Greywater Reuse: A Sustainable Alternative Water Resource

by Ir. Ellias bin Saidin

INTRODUCTION

Sewage generated in a household may be separated into greywater and blackwater discharges. Greywater is commonly defined as wastewater discharged from laundry, baths, hand basins and (cleaned) dishwashing machines. It excludes discharges from the kitchen, toilets, urinal and bidet (NSW Guidelines, 2008).

The term greywater is used as the wastewater generated is cloudy and the colour compared to white water (clear freshwater) and black water (soiled wastewater from sewage). This water contains nutrients from detergent, soap and organic matter (which is suitable for irrigation of grass, plants and selected vegetables).

The WHO recognises that the utilisation of greywater contributes to less pressure on water resource, reduces health risks of downstream communities, helps to improve environmental health and reduces environmental impacts downstream (WHO Guidelines 2006). In developed communities, the reuse of greywater is part of the practice of Integrated Water Management practices which results in water conservation and reduces impact on the water environment downstream such as flooding, erosion, water quality as well as reduces the cost of providing urban drainage infrastructure.

At present, many local authorities and health department in various countries have given due recognition to the reuse of greywater within the households. Greywater utilisation systems can be installed in homes by complying with guidelines and regulations issued by the authorities.

In Europe, Australia and USA, where the International Plumbing Code is adopted, greywater from showers, bathtubs and hands basins used for toilet flushing contributes to over 30% of domestic demand for water. (Chap 13, International Plumbing Code).

The city of Malibu in California passed a law in 1994 on the standard of greywater systems installed in homes. However it was also reported that in 1992, 8% of beachfront homes and 33% of inland homes were already using some form of greywater systems.

In 2001, the Arizona Department of Environmental Quality issued guidelines and permitted the use of greywater in a residential property generating less than 400 gallons per day, for subsurface irrigation within the premises. The water table has to be a minimum of 1.5m (5ft) below the ground surface, and discharged at 1.2m from building foundations, with the soil being sufficiently permeable without percolation on the surface (Val L Little, 2001).

States in Australia regularly update their guidelines on the installation of greywater systems in the home to be carried out by licensed plumbers and issue certificates of approval for greywater systems. Grants are offered to homes in Australia installed with greywater systems. The government of Cyprus offers subsidies of up to €1700 for the use of greywater in a home.

In Tokyo, greywater reuse is mandatory for buildings >30,000 m^2 or with potential non-potable demand of more than 100m^3/day. (Environment Agency, 2008).

Japanese Cascading Toilet Bowl

Health safety concerns on the reuse of greywater in residential homes are minimal as pathogens are usually killed after being placed in the soil. Pathogens are not spread to others as atmospheric spraying is not permitted (spraying will generate droplets in the air which can be transported to neighbouring premises).

Family members are not at high risk even if they come in contact with these water-borne pathogens as, within the home itself, cross contamination will already occur through bodily contact and other means of contact.

An agricultural concern is the high concentration of salts in greywater, especially sodium in detergents which may inhibit seed germination and break down the clay molecules in soil.

QUALITY OF GREYWATER

The NSW Guidelines conveniently identifies two greywater streams – bathroom greywater and laundry greywater. Bathroom greywater contains soap but in very low concentrations which lets water move more easily around the soil particles. Also, dead skin cells and other body waste from sweat and other organs contain nitrates and minerals which turn into nutrients for plants.

On the other hand, although laundry greywater is easier to collect and use, it is usually contaminated with faecal pathogens from soiled clothing. Laundry water contains phosphates and human organic matter for healthy plant growth.

The quality of greywater is highly dependent on the detergents, soaps and household practices. A typical composition of greywater from a Western Australia home is reproduced (see page 15) from West Australia Water Corporation Draft Guidelines 2002.

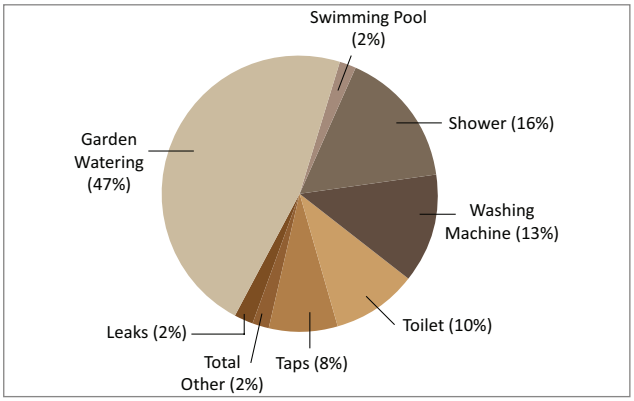
Table 1: Typical Composition of Greywater compared with Raw Sewage

Parameter		Greywater[a]		
		Range	Mean	
Suspended Solids	mg/L	45 – 330	115	100 – 500
Turbidity	NTU	22 – >200	100	NA
BOD_5	mg/L	90 – 290	160	100 – 500
Nitrite	mg/L	<0.1 – 0.8	0.3	1 – 10
Ammonia	mg/L	<1.0 – 25.4	5.3	10 – 30
Total Kjeldahl Nitrogen	mg/L	2.1 – 31.5	12	20 – 80
Total Phosphorous	mg/L	0.6 – 27.3	8	5 – 30
Sulphate	mg/L	7.9 – 110	35	25 – 100
pH		6.6 – 8.7	7.5	6.5 – 8.5
Conductivity	mS/cm	325 – 1140	600	300 – 800
Hardness (Ca & Mg)	mg/L	15 – 55	45	200 – 700
Sodium	mg/L	29 – 230	70	70 – 300

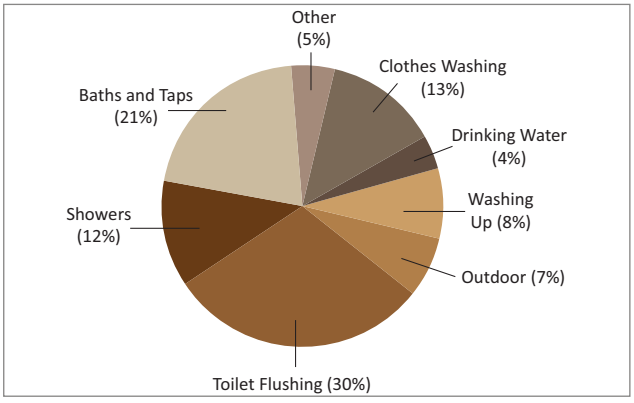
[a] Based on Jeppersen and Solley (1994)
NA = Not Applicable

HOUSEHOLD GREYWATER QUANTITY

The amount of greywater available for reuse in a household may be estimated from the daily household consumption. The charts below show the consumption for a typical home in WA, Australia and Malaysia.



Source: Western Australia Water Corporation (2002)



Water used in Malaysian home
(Source: Bulletin JKR & Alam Sekitar (2006))

The figures indicate that 29% (WA) and 46% (Malaysia) of domestic water consumption may be safely reused without treatment, with up to 40% and 70% respectively available for reuse after basic treatment. It is noted that in WA, where garden watering constitutes 47% of daily water demand, the reuse of greywater is most encouraging to reduce water demand in the home.

GREYWATER REUSE SYSTEMS

Greywater systems range in complexity from direct reuse with no treatment or basic physical and chemical treatment to more complex biological and bio-mechanical treatment which will allow for longer storage periods. The more complex systems are applicable for high consumption and large population conditions and, in the UK, have been reported to be quite unreliable in terms of odour and water quality (UK, Environment Agency; 2008).

In Australia, the NSW Government permits the reuse of household greywater in three categories. The first is where untreated greywater is diverted through pipes for use in lawn subsurface irrigation within the premises. The second is where greywater is partially treated for reuse in toilets and for laundry and open irrigation. The third is where the greywater is manually transported in buckets (NSW Guidelines 2008).

A greywater reuse system comprises the source, piping and conveyance, surge or balancing tanks, filters, pump and delivery piping system. A separate sanitary plumbing system has to be installed to separate greywater from wastewater discharge in a home. Some allowance for chlorine treatment may be necessary.

Components in greywater drip irrigation system
(Source: http://www.platypusenviro.com.au)

The amount of water to be used shall be balanced against the demand requirements of the lawn, vegetables or other user demand. The surge tank should not store the greywater for more than 24 hours to avoid odour and microbial problems unless chemical and/or microbial treatment is provided. The pumping flow rate needs to be matched with the infiltration capacity of the soil with the water being preferably fed through subsurface drip piping systems which feed directly the roots of the plant.

The water shall not be sprayed or otherwise applied so as not to form airborne aerosols. Overflows and bypass systems must be installed for the greywater to overflow into the municipal wastewater system when there is excess or during heavy rainfall.

Under the NSW Code of Practice, 2006, greywater discharges from the laundry and bathroom may be reused through Greywater Diversion Devices (GDDs) without any treatment process. However for kitchen greywater, a Greywater Treatment System (GTS) must be installed before the water can be reused, either for toilet flushing, laundry and surface and/or sub-surface irrigation outdoors.

It is better to install the greywater system during construction as retro fitting is costly and with long investment return periods. Although communal systems may be more reliable in terms of matching supply/demand and water quality, public perception and acceptability has to be overcome.

STUDIES OF GREYWATER REUSE

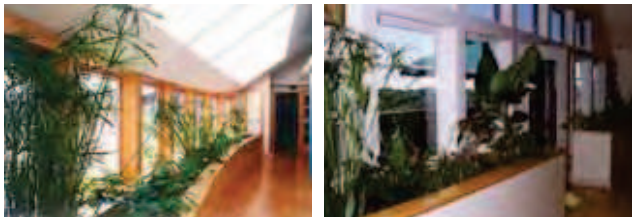
Texas A&MEl Paso Research Center studied the effects of using greywater (laundry water) discharged from a prison (3,500gpd) on vegetable and cotton crop plots in an arid area receiving less than 250mm of rain. It concluded that greywater was a good alternative source for irrigation and landscaping.

Mature cotton plants
Photo: Texas A&M University

Young tomato plants
Photo: Texas A&M University

The Water Environment Research Foundation, USA, carried out a study which concluded that there was no apparent long-term effect on landscape irrigation using household greywater and that the soil microbes seemed to benefit from the nutrients. However, subsurface irrigation was recommended to reduce pathogenically contamination (WERF;11/2007)).

Households in US have reused greywater by feeding it through sandy flower beds in sunlit indoor areas as shown below.



Household indoor greywater reuse with sub-surface bed irrigation
(Source: http://www.greywater.com/samples.htm)

CONCLUSION

The practice of greywater reuse has to be driven by government incentives and regulations. The practice will prove more economical as the cost of water is ever increasing. Public awareness of sustainability practices to conserve resources and to save the environment will result in more turning to the practice of greywater reuse.

In homes, greywater reuse addresses the issue of water conservation, particularly in water stressed areas, and broadly addresses the sustainability of an alternative water resource for the household where the water is utilised at the source generated.

The areas of concern in reusing greywater are potential health threats and the adverse effect on plants and soil biochemistry. With good practices being implemented through issued rules and guidelines from the authorities, the above concerns may be mitigated. ■

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Ir. Ellias bin Saidin is the Advisor, Water Resources Technical Division and he is also IEM Council Member for Session 2013/2014. He is a Principal at Perunding Ikatan.

ANNOUNCEMENT

We are pleased to announce that the **IEM 55th Annual Dinner and Awards Night 2014** will be held on **19 April 2014** (Saturday) at the Imperial Ballroom, One World Hotel, Bandar Utama, Petaling Jaya.

More details will be announced soon.

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