# DEVELOPMENTS IN DOMESTIC GREYWATER RECYCLING IN WESTERN AUSTRALIA

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## Abstract

Water is a key yet limited resource in Western Australia. Management of this valuable resource is not only an environmental issue, it has important economic and social implications. The smart use of water in Western Australia is an important issue to address with the State's population expected to increase to 2.9 million by 2030 with Perth's current population at 2.1 million. Paralleling this are predicted decreases in annual rainfall of up to 20% by 2030 and 60% by 2070 for the South-West of Western Australia, threatening the state's ability to provide a sustainable water source for its population.

The Western Australian Department of Health, after various trials, pressure from the general public and recommendations from several studies, prepared draft guidelines for domestic greywater recycling, with the guidelines release expected mid-2003.

The sustainable development of the State can benefit significantly through the promotion of water conservation strategies involving wastewater reuse. A wide range of environmental benefits can be obtained, in particular water conservation; however, benefits also extend to the economic and social spheres. Related industries, such as the plumbing industry, are likely to benefit from the use of plumber's skills in installation but also the design process and on-going maintenance and development of small-scale systems. The wider community benefits from increased environmental awareness and improvement in urban amenities.

This paper examines recent developments in domestic greywater recycling in Western Australia, including system innovations and recommendations for further progress.

## Keywords

greywater, wastewater recycling, water conservation

## 1 Introduction

Water is a key yet limited resource in Western Australia. Management of this valuable resource is not only a natural resource management and environmental issue, it is also an important economic issue and its management has significant social implications. The smart use of water in Western Australia is an important issue to address with the State's population expected to increase to 2.6 million by 2026 with Perth's population at 1.9 million (Western Australian Planning Commission, 1995). Paralleling this are predicted decreases in annual rainfall for the South-West of Western Australia (Commonwealth Scientific and Industrial Research Organisation, 2001), threatening the states ability to provide a sustainable water source for a majority of its population.

The sustainable development of the State can benefit significantly through the implementation of water conservation strategies involving wastewater reuse. A wide range of environmental benefits can be obtained, in particular water conservation, but adverse impacts related to wastewater can also be reduced. Benefits also extend to the economic and social spheres. Related industries, such as the plumbing industry, are likely to benefit from the use of plumber's skills in installation but also the design process and ongoing maintenance and development of small-scale systems. The wider community benefits from increased environmental awareness and improvement in urban amenities.

The Western Australian Department of Health developed *the Draft Guidelines for t*he reuse of Greywater in Western Australia (Department of Health 2002) which is awaiting final approval and public release. The release of the Draft Guidelines in early 2002 resulted in an upsurge in development of greywater technology innovations. This paper will briefly examine a number of technologies available to WA households for domestic greywater reuse. Recommendations for future initiatives to generate greater interest in greywater reuse are also made.

## 2 Background

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 consumption will continue to increase whilst climate change will reduce availability have 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 (Waters and Rivers Commission, 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).

Of the potable water supplied for domestic use in Perth, between twenty and forty percent is discharged as "greywater" from laundries and bathrooms respectively. This equates to around 300 litres per household per day, for transport, treatment and disposal via the sewerage system (Water Authority of Western Australia, 1995). This further 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 500 L per day per household (Water Corporation, 2002). Despite this considerable use, there is little research undertaken on the use of alternative water sources for domestic irrigation.

# 3 Draft Greywater Guidelines

Domestic greywater reuse, regulated under the Health Act 1911, 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 from 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 Department of Health Western Australia and the Water and Rivers Commission have developed the Draft Guidelines for the Reuse of Greywater in Western Australia (Department 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 AS/NZS1547:2000 "*Onsite Domestic Wastewater Management*".

The Draft Guidelines provide introductory information for the public including greywater characteristics, typical composition and volumes. The Guidelines then set out in detail:

1. Health and Safety Requirements;
2. Design and Performance Requirements;
3. Greywater System Options;
4. Greywater Irrigation Options;
5. Design Criteria;
6. Maintenance Requirements;
7. Process of System Approval

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 dependent upon the level of treatment of the greywater (Department of Health, 2002).

The Draft Guidelines identify two levels of treatment for greywater 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 TSS and >10 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.

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 of concern that may lead to some of these problems: poor design (or no design). This includes the manner by which the system is integrated into the landscape. The Draft Guidelines and AS/NZS 1547:2000 do, for example, specify minimum setbacks from houses and lot boundaries, provide ways of avoiding inundation and give design criteria for reuse via irrigation.

# 4 Systems Innovation

In Western Australia currently there exists a range of approved innovative systems that enable greater choice in system selection for householders. The range allows flexibility in system cost, maintenance requirements, treatment levels and effluent irrigation methods. The systems briefly examined below range from low maintenance inexpensive systems to higher maintenance tertiary treatment level systems.

## 4.1 Greywater Saver

The Greywater Saver can be employed either as a stand-alone primary treatment system, or as an initial filtration component for other treatment systems. The recommended reuse method for use following the Greywater Saver is a simple infiltration tench, however constructed wetlands or similar would also be suitable. The system consists of a diverter vessel, constructed from PVC, with a stainless steel mesh removable filter. The diverter vessel is connected to the external plumbing of a household (not suitable for in-pad plumbing, unless a raised pad) and diverts the filtered greywater to a irrigation trench, or a further treatment system. The system maintains the household connection to the reticulated sewer and has a diversion selector that enables greywater to go to the sewer if desired (e.g. during periods of high rainfall) and overflow protection (see http://www.greywatersaver.com).

## 4.2 Greymax

The Greymax has been developed to reuse greywater exclusively, thus reducing treatment requirements. An early system was installed at the Fremantle Inner City Agriculture Garden, an 800 $m^2$ community garden that employs the greywater from two adjacent houses to irrigate it. This is part of a water-sensitive, permaculture design approach which also involves harvesting rainwater from the two houses' roofs, heavy mulching and appropriate, low water use species selection for growing food in a perennial polyculture. Design and sizing of the system was in accordance with the current Standard (AS/NZS 1547:2000) but flow monitoring and resident behaviour to date indicate the system is over-sized.

Greywater from the two houses enters a collection tank in the park under gravity. The duty field is a variation of the 'Ecomax' principle (Bowman, 1996) comprising two laterals of 20 m x 1.2 m and 25 m x 1.2 m wide. The plastic lined trenches are filled with a mix of 85% red sand and 15% red mud (with 5% gypsum in the latter to neutralise its alkalinity). The red mud and sand are by-products of bauxite refining to alumina. Phosphorus is adsorbed into this clay material and nitrogen is removed from the system by intermittent drying and wetting causing nitrification-denitrification. Pathogens are filtered and die-off. The field is heavily vegetated causing significant nutrient uptake and transpiration.

### 4.3 Galvins Greywater 1200 & 1800

Galvins Concrete and Sheetmetal, a group that has produced septic tanks for a number of years now produces a range of wastewater treatment systems. The Greywater 1200 is a simple sedimentation chamber divided by a baffle, with a pump in the second chamber for effluent reuse via a simple disposal trench. The larger capacity 1800 unit has been designed to provide the ability to treat all greywater (i.e. kitchen, laundry and bathroom) greywater, due to the greater retention time of wastewater in the initial chamber. Both systems also have a sewer diversion capability and a built-in emergency sewer diversion outlet. The Environmental Technology Centre has plans to install the smaller unit to receive greywater from an ablutions block late in 2003.

### 4.4 Biomax

In Cottesloe, Western Australia, a sewered suburb, a greywater reuse system that utilises the Biomax aerobic treatment unit was approved and installed in May 1996. The Biomax unit is a locally produced unit that is generally employed for tertiary level treatment of all household wastewater for landscape irrigation. The greywater unit has had additional baffles installed in the anaerobic and aerobic chambers to enable more effective treatment of the lower biomass effluent input. The effluent is irrigated to the front and back yards via 'Dripmaster' subsurface tubing. Further research is being conducted at the Environmental Technology Centre in using this effluent for “aquaponics”, the reuse of effluent via hydroponic horticulture.

## 5 Future Initiatives

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 (Waters and Rivers Commission 2002), is the use of a rebate scheme for efficiency projects that reduce demand on scheme water, such as wastewater reuse systems.

Most importantly, the need exists to promote domestic greywater 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. Currently, there are few avenues available to the public to find out more about greywater reuse practices. The Environmental Technology Centre runs workshops for the public to help in interpreting the State regulatory documents and further support through practical demonstration of appropriate technologies.

Effective community promotion and uptake of greywater reuse will occur through comprehensive demonstration programs. Implementation of greywater reuse as part of an Integrated Urban Water Management (IUWM) demonstration program is the key. The elements of an IUWM program will include: water sensitive urban design (localized

stormwater management), water efficient irrigation systems, water saving and native garden designs, household greywater recycling systems, neighbourhood scale wastewater recycling systems. Economic support from government will be necessary to initiate the program. The participation of industry associations, the private sector and community groups will be vital. Such a program needs be implemented across a whole block or neighbourhood so the longer-term synergistic effects of water conservation can be understood. It will also be possible then to examine localized water and nutrient balance, soil quality, public health and equipment maintenance issues. In Perth, there are numerous sites where a development of this scale can occur. Developers of South Beach Village in Fremantle and Harvest Lakes in Atwell South have integrated sustainable construction and technologies into their planning and have expressed interest in employing domestic greywater reuse systems.

For South Beach Village consultants have prepared an Integrated Urban Water Management plan for the developers (Anda et al, 2003). In this plan several options for greywater recycling are given, including household Greymax systems (approx $2000/house for irrigation of part of the house yard), with the recommended option a centralised collection, treatment and distribution system. This system equates to approximately $1000/house for the 500 dwellings and irrigates all Public open spaces, businesses and front yards. The treatment recommended is settling or coarse filters, followed by sand filtration and constructed wetland. At Harvest Lakes the developer has only suggested that householders be encouraged to take up onsite greywater recycling with no support from the developer.

# 6 Conclusion

Although support exists for domestic reuse, the ability of greywater to provide an effective alternative source of water is limited by the expected uptake of reuse technologies, therefore promotion within the community is required. 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 effective domestic reuse. 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.

Implementation of comprehensive demonstration programs will improve the effectiveness of community promotion and uptake of domestic greywater reuse. Implementation of greywater reuse as part of an IUWM demonstration program is the key. These will need to be done alongside the development of a new policy framework that can enable the continued and widespread implementation of IUWM.

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, it is therefore likely that domestic greywater reuse will soon be officially permitted.

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