ON-SITE GREYWATER REUSE

Noelene O'Keefe

Environment Protection Authority Victoria

Abstract

Currently in Australia there is a variety of on-site greywater reuse schemes and individual practices that vary quite significantly. These range from direct diversion apparatuses to wastewater treatment systems that are reported to achieve high quality water suitable for a wide range of potential uses. As Victoria is currently experiencing increasing pressure on its finite water resources, a corresponding increase in interest has occurred in water conservation. This in turn is currently resulting in a sharp increase in the public and professional interest in on-site greywater reuse.

A review of the various state regulatory authorities requirements has been undertaken which shows that there is a range of on-site greywater reuse controls that are currently in place. The review shows that all authorities are concerned with managing the environmentally safe reuse of on-site greywater in a long-term sustainable manner.

A nationally consistent approach with mutually acceptable greywater reuse programs would have benefits for the on-site wastewater treatment industry, the regulatory authorities, and the final owner of the greywater treatment system. Uniform expectations would assist in ensuring environmentally safe treatment and sustainable reuse of the treated greywater.

This is something to aim for.

Keywords

Greywater, greywater legislative controls and guidelines, fit for purpose, on-site wastewater treatment

1 Introduction

1.1 On-site Greywater Regulation

In recent times, State, Territory and Local Government controls for the management of greywater have come under much scrutiny. From the emphasis of last century to maintain public health and environmental standards by directing all wastewater to sewage or septic tank systems, there is currently emerging a new management regime to reuse a portion of what has in the past been referred to as "sullage".

"Sullage" which typically consists of all domestic wastewater with the exception of toilet / urinal wastewater is now being commonly referred to as "greywater". As water is becoming an increasingly valued commodity, much interest is being shown in the possibilities of reusing, where appropriate, greywater in a "fit for purpose regime".

Greywater legislation and guidelines have been developed or are currently under review in most Australian jurisdictions. This work has been initiated to provide direction for ensuring that the new interest in reusing greywater is managed in a public health and environmental safe long-term sustainable manner.

The National On-site Regulators Forum (NORF) which consists of a legislative representative from each State or Territory Regulator, is currently examining greywater reuse options with the objective to produce a monograph of on-site water reuse objectives for the use by all Regulators in Australia. The aim of this monograph is to encourage consistency in the management strategies for on-site water reuse wherever practically possible.

Domestic greywater is currently considered to be a potentially valuable resource. Greywater reuse on-site for garden and lawn watering, toilet flushing and laundry use depending of the type of greywater and its level of treatment and management has the potential to reduce the demand on high quality water more suited for drinking and other domestic purposes.

However, before proclaiming the proposal that greywater reuse can simply solve our potable water shortage problems, it would be prudent to examine the public health and environmental potential hazards associated with on-site greywater reuse.

2 Characteristics of Greywater

The composition of greywater depends on sources and installations from where the water is drawn. The quality of the greywater can also be expected to vary with the habits and lifestyle of the residents producing the greywater (Gerba, et al. 1995).

Characteristics of greywater can also depend on the quality of the water supply and the type of distribution net for drinking water and the greywater (leaching from piping, chemical and biological processes in the biofilm on the piping walls).

2.1 **Chemical**

Chemicals present in greywater originate from household chemicals, cooking, washing and the piping. Eriksson (2002) states that greywater in general contains lower levels of organic matter and nutrients compared to ordinary wastewater, since urine, faeces and toilet paper are not included. Chemicals that have the potential to occur in greywater include heavy metals, pharmaceuticals as well as organic chemicals such as herbicides, pesticides, polychlorinated biphenyls, chlorinated phenols, chlorinated hydrocarbons, halogenated and non-halogenated aromatics.

2.2 **Physical**

Physical parameters of relevance are temperature, colour, turbidity and content of suspended solids. Greywater often has high temperatures, which may be unfavourable since they favour microbial growth and could induce precipitation in super saturated waters (eg. calcite) (Eriksson, *et al*. 2002). Sources of solid material in greywater include food particles and raw animal fluids from kitchen sinks and soil particles, hair and fibres from laundry wastewater. Analysis of colour and measurement of turbidity can sometimes give information about the content of particles and colloids within the greywater.

2.3 By-products and Degradation Products

By-products can be formed when different chemicals react with each other in the greywater (Eriksson, *et al*. 2002). Oxidation and microbiological activity may also lead to production of degradation products that have other properties than their parent compounds. Eriksson refers to an example where the presence of chloro-containing powder detergents in machine dishwashers was found to increase the content of absorbable organic halogens.

2.4 Micro-Organisms

There are numerous enteric microbial diseases that can be transmitted by greywater (Asano, 1998). Pathogenic viruses, bacteria, protozoa and helminths escape from the body of infected persons in their excreta and may be passed onto others via exposure to wastewater. These microorganisms can be introduced to greywater by hand washing after toilet use, washing of babies and small children connected with diaper changes and dish washing. Enteric organisms may also be present on raw foods such as chickens and vegetables (Rose *et al*., 1991).

Noah (2002) advises that if a communicable disease (eg. flu, hepatitis, measles) is diagnosed within the household, greywater irrigation should be discontinued by diversion of all waste into the blackwater system until the affected person has completely recovered. A diversion capability in case of system failure is also recommended.

3 Environmental and Health Risks

Potential management issues related to greywater reuse include both environmental and health issues. These issues include:

- hydrodynamics of an area (surface and groundwater protection);
- irrigation management (treatment level, winter storages);
- nutrient management (soil quality);
- food quality (stress related, pathogenic contaminants);
- short and long term effects of greywater on soils (salinity, sodicity, phosphorus and structure); and off site impact.
- human and animal health;
- system failure; and
- scheduling and maintenance (biological solids).

3.1 Environmental

The use of greywater poses a number of potential environmental risks. Contaminants in greywater may accumulate in the environment where they can cause unacceptable damage to soil, surface water and/or groundwater. Environmental sustainability should be a major criterion when developing any policy on the use of greywater or reclaimed wastewater.

DPI Queensland states that for sustainable reuse of greywater there should be adequate irrigation area so that there is no on-site water logging, no run-off of potentially contaminated water and no unwanted ecological effects on the surrounding land. Sustainable recycling of greywater occurs when it is applied to meet plant requirements and there is a negligible discharge to the environment.

Inappropriate reuse of greywater or ineffective irrigation regimes will result in the migration of greywater off premises to stormwater drainage, to intermittent natural streams and to groundwater (NSW Health, 2000). Greywater reuse has the potential to significantly alter the hydrodynamics of an area if not managed effectively. Transportation of nutrients off-site into surface waters can cause 'eutrophication' of waterways and severe impact on the ecology of those environments.

Over application of greywater has the potential to cause a rise in the groundwater table. If saturated soil conditions persist within 1-1.5 metres of the surface, salts present in the groundwater tend to accumulate in the topsoil as water evaporates from the surface and is extracted from the soil by plants (EPA Victoria Publication 168).

Amenity issues (including aesthetic and health) associated with soil saturation and ponding of greywater include odour problems, mosquito breeding, rodent attraction, the development of unsightly areas of grey/green slime and in some cases the deterioration of building foundations (EPA Victoria Publication 812).

Suspended solids and colloidal matter within greywater can induce not only the clogging of installations such as the piping used for transportation or sand filters used for treatment but also the of soils.

Effects from infiltrating greywater on soil pH and buffering capacity will be determined by the alkalinity, hardness and pH of the infiltrating water.

Table 1: Summary of environmental risks associated with greywater reuse

Adapted from EPA Victoria, Department of Health WA, Queensland Government Publications, and Eriksson and Al-Jayoussi

Environmental Issue	**Impact**
Exceed the hydraulic loading of land application system with water	cause ponding and stagnation of greywater migration of greywater off-site pollution of stormwater drains and surface water systems raise water table, cause odours
Raise water table	affect foundation of houses cause soil to become permanently boggy affect vegetation growth cause odours
Overload the land application systems with nutrients	alter the soil cation exchange capacity alter the soil phosphorus sorption capacity alter the soil dispersiveness affect vegetation growth
Alteration of soil characteristics	alter soil salinity, pH, sodicity and electrical conductivity alter soil structure and dispersiveness affect the properties of the soil to assimilate nutrients or water, affect vegetation growth
Disposal of screenings and filter waste	affect growth of root vegetables
Disposal of sludge	alter soil characteristics affect vegetation growth cause odours

3.2 Health

Exposure - A number of exposure paths to humans and the environment exist, including:

- direct contact during use;
- consumption of irrigated foods;
- wetting by irrigation spray;
- contact with irrigated grass;
- contact with ponded water;
- contamination of BBQs, drinking fountains, playground equipment etc.; and
- off-site spray drift.

Exposure to these risks can be reduced by using appropriate irrigation methods and systems.

Table 2: Summary of microbial risks associated with greywater reuse

adapted from Mahin and Pancorbo, Baker and Hegarty and Froese and Bodo (1999)

Bacteria	**Illness**	**Dose**
Vibrio cholerae	cholera	moderate
Salmonella typhi	typhoid	high
Enteropath *E.coli*	enteric	high
Campylobacter	enteric	high
Shigella	dysentery	high
3.3 Viruses		
Enteroviruses	enteric meningitis	low
Adenovirus	enteric respiratory	low
Reovirus (inc rotavirus)	enteric	low
Norwark virus	enteric	low
Hepatitis A	hepatitis	low
3.4 Protozoa		
Giardia	enteric	low
Cryptosporidium	enteric	low
Entamoeba histolytica	dysentery	low
3.5 Helminths		
Ascaris lumbricoides (roundworm)	enteric	low
Trichuris trichuria (whipworm)	enteric	low
Ancylostoma duodenale	enteric	low
Necator americanus *(hookworms)*	enteric	low
Taenia saginata	beef measles	low

4 Advantages of Domestic On-site Greywater Systems

4.1 Advantages include:

- Reduced the demand on the potable water supply
- Preservation of drinking water as a resource
- Recovery of otherwise lost nutrients beneficial for plant growth
- Reduced impact on existing sewerage schemes
- Reduced discharge and associated effects from existing sewerage schemes
- Lower water and sewerage bills
- Increased service life and improved performance of the existing treatment system through the reduction of the hydraulic load and less energy and chemical use.

5 Disadvantages of On-site Greywater Systems

5.1 Disadvantages include:

- Potential for spreading disease through human contact if greywater is not properly managed. Greywater can undergo significant change when stored even for short periods. Under warm storage conditions there can be a several fold increase of microorganisms in greywater.
- Potential environmental impacts due to the many pollutants greywater may contain, such as particles of dirt, lint, food, human waste products and other cleaning agents

- Off-site discharges. For example saturating the soil could cause wastewater to discharge at the surface and run off into a neighbouring property. The greywater may find its way into stormwater drains, rivers or streams, contributing to the pollution loads in these environments.
- Damage to the soil caused by long-term use (potential for salt build up in certain soils etc.)
- Potential hydraulic overloading of some sites could lead to land instability or landslip.

6 Conclusion

There is a range of opportunities to reuse greywater for "fit for purpose uses" if managed correctly in domestic situations. The presenting challenge is to develop a suitable and effective management and administrative system for the environmental and public health safe reuse of household greywater. To effectively manage wastewater it is essential that water conservation is practised. While regulation, auditing and enforcement would be paramount in obtaining compliance with the performance objectives, education is also important to ensure that stakeholders understand the significance of the benefits and hazards associated with greywater reuse. All stakeholders, including system manufacturers, regulators and service providers should consider developing appropriate education and training programs to encourage the safe sustainable reuse of this potentially valuable resource.

References

EPA Victoria Domestic Wastewater Management Series Reuse Options for Household Wastewater, Publication 812

EPA Victoria Domestic Wastewater Management Series Land Capability Assessment for On-site Domestic Wastewater Management, Publication 746.1;

EPA Victoria Guidelines for Wastewater Irrigation, Publication 168.

Eriksson, E., et al. 2002. *Characteristics of grey wastewater*, Urban Water 4. pp 85-104.

Froese, K. and Bodo, K., 1999. *Health Effects Associated with Wastewater Treatment, Disposal, and Reuse*. Water Environment Research. Vol. 71, No. 5, pp 1119-1126.

Gerba, C., et al. 1995. *Water Quality Study of Graywater Treatment Systems* Water Resources Bulletin – American Water Resources Association. Vol. 31, No.1, pp 109-116.

Noah, M. 2002. *Graywater Use Still a Gray Area*. Journal of Environmental Health. Vol. 64, Iss. 10, pp 22-25.

Rose, J., et al. 1991. *Microbial Quality and Persistence of Enteric Pathogens in Greywater from Various Household Sources*, Water Resources. Vol. 25, pp 37-42.

Stevens, D., et al. 2000. *Agronomic Issues When Using Reclaimed Water: The Northern Adelaide Plains Experience*, Water Recycling Australia, pp 55-60.

Thomas, K., et al. 2000. *Residential Water Recycling: Quantity and Quality Aspects,* Water Recycling Australia, pp 55-60.

Table 3: Review of Australian States & Territories Controls for Greywater Reuse

Jurisdiction	Vic	NSW	Qld	Tas	SA	WA
Direct diversion to garden of untreated greywater regulated	No	Yes	Yes	Yes	Yes (Policy)	No To be regulated
Direct diversion to garden of untreated greywater permitted	Yes	Yes	Not in sewered areas	Yes	No (Policy)	No To be regulated
Direct diversion to garden of coarse filtered greywater controlled	Yes	No	Yes, in sewered areas	Yes	Yes	Yes
Quality of treated greywater permitted for surface irrigation	20/30/10	20/30/10	20/30/10 Only in unsewered areas	20/30/10 Only in unsewered areas	20/30/10	20/30/10
Quality of treated greywater permitted for subsurface irrigation	20/30 for treated wastewater	No regulated quality	No regulated quality for diversion systems in unsewered areas	20/30 in unsewered areas	Primary	Primary
Regulated quality of treated greywater permitted for trenches	No	No	Primary	Primary	Primary	Primary
Internal reuse of untreated greywater permitted for toilet flushing regulated	Not regulated	Yes	Not regulated	No	Yes Class A	Not regulated
Internal reuse of treated greywater for toilet flushing regulated	Not regulated	Yes	Not regulated	Not regulated	Yes Class A	Not regulated

20/30 refers to 20 mg/L Five day Biochemical oxygen demand, 30 mg/L total suspended solids, 10 *E.coli* is 10 colony forming units per 100 mL