Advancing Perth's Eastern Region

Reuse of Greywater in Western Australia

Discussion Paper
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Table of Contents

1. Introduction

1.1. Background

Greywater is referred to as the household waste water that results from people using fresh/clean (typically scheme) water for their daily household activities such as showering, washing clothes, brushing teeth, washing dishes and other activities that result in water going down the ‘drain’. Waste water coming from the kitchen sink or a dish washer appliance is regarded as greywater, however due to the high content of oils, fats and detergents, this water can not be reused through the Greywater Diversion Device (COP, 2010). Kitchen greywater needs to be treated before being used on the garden and because of this it is often exempt from the greywater reuse systems. Waste water coming from toilets and urinals is known as blackwater and unlike greywater it is regarded as unfit for recycling on a localised scale (COP, 2010).

According to the Department of Health (DoH, 2010), there are two types of Greywater Reuse Systems: the Greywater Diversion Device (GDD) and the Greywater Treatment System (GTS), and both have to be approved prior to installation. Two types of GDDs exist; the Gravity GDD, and the Pump GDD. The Gravity GDD as the name suggests relies on gravity and has a manual switch or a valve fitted to the outlet of the waste pipe such as laundry sink, and the greywater is directly diverted to a sub-surface garden irrigation system. The Pump GDD incorporates a surge tank to accommodate sudden surges of greywater and a pump to distribute the collected greywater to the sub-surface garden irrigation system. The surge tank does not act as a storage tank (DoH, 2010). For a simplified schematic of greywater reuse through a diversion valve including a surge tank see Appendix Figure 2.

The GTS is different to GDD as it collects and treats greywater to a higher quality, which incorporates the disinfection of greywater, which in turn means that it can be used for surface irrigation, toilet flushing and possibly for cold-water in washing machines. The Department of Health (2010), advises that conditions of approval may vary, depending on the design, size, not excepting kitchen flows and with some systems not being permitted in unsewered areas. For schematics of GTS’s see Appendix Figure 3, Figure 4, and Figure 6.

A number of different greywater reuse systems exist on the market, and in order to help choose an appropriate system the Department of Health (2010) has created a list of Approved Greywater Reuse Systems including the brand, model, date approved, Watermark Licence number and the manufacturer. The list can be found on the following web page: (http://www.public.health.wa.gov.au/3/667/2/greywater_.pm) under the name “List of Approved Greywater Systems (PDF 100KB)”.

Besides greywater reuse, another method of reusing wastewater is through recycling. Wastewater recycling is often confused with greywater reuse or the two terms are used interchangeably. Greywater as mentioned earlier is particular type of wastewater, it is the water that in its original state (coming out of the source) is relatively “clean” and not containing either black or yellow water. Wastewater recycling on the other hand does include either or both black and yellow water, and for that reason is treated differently and to a higher degree. Wastewater recycling can also include stormwater.

Most greywater reuse systems are installed to residential households and are made more attractive through state government rebates. There are not many examples of use in Local Government as there are no incentives and scheme water is relatively inexpensive. Due to the increasing pressures on water sources and the cost of scheme water expected to rise, the need for alternative sources and increased conservation and efficiency is growing.

Besides the options for localised/decentralised and individual wastewater recycling and greywater reuse, another way to ensure the long term sustainability of our water resources is through large scale centralised wastewater recycling. Instead of pumping partially treated wastewater out into the ocean, State Government is supporting a trial of further treating the wastewater and improving its quality through managed aquifer recharge (CSIRO, 2010).

1.2. Reasons for Reuse of Water

Australia being the driest inhabited continent on the Earth has always had a limited supply of fresh water. Recently this problem has been receiving more attention due to a number of reasons, including Australia's population growth and changes in weather patterns as a result of climate change. Australia's population has increased rapidly in recent years with an even sharper population growth predicted for the future. All states and territories experienced increased population growth over the 12 months ended 30 June 2010, with Western Australia recording the largest percentage gain of 2.2% (ABS, 2011). Based on the Australian Bureau of Statistics information (ABS, 2011), "Australia's estimated resident population (ERP) at 30 June 2007 of 21 million people is projected to increase to between 30.9 and 42.5 million people by 2056, and to between 33.7 and 62.2 million people by 2101".

As a result of climate change different parts of Australia have experienced changes in local and regional weather patterns. In particular the South West of WA has experienced a decrease in average annual rainfall of 15% since the 1960s accompanied by an increase in the number of sunny days, resulting in increased evaporation (CSIRO, 2007). Decreasing rainfall resulting in decreasing water supply, and increasing population resulting in increasing water demand, means that efforts and actions to increase water use efficiency and water conservation are needed more than ever before. Greywater reuse and wastewater recycling are some of the actions that can aid in improving water efficiency and water conservation.

The State Water Recycling Strategy (DoW, 2008), and Water Corporation's Water Forever Strategy (Water Corporation, 2009) have been developed in recent years to deal with the above mentioned water associated issues. The State Water Recycling Strategy (DoW, 2008) has been designed to outline initiatives that would help increase recycling of wastewater, and has set a target of recycling 30 % of WA wastewater by 2030. Achieving this goal has to be both sustainable and accepted by the community.

Water Corporation's Water Forever Strategy (Water Corporation, 2009) has also developed targets, initiatives and options to manage WA water demand and supply. The following targets are to be reached by 2060, and they include:

- reducing water use by 25%;
- increasing wastewater recycling to 60%; and
- developing new sources.

2. Guidelines, Legislation and Practice

In order to help alleviate the unsustainable demands for potable water, recycling of water is increasingly being incorporated into Australian policy framework and guidelines development.

2.1. Code of Practice for Reuse of Greywater in Western Australia 2010

(The "Code of Practice for the Use of Greywater in WA 2010", has been endorsed by the by the Executive Director Public Health in accordance with Section 344A (2) of the Health Act 1911).

The Code sets the minimum requirements for the reuse of greywater in sewered areas of Western Australia on:

- Single residential domestic premises
- Multiple dwellings producing up to 5000 L/day of greywater
- Commercial premises reusing up to 5000 L/day

The Code provides information about greywater composition and the health and environmental risks of using greywater as well as setting out the minimum requirements for each of the greywater reuse options.

The Code provides details on greywater volume calculations, land application and installation requirements. Local Government is responsible for the approval of all greywater reuse systems used in single dwellings. For multi-dwelling and commercial premises, this code defines the responsible agency (i.e. local government or the Department of Health, Western Australia) that will approve the greywater reuse system based on treatment method, proposed end use and estimation of volumes of greywater produced (COP, 2010).

2.2. Draft Guidelines for the Use of Recycled Water in Western Australia April 2009

These guidelines are designed to cover the non-potable uses of recycled water in Western Australia. The water sources covered include greywater, industrial wastewater and sewerage (yellow water and black water). 'Code of Practice for Reuse of Greywater in Western Australia 2010' refers to the Draft Guidelines for the information regarding greywater reuse in unsewered areas of Western Australia.

Besides the guidelines dealing primarily with recycling municipal wastewater in treatment plants and recycling of some industrial wastewater, they also include individual commercial premises that may generate large wastewater flows (i.e. hotels, motels, mining camps, schools, caravan parks etc) (DoH, 2009).

2.3. National Rainwater and Greywater Initiative: Household Rebate Guidelines

These guidelines are designed to outline all the eligibility requirements for a successful rebate application. See section *3.3 Government Rebates* of this document for more details on these guidelines.

2.4. *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs)*.

This code of practice has been developed with a primary goal of providing a set of minimum standards for the design, manufacture, installation and operation of ATUs, and also to provide guidance to local government in terms of how to assess the installation and ongoing operation of ATUs (DoH, 2001).

2.5. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2): Managed Aquifer Recharge.

These guidelines have been designed to “provide an authoritative reference that can be used to support beneficial and sustainable recycling of waters generated from sewage, greywater and stormwater, which represent an underused resource” (NRMMC, EPHC, & NHMRC, 2009). The guidelines describe a broad range of recycling options, and provide the scientific basis for implementation of water recycling (NRMMC, EPHC, & NHMRC, 2009).

3. Related Installation Costs and Examples

3.1. Standard costs of Greywater Reuse for households

According to a Western Australian company Earth & Water Pty Ltd based in Welshpool, standard costs for a hand drawn design of a greywater reuse system for council approval and cost assessment starts at $90 plus GST, and an Auto-cad drawing from $180 plus GST. A cost of $90 plus GST is charged for processing Council approvals. This is optional as it is not a complex process and applicants can do it on their own if they wish to. The cost of a system and related installation costs depend on the type of system and size of the dispersal area. The costs of individual systems can range from $550 to $7,000 plus the additional costs associated with the approval process and installation. Examples of a few systems Earth & Water Pty Ltd (2011) offers are included below.

- The least expensive system that requires no major plumbing is the Gravity Feed type “G Flow” used mainly for laundry washing machine reuse. For an area of 20 square meters drip irrigation, the full cost of the system and installation is $1,200 plus GST.

Breakdown of cost:

G Flow = $300
Labour to install G Flow = $250
Plumber (Overflow to gulley trap) = $200
Drip Irrigation and pipes to garden = $200
Labour to install drip system $250

- A middle range system that reuses all the greywater from the house via a sump or a tank, and pumps it out to a 60 square meters drip irrigation system would cost around $4,000 plus GST, including installation. This system produces class C greywater, meaning it can only be used for subsurface drip irrigation.

  Breakdown of cost:

  Grey Water Unit (Gator Pro or Grey Flow) = $1,300
  Labour to install pump system with lid = $600
  Plumber (by pass via reflux valve) = $900,
  Electrical connection = $200
  Extra filter, Drip Irrigation and pipes to garden = $400
  Labour to install drip system = $600

- A top range system "NovaGrey" reuses all greywater from the house via a sump or a tank, and pumps out to 60 square meters drip irrigation system costs $10,800 plus GST, including installation. NovaGrey is suitable for installation in all areas (including sewered and unsewered). It can recycle up to 1,148 litres of grey-water per day, producing high quality recycled water (class A) that can be used in the laundry, for flushing the toilet, watering the garden, washing the car, external hosing, etc. NovaGrey recycled water can be used for both above and below ground garden irrigation (Water Gurus, 2011).

  Breakdown of cost:

  NovaGrey Unit = $7,000
  Labour to install NovaGrey = $1,000
  Plumber (by pass via reflux valve) = $1,600
  Electrical connection = $400
  Labour to install drip system = $800

According to the Australian Water Conservation and Reuse Research Program conducted by CSIRO (Diaper C., 2004), in terms of maintenance and monitoring of greywater systems there are two main categories. The first category requires minimal or no monitoring and continuous user maintenance and operation of the system is required. The other category is where operations are highly automated and controlled and user interaction is minimal. There is also a difference in the associated costs of each type. Greywater system materials, costs, energy and maintenance requirements are shown in Table 1.

Table 1. Greywater system materials, costs, energy and maintenance requirements (Source: Gardner et al, 2003 sited in [Diaper C., 2004]).

Process type	***Lo or Hi tech***	***Materials/major components***	***Capital cost per household***	***Energy usage***	***Operation and maintenance requirement***
Simple diverter valve	Low	uPVC pipe	$30-40	None - Gravity fed for irrigation	Minimal maintenance of valve. Continuous user control of irrigation area
Sedimentation tank and ecosoil irrigation field	Low	Standard piping Tank Gravel/ecosoil	$12000 (1000 L/day)	Gravity fed or pumped	Continuous user control of irrigation Desludging of sedimentation tank
Diverter valve, filtration, storage (drip irrigation)	Low	Piping Tank Pump Drip piping	$30-40 $250 $250 $1-2/m	Pumping required	Continuous user control of irrigation Filter cleaning
Sand filter[1] (for subsurface irrigation or toilet flushing)	Low	Tank Pump UV lamp	$5500	Pumping and UV 7.2 kWh/kL (80% for UV)[1]	Continuous user control of irrigation None specified UV lamp replacement?
Aeration (for toilet, garden and clothes)	High	Coarse filtration Tank Pumps Air blower UV lamp Microprocessor	$6500	Air blower Pumping UV Total 0.6 kWh/day (for 2400 L)	UV lamp replacement (annually)
Electroflotation (for toilet, garden and clothes)	High	Tank Pumps x2 Electrodes pH control Microprocessor	$7500	0.5-0.8 kWh/kL	Electrode replacement
Pressure filtration (toilet, garden and clothes)	High	Coarse filtration Tanks Pumps Filtration medium UV lamp Microprocessor	NA	Pumping required	Coarse filter cleaning (monthly) Replace filter media (annually) Desludge tank (annually) UV lamp replacement (annually)

3.2. Example and cost of Integrated Water Management System in Local Government

The 'Grove', which includes the new Cottesloe - Peppermint Grove - Mosman Park combined Library, Shire of Peppermint Grove's council offices and community centre located within the Shire of Peppermint Grove has had an on-site wastewater treatment and reuse system installed. The system incorporates a source-separation approach, and uses recycled water for irrigation. By using the recycled water for irrigation the library is expected to reduce the groundwater use by 700,000L each year (The Grove, 2010). The system is more complicated than greywater systems because it incorporates treatment of brown and yellow wastewater. The greywater coming from showers and hand basins, including the kitchen wastewater, brown water coming from toilets, and yellow water from urinals is being separated at the point of generation and plumbed to respective treatment and storage tanks for effective reuse. The schematic design of the integrated wastewater treatment and recycling is shown in **Figure 1** below. A photograph taken during the treatment and storage tanks installation can be seen in Appendix Figure 5.

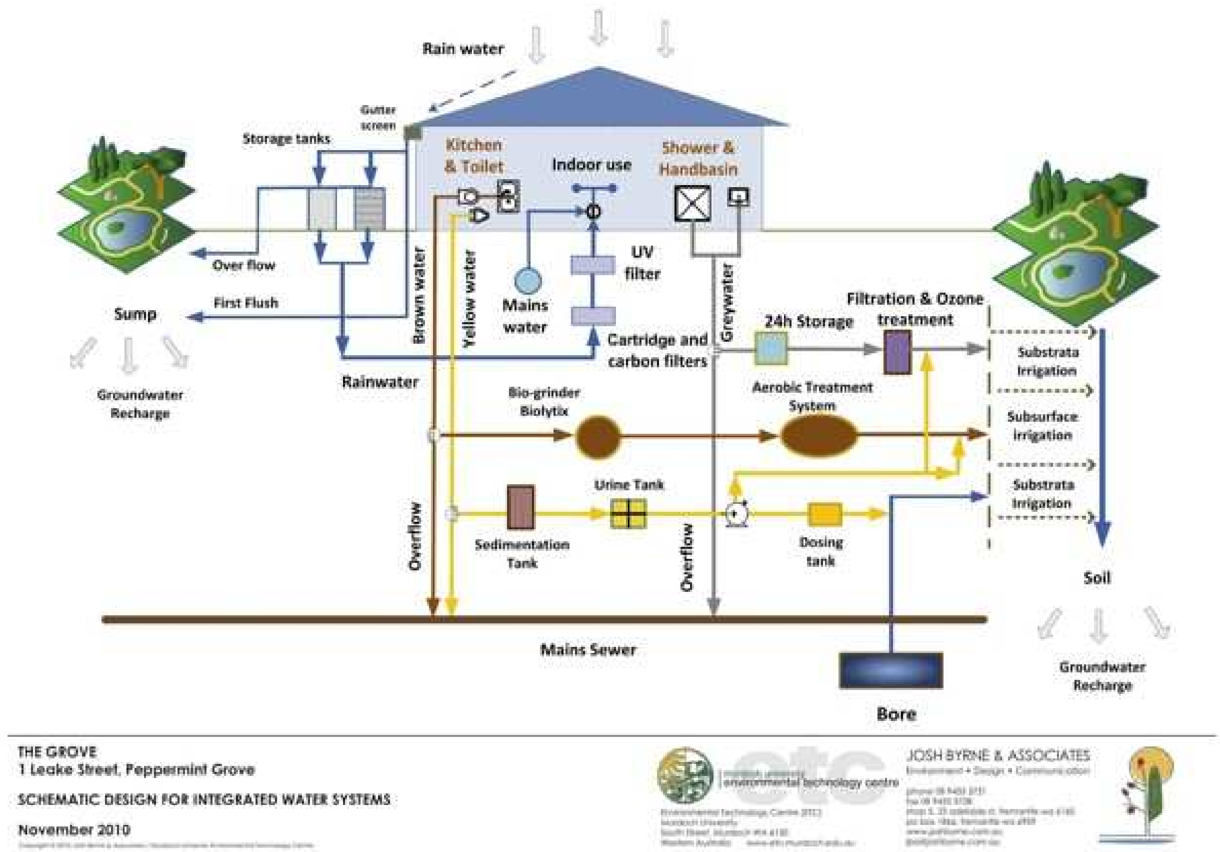

Figure 1 - Schematic Design for Integrated Wastewater system at Cottesloe - Peppermint Grove - Mosman Park Combined Library (Source: http://thegroveprecinct.com/the-building/water-systems/#wastewater).

Benefits of this type of system include a tailored treatment of what is required for particular wastewater stream, and in case of urine diversion, it allows for efficient capture and storage of nutrients for later application as fertiliser through a controlled irrigation system. The system incorporates an overflow and diversion capacity in case of a malfunction or overloading (The Grove, 2010). For detailed information on the 'Grove" project and the Environmentally Sustainable Design (ESD) please refer to the ESD Fact Sheets found at www.http://thegroveprecinct.com/.

The total cost of the integrated on-site wastewater treatment and reuse system installed at the new Cottesloe - Peppermint Grove - Mosman Park Combined Library according to Yew Han Goh of PS Structures Pty Ltd, the main builders on the project was $550,000.

3.3. Estimated cost of a Greywater Reuse system for a Local Government building

According to Ian Kikkert, a Business Development Engineer at Aquacell Pty Ltd (Queensland), a 5kL/day greywater reuse system would be suitable for a Local Government building (similar to the EMRC Administration Building) of following characteristics:

- Existing two storey building with;
- 3 kitchens;
- 6 toilets;
- 2 showers;
- 100 full time employees; and
- approximate irrigation area of about 550 m^2.

The 5kL/day system is based on the assumption that 100 people will be using approximately 50L of water per person per day. This is a relatively small system, however because it is a commercial system it will need to demonstrate that the unit adequately addresses all public health risks associated with greywater treatment and reuse. According to Kikkert all of Aquacell systems demonstrate this as they are based on the Australian Guidelines for Water Recycling, which are the national risk based standard which many State regulations refer to.

The cost to install a 5kL/day greywater unit is between $130,000 and $160,000, and includes:

- Obtaining the necessary regulatory approvals – excluding fees;
- Process equipment – membranes, reactor tank, blowers, UV, chlorination, control panel; and
- Installation and commissioning.

Additional costs for a collection tank and effluent storage tank, reticulation pumps (i.e. delivering the treated effluent throughout the building) and freight to site should also be considered on top of the initial cost stated above.

There are also the operational costs of approximately $40,000 to $50,000 per year to cover regulatory compliance costs, sample analysis, remote monitoring, monthly servicing and calibration of instruments, consumables, annual full technical servicing, power, asset replacement. Etc (Aquacell, 2011). It should be noted that the costs of installation are higher for an existing building.

3.4. Government rebates

3.4.1. Households

The National Rainwater and Greywater Initiative - Household Rebate, provides rebates of up to $500 for the purchase of new Rainwater tanks and Greywater reuse systems (DoSEWPC, 2011). The “National Rainwater and Greywater Initiative: Household Rebate Guidelines” outline all the eligibility requirements for a successful rebate application.

The Australian Government indicated that the National Rainwater and Greywater Initiative household rebates are no longer available for rainwater tanks or greywater systems purchased after 10 May 2011 and the scheme will cease altogether in November 2011. All applications for the systems or tanks bought before 10 May 2011 must still meet the eligibility criteria and must be received by the Department of Sustainability, Environment, Water, Population and Communities by 10 November 2011. Applications received after 10 November 2011 will not be eligible (Senator Don Farrell, 2011).

According to the “National Rainwater and Greywater Initiative: Household Rebate Guidelines” (DoSEWPC, 2011), rebates will not be eligible where:

- The dwelling where the rainwater tank/s or greywater system is installed is owned by a state, territory or Commonwealth authority; or
- a rebate under *the National Rainwater and Greywater Initiative* has previously been paid for that dwelling (one rebate per dwelling allowed).

3.4.2. Local Government

Currently there are no Local Government grants available for greywater reuse or wastewater recycling in Western Australia. However under the Water for the Future's National Urban Water and Desalination Plan, the Australian Government is supporting stormwater harvesting and reuse projects in both large and small cities and towns that contribute to:

- improving the security of water supplies in Australia, without adding to greenhouse gas emissions;
- reducing the demand on potable water supplies; and
- helping to reduce the impact of urban runoff on water quality in receiving waters.

Common uses for the stormwater harvested from these projects include the irrigation of parks, roads, gardens, ovals and golf courses. In addition, roof water from non-residential buildings is increasingly being used for the watering of gardens, toilet flushing, car washing and other municipal and commercial purposes (DoSEWPC, 2011).

4. Risks and Benefits of Greywater Reuse

Many consider greywater to be relatively clean due to not containing any blackwater. However there are still environmental and health risks associated with reuse of greywater due to possible high levels of substances such as: disease causing organisms including bacteria, viruses, protozoa, etc.., suspended matter, organic matter, oils, fats, lint, food, hair, body cells, and traces of feaces, urine, and blood, and a range of chemicals coming from soaps, shampoos, toothpaste, mouthwash, dyes, bleaches, disinfectants and other products (COP, 2010).

4.1. Risks

There are a number of risks associated with greywater systems that need to be taken into account. With regular and thorough monitoring, these risks can be minimised.

4.1.1. Health risks

Potential risks to public health could be fecal contamination if greywater was insufficiently treated and came in contact with skin, or if a person inhaled or swallowed spray in the case of above ground irrigation. In order to protect human health and prevent this from happening developed guidelines and the Code of Practice indicated in section 2 of this document should be followed and referred to.

4.1.2. Environmental risks

Key potential environmental risks from reusing greywater include build up of chemicals in soils and vegetation over time, and eventually reaching and contaminating groundwater. Chemicals such as bleaches and disinfectants can potentially kill useful micro-organisms in soils, and build up of fats and oils which can not be broken down can over time make soils water repellent (Water Corporation, 2010). Code of Practice and guidelines are also applicable to environmental risks.

4.1.3. Financial Risks

Besides the associated health and environmental risks, there are also the risks or disadvantages associated with long payback periods and medium to high capital costs due to the concept and technology being relatively new. There are also the costs associated with regular testing and maintenance of the systems, as well as with the testing of the soil to make sure the system is functioning properly and not contaminating the soil and eventually groundwater. These costs are usually overlooked or not considered in the initial planning of the project and may later be seen as an additional cost. In some instances because of this, systems are not maintained properly, or the soil testing is not performed to avoid the perceived 'additional' cost resulting in contamination of the ground and or making the system inefficient. There is also the risk that the use of grey water may encourage and eventually lead to increased water use. Another risk associated with decreased wastewater flows in the sewer pipelines due to diversion of majority of liquid waste is the cost of services to unblock sewer lines. This risk is relatively high especially in WA due to low gradients and the nature of landscape.

4.2. Benefits

There are a number of benefits to Grey Water systems including:

4.2.1. Financial savings

- Reducing scheme water consumption by switching garden irrigation from scheme to greywater, or at least complementing the scheme water irrigation with greywater, and therefore reducing the water bills.

4.2.2. Environmental benefits

- Reducing the amount of sewage discharged to the ocean or rivers;
- Reducing the pressure on existing freshwater sources;
- Reducing the impacts associated with development of new water sources such as desalination plants, and associated running impacts; and
- Increasing groundwater recharge.

4.2.3. Social benefits

- Having a green garden all year round;
- Irrigating gardens during a sprinkler ban;
- Enable use where potable water may not be available.

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4.3. Viability

According to the Department of Water (2011a), the viability of a wastewater reuse scheme will depend on factors including:

- availability and intended uses, estimated demand and back-up (contingency) water source
- required level of treatment for intended uses
- management of health and environmental risks
- site limitations, including proximity to public drinking water source areas or to conservation category wetlands
- infrastructure requirements
- cost of implementation and ongoing management of the scheme
- governance issues surrounding long-term ownership, operation and management.

5. Cost-benefit Analysis

A cost-benefit analysis of greywater reuse system in urban areas (Table 2) has been developed based on the calculations of potable water cost savings of reusing greywater for individual household applications such as watering the garden, washing laundry and flushing the toilet (Wiltshire, 2005). The average amount of greywater used in an urban setting was calculated to be around 400 L per day, per household. This amount was derived from an average city household wastewater flow of 586 L per day (Redcliffe, 2003, sited in Wiltshire, 2005), and an assumption that 68% of wastewater flow is composed of greywater (Emmerson, 1998, sited in Wiltshire, 2005). The greywater flow was then divided into individual household application, and these flows were converted to costs by determining annual usage and applying the true cost of potable water supply in Queensland. The true cost of potable water in Queensland according to PWC (2000), was estimated to be $2.50 per kL. To determine the energy cost a standard rate (at the time of this cost benefit analysis) of $0.15 per kWh was used (Wiltshire, 2005).

It is evident from Table 2 that the payback period for a more complex greywater system is quite long between 6 and 15 years, which in the case of primary pressurised surge tank system is beyond it service life. The two most expensive systems, which produce the highest grade quality water appear to be not financially viable at all, as the payback period can not be reached. From this cost-benefit analysis the least complex systems with lowest capital costs appear to be most cost effective, however it should be noted that due to no or low level of treatment further costs of soil testing and installation of subsurface irrigation should be considered as they were not included in this cost-benefit analysis.

Table 2. Cost-benefit Analysis of Greywater Reuse in Urban Areas (Wiltshire, 2005).

Treatment Level	Source	Materials / Major Components	Capital Cost	Energy Usage	Operation & Maintenance Requirements	Operating Cost	Water Saving KL ($) per year	Application	Payback Period Yrs
Primary (Diversion)	Laundry	Diversion Valve	$40	None – gravity fed	Minimal maintenance of valve	None	23 ($58)	Garden watering	< 1
Primary (Gravity Surge Tank)	Laundry	Surge tank	$50	None – gravity fed	Annual tank clean	None	23 ($58)	Garden watering	< 1
Primary (Pressurised Surge Tank)	Laundry	Surge tank Submersible Pump PVC Pipe Coarse Filter Installation	$520	0.3 KWh/ KL	Annual tank clean; Annual pump clean; Fortnightly coarse filter clean; Annual coarse filter replacement.	$23	23 ($58)	Garden watering	15 (Beyond service life)
Primary (Pressurised Surge Tank)	Laundry, Bathroom	Surge tank Submersible Pump PVC Pipe Coarse Filter Installation	$550	0.3 KWh/ KL	Annual tank clean; Annual pump clean; Fortnightly coarse filter clean; Annual coarse filter replacement.	$23	50 ($124)	Garden watering	6
Primary (Pressurised & Fine Filtered Surge tank)	Laundry, Bathroom	Surge tank Submersible Pump PVC Pipe Coarse Filter Sand Filter Installation	$800	0.3 KWh/ KL	Annual tank clean; Annual pump clean; Fortnightly coarse filter clean; Quarterly backwash; Annual coarse filter replacement.	$23	50 ($124)	Drip Feed Garden watering	8
Secondary	Laundry, Bathroom	Surge tank Submersible Pump PVC Pipe Coarse Filter Storage Tank Sand Filter UV Disinfection Installation	$5,500	7.2 KWh/ KL	Annual tank clean; Annual pump clean; Fortnightly coarse filter clean; Quarterly backwash; Annual coarse filter replacement; Quarterly UV lamp clean; Annual UV lamp replacement.	$370	60 ($150)	Garden Irrigation Toilet Flushing	Never
Tertiary (aeration)	Laundry, Bathroom	Surge tank Pumps PVC Pipework Coarse Filter Storage Tank Air Blower UV Disinfection Installation Automatic Control	$6,500	0.6 KWh/ Day/ (for min. daily requirement of 2400L)	Annual tank clean; Annual pump clean; Fortnightly coarse filter clean; Annual coarse filter replacement; Quarterly UV lamp clean; Annual UV lamp replacement; Annual blower maintenance.	$390	60 ($150)	Garden Irrigation Toilet Flushing Laundry	Never

Note: It should be noted that this Cost-benefit Analysis has been developed during the period of 2004/2005, and has used data that may be outdated or superseded due to the rate of technological advances, changing environmental and health regulations, and increasing energy and water prices.

6. Limitations

EMRC Officer was unable to obtain quotes for a greywater system for the EMRC Ascot Place Building over the phone or email due to the complexity and size of the building. A call out fee of approximately $400 was requested by the Earth & Water Pty Ltd for a consultant to undertake a preliminary site assessment, including the assessment of building design drawings and assessment of the existing plumbing configurations.

Due to greywater systems being relatively new and technology constantly improving and changing it is not possible to develop an accurate cost-benefit analysis for a Local Government building that can be applied on a generic level. Another factor that also influences development of a cost-benefit analysis is the fact that every single building / facility is different and factors such as size of the building, design, number of people working or visiting the building, size of the irrigation area, etc, all affect the cost-benefit analysis. Therefore an accurate cost-benefit analysis could only be developed based on the detailed project specific plan that incorporates all of the variables associated with the particular project.

7. Conclusion

In conclusion, greywater reuse systems offer a great option for creating an alternative water source mainly for non-potable uses, such as garden irrigation. This means reducing the pressure and demand on the potable water sources. There are also other options such as Waste Water Recycling (centralised and decentralised scale). A number of different greywater reuse systems exist on the market and depending on the customer needs, type of the building / facility, size of the irrigation area and other factors, the cost of the system can vary from $550 to $7,000 plus the additional costs associated with the approval process and installation for a household, and up to $550,000 for a complete wastewater recycling system for a large Local Government building such as a library.

Risks associated with greywater reuse include potential risk to human health in the form of faecal contamination if greywater or recycled wastewater that was not sufficiently treated got in contact with skin, or if the water is ingested. More advanced and more expensive systems are able to recycle greywater or wastewater to a high level where it can be used for external and above ground uses. These systems are not very popular due to their high capital costs and long or no payback periods. Payback periods are relatively high due to the current low cost of water. However, prices for water are expected to increase in the near future which would decrease payback periods.

Potential environmental risks include contamination of soil and groundwater through accumulation of chemicals, which in turn could affect the health of vegetation and useful micro-organisms in the soil. These risks can be avoided and or minimised by following guidelines developed by government departments and adhering to the relevant codes of practice.

Benefits associated with greywater reuse include reduced water bills from not using scheme water for irrigation, reducing the amount of sewage discharged to the ocean or rivers, reducing the pressure on existing freshwater sources, reducing the impacts associated with development of new water sources such as desalination plants, irrigating during sprinkler bans and potentially having a green garden all year round. The use of greywater by local government is seen to be innovative and leading by example.

Due to the concept of greywater reuse being relatively new and technology constantly improving and due to great variability in the system components and depending factors, it is not possible to develop an accurate cost benefit analysis for a Local Government facility that could be used as a generic model across all local governments.

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9. Appendix

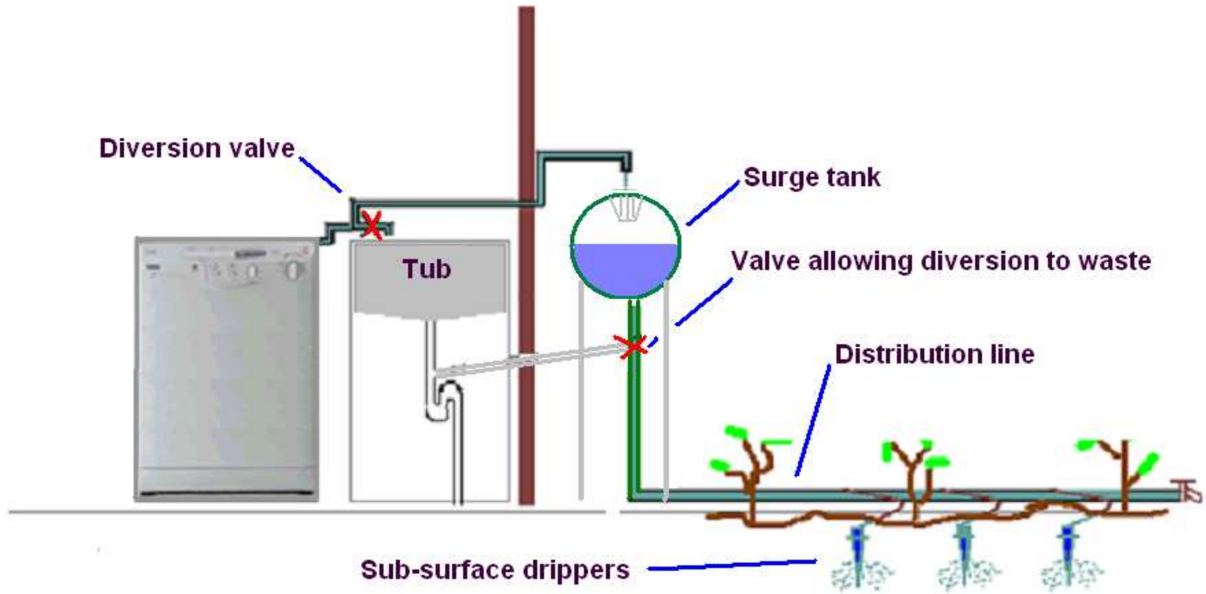

Figure 2 - Simplified schematic of greywater reuse through a diversion valve including a surge tank (Source: www.sydneywater.com.au).

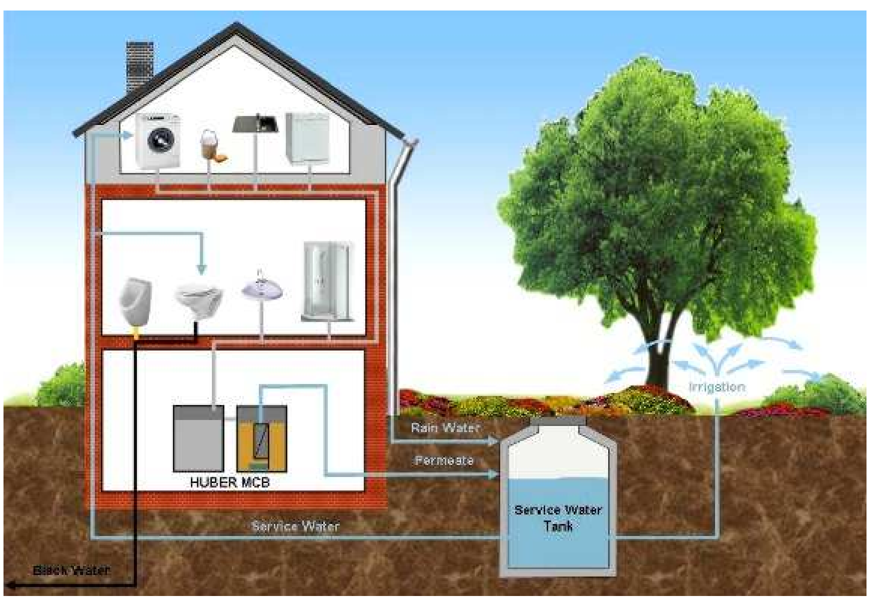

Figure 3 - Simplified schematic of greywater reuse for above ground irrigation (Source: www.ecohomeresource.com).

Figure 4 - Simplified schematic of greywater reuse for toilet flushing (Source: www.plumbingsupply.com).

Figure 5 - Photo of installation of wastewater recycling system at the Cottesloe - Peppermint Grove - Mosman Park Combined Library (Source: http://thegroveprecinct.com/the-building/water-systems/#wastewater).

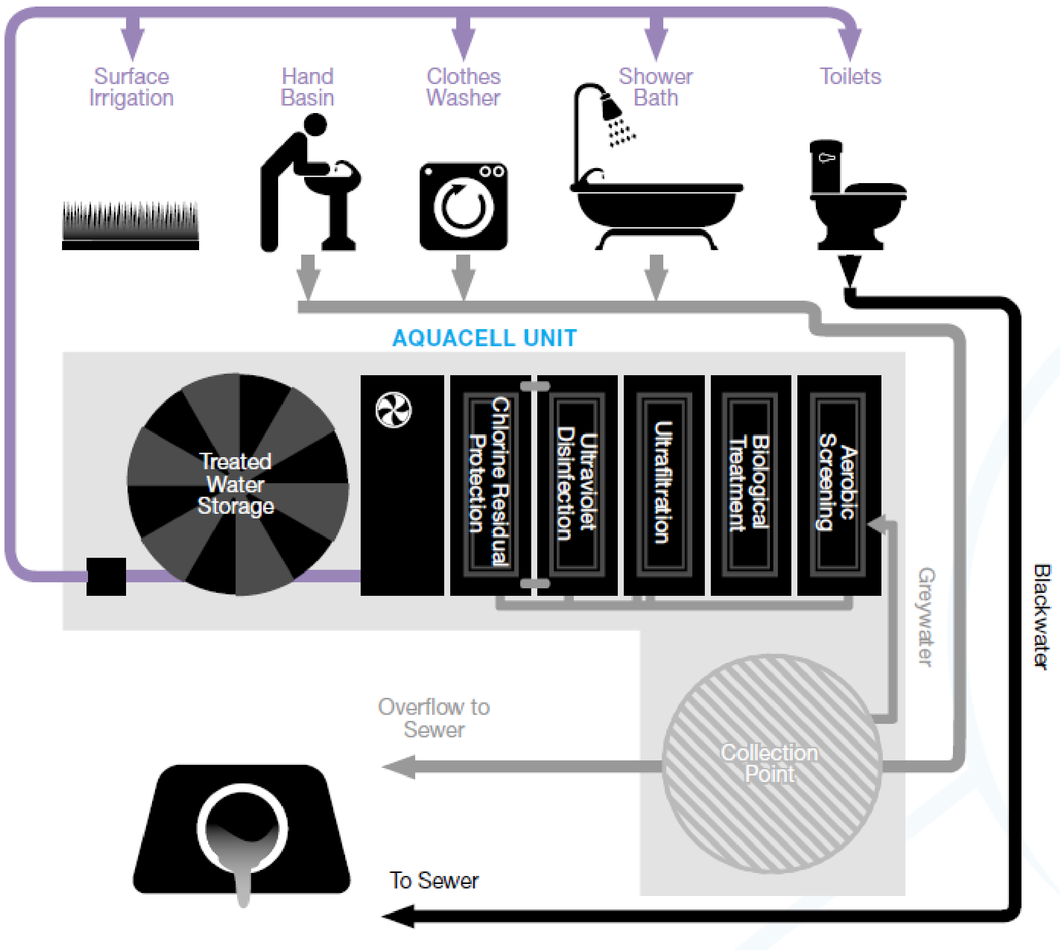

Figure 6 - Simplified schematic of a comprehensive greywater reuse system that produces high grade quality water (Source: www.aquacell.com.au).

Note: The ability of reusing treated greywater for shower or bath as indicated in Figure 6 above depends on each State's health and environmental regulations.