reducing the amount of wastewater going to centralised treatment plants and ocean outfalls.

The current water shortage crisis facing the State has created an opportune time to legislate to implement domestic wastewater reuse, with increasing need and public support. The Western Australian State Government is supportive of wastewater reuse schemes, as demonstrated in the progressive State Water Conservation Strategy and the State Water Recycling Forum, therefore it is likely that domestic greywater reuse will soon be legal.

Although support exists for domestic reuse, the ability of greywater to provide a source of water for effective irrigation is limited. A range of systems exist that can treat greywater to varying levels prior to disposal, however, a lack of research and experimentation has resulted in a limited range that are suited to domestic irrigation. To ensure that implementation does not weaken the existing position of reuse in the political arena and the wider community, research is required to aid in regulating system installation and reuse practices.

REFERENCES

Coghlan. P and Higgins. C. (2000) *Domestic Water Use Study*, 3rd International and Water Resources Symposium of the Institution of Engineers of Australia, 20 – 23 November, 2000, Sheraton Hotel, Perth Western Australia.

Colwill J (1996) *The Waterwise Garden and How to Create One*, Water Authority of WA, Perth.

Commonwealth Scientific and Industrial Research Organisation, (2001) *Climate Change Projections for Australia* Available World Wide Web: http://www.dar.csiro.au/publications/projections2001.pdf accessed 2/8/02

Cristova-Boal, C., Eden, B. and McFarlane, S. (1994) An Investigation into Greywater Reuse for Urban Residential Properties. In: Mathew, K. and Ho, G. (eds) *Workshop Papers on Localised Treatment and Recycling of Domestic Wastewater*, Murdoch University, Perth, Western Australia

Department of Health, Western Australia (2002) *Draft Guidelines for the Reuse of Greywater in Western Australia*, Perth, Western Australia

Lugg, R. (1994) Health Controls on Wastewater Reuse, in Mathew K & Ho G (eds), *Workshop on Localised Treatment and Recycling of Domestic Wastewater*, RADG, Murdoch University, Perth, Western Australia

Mathew K & Ho G (1993) *Reuse of Wastewater at Jigalong Aboriginal Community*, RADG, Murdoch University, Perth, Western Australia

Mollison, B. (1988) *Permaculture: A designer's manual*, Tagari Publications, Tyalgum.

Salter, R. 2002, Personal communication, 22 August

Standards Australia (2000) AS/NZS1547:2000 *Onsite Domestic Wastewater Management*

Stone, R. (1996) Water Efficiency Program for Perth, *Desalination*, **106**, 377 - 390.

Water and Rivers Commission (2000) *Western Australia Water Assessment 2000, Water Availability and Use*, Water and Rivers Commission Policy and Planning Division, Perth, Western Australia

Water and Rivers Commission (2002) *State Water Conservation Strategy, Draft*, Perth, Western Australia

Water Authority of Western Australia (1994) *Wastewater 2040 Discussion Paper*, WAWA, Perth, Western Australia

Water Corporation (2002) *Watermark* Information Brochure,