University of Southern Queensland

Faculty of Engineering & Surveying

ASSESSMENT OF FACTORS INFLUENCING WATER REUSE OPPORTUNITIES IN WESTERN AUSTRALIA

A dissertation submitted by

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Abstract

Water is used within our society for human consumption and food production, industrial processes and energy generation, maintaining natural ecology and biodiversity and recreational purposes. Authorities now face the challenge of ensuring the quantity, distribution, quality and allocation between the various uses are sustainable. One source not considered in the past on a large scale is the reuse of wastewater.

Recent state elections in Western Australia have brought the issue of water resources to the forefront of the public perception. Several solutions were put forward during the elections including a large desalination plant, building a canal to transport water from the north of the state and increased pumping of local aquifers.

The Water Corporation of Western Australia tells us that 'by 2031, Perth is expected to need an extra 150 GL (gigalitres) of water. This will be met by an integrated water cycle approach including new sources, efficiency measures, water recycling, water trading and catchment management.' However, it is expected that any new water sources will be more costly than current supply from local dams and groundwater.

The objective of this project is to identify factors that have led to the current water crisis in Western Australia, examine water opportunities that are available to Western Australians and recommend a solution that is consistent with triple bottom line objectives. This includes an assessment of the large amount of information available on the factors influencing water reuse opportunities in Western Australia.

Water reuse technology is essential to support our growing population. There is the need to assess the past, current and future situations to ensure there is sufficient water available in the future. It is also important that there is an awareness within the community and government agencies of the seriousness of the current water crisis.

The greatest factors affecting the successful expansion and integration of water recycling into future sustainable water management plans are associated costs compared to other water sources, acceptance by the general public, minimization of environmental and health impacts, technology to treat water to an appropriate standard and the examples set by other Australian states and territories.

Western Australia has the capacity to embrace water recycling initiatives, but the government first needs to introduce detailed regulatory guidelines on water recycling and the use of recycled water to educate public sector departments, local governments, private industry and the general public on the best path to follow. Western Australia is well behind other states in implementing water recycling initiatives, which are confined to irrigation projects and industry use. The trend to develop contained housing estates in Western Australia lends itself to community developments in New South Wales and South Australia, where recycled water now forms a part of everyday life.

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Date

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CHAPTER 1

INTRODUCTION

'Western Australia has reached a critical point in the way we use and reuse our precious water resources.

The water shortage we have had to live with in recent times has shown us that the efficient use of water is no longer a response to the current drought but in fact an essential step in learning to live with less water without compromising our way of life.'

Source: Government of Western Australia, *A State Water Strategy for Western Australia – Summary Document*, February 2003.

The main factors that have led to the current water situation are:

- Decreased Rainfall (12-15% lower since 1976, WA Water Corporation)
- Growing Population (increasing by 1.8% per year or 500 people per week, CSIRO)
- Increased industry and agriculture (WA Water Corporation)
- Climate suited for growing European gardens, particularly in the cold, wet winters

Recent state elections in Western Australia have brought the issue of water resources to the forefront of the public perception. Reading letters to the editor in the state newspaper The West Australian illustrates the lack of knowledge that exists in the wider community of the importance of water, the types of water re-use opportunities available and the steps individuals can be taking to ease the increasing demand on water resources.

Both political parties put forward their 'solutions' to the problem of meeting future water needs. These solutions included the construction of a desalination plant, the building of a canal to transport water from the Fitzroy River in the state's north and the pumping of the Yarragadee Aquifer in the state's south.

Since the State election work has now begun on the desalination plant and it is expected to producing 45 GL (gigalitres) a year from October 2006, (Source: WA Water Authority Media Release, 14 April, 2005)

On the 7th May, 2005 The West Australian newspaper reported that a second desalination plant was being planned for if approval for the pumping of the Yarragadee Aquifer was not forthcoming. The report quotes a January 12 document from the WA Water Authority that there are fears that Perth will begin running out of water by late 2008 without one of these two developments.

The Water Corporation of Western Australia tells us that 'by 2031, Perth is expected to need an extra 150 gigalitres of water. This will be met by an integrated water cycle approach including new sources, efficiency measures, water recycling, water trading and catchment management.' However, it is expected that any new water sources will be more costly than current supply from local dams and groundwater. (Source: WA Water Corporation website, Water Options and Sources, http://www.watercorporation.com.au/water/water_options_sources.cfm).

It was with these events in mind that this project seeks to address the reasons behind why Western Australia is facing a water shortage, assess the options that are available for water reuse within the state and which options better serves the objectives of the triple bottom line. The following report will cover the background to the current water situation; review the current policies and practices in Western Australia in chapter 3 and other Australian States and Territories in chapter 4; discuss public perceptions to water reuse in chapter 5; types and availability of waste water for re-use and available technology to treat the waste water in chapter 6 and 7 respectively; feasibility assessment of water re-use is discussed in chapter 8; and conclusions in chapter 9.

1.1 AIMS AND OBJECTIVES

The aims of this project is to:

- Identify the factors that have led to the current water crisis in WA
- Examine water re-use opportunities that are available to WA
- Recommend a solution that is consistent with triple bottom line objectives

The following objectives have been identified to achieve the above aims:

- Review of current WA Government Agencies
- Review of other Australian States
- Review of public perceptions to waste water reuse
- Review of technology available
- Assessment of future opportunities

CHAPTER 2

BACKGROUND

The text Global Environmental Crises – An Australian Perspective written by Aplin et al (2000) tells us that water is essential for life on Earth, that it is an integral part of virtually all environmental and societal processes. Uses for water include human consumption and food production, industrial processes and energy generation, maintaining natural ecology and biodiversity and recreational purposes.

Aplin et al (2000) suggests that unlike most natural resources water is renewable and mobile and therefore extremely manageable. It is possible to store, divert, transport and recycle water. However, despite these benefits, authorities face major problems relating to quantity, distribution, quality and allocation between various uses.

On June 11 2003 a motion was passed by the Legislative Council of Western Australian, referring the Water Services inquiry to the Public Administration and Finance Committee:

> *'That the Public Administration and Finance Committee inquire into and report on the issues confronting Western Australia that arise from, or relate to, the present and future sustainable supply, quality, retention, and maintenance of water services throughout the State.'*

The inquiry was duly published in the State newspaper and public submissions were invited. The subcommittee established to conduct inquiries, hear evidence and produce a draft report agreed in March 2004 that the inquiry's main focus would be:

- The quantity, quality and location of water resources currently available in Western Australia;
- Possibilities of future sources of water;
- The quantity, quality and location of current and potential future demand for water; and
- The most cost-efficient way to meet current and potential future demand for water.

The subcommittee investigated the following potential sources of water:

- Groundwater
- Surface water
- Regional transfers
- Demand reduction
- Desalination
- Re-use
- Stormwater
- Cloud Seeding
- Harvesting Water Offshore

The Water Authority of Western Australia is promoting "security through diversity". The following, which are consistent with the findings listed above, are just some of the ways that they are hoping to boost water supplies:

- ➢ Desalination of seawater
- ➢ Recycling of treated wastewater
- ➢ Better management of dam catchments to improve inflows
- ➢ Trading of water from irrigation cooperatives.

Figure 2.1 is a diagram of the water cycle showing the integration of water recycling and this represents the growing awareness that recycling is an important factor in cementing a sustainable water future. Government agencies, private companies and everyday people have realized that there is an issue with our water use and water supplies. The task ahead is how to deal with these issues, and how to assess the most acceptable options available.

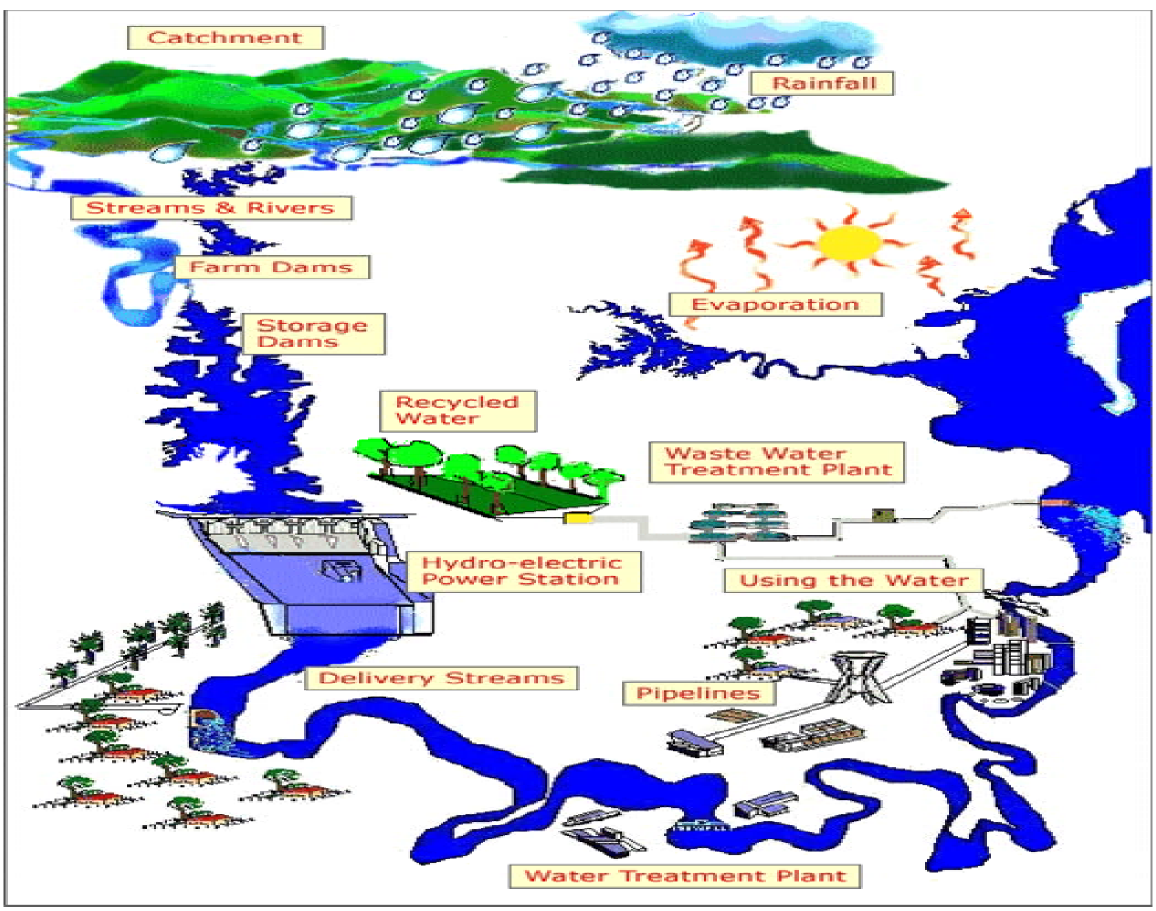

Figure 2.1 Water cycle diagram showing the integration of recycled water
Source: SEQ Water, Available: http://www.seqwater.com.au/content/standard.asp?name=TheWaterCycle

CHAPTER 3

REVIEW OF CURRENT WESTERN AUSTRALIAN GOVERNMENT POLICIES AND PRACTICES INFLUENCING WATER RE-USE

In February 2003, A State Water Strategy for Western Australia was released by the Government of Western Australia, with the aim of 'securing our water future'. The key initiatives of the strategy include the following:

- The allocation of funds to support water efficiency, including rebates for those people installing rain water tanks, garden bores, tap timers, soil wetting agents, water efficient shower heads, washing machines rates AAAA or better, greywater recycling units and aerobic treatment units (See Appendix E for copy of rebate form for grey water recycling systems).

- Increasing the cost of water for those customers using in excess of 550 kL to target those persons wasting water. A consumption level of 155kL/person/year for customers served by the Integrated Supply Scheme to be achieved by 2012.

- The establishment of the Premier's Water Foundation to encourage research and development in Western Australia's water future.

- Daytime sprinkler restrictions between 9 am and 6 pm for all garden bores, including local authorities.

- The construction of two new dams on Samson Brook and Wokalup Creek in the South West of the state, to provide up to 23 gigalitres a year.

- The allocation of $6 million to investigate the feasibility of allowing water allocations to be drawn from the South West Yarragadee Project. It is hoped that it will provide up to 45 gigalitres a year.

- A target of 20% of treated wastewater is reused by 2012 is established.

It is noted that water reuse is acknowledged as an important facet in establishing a long term strategy for sustainable water management. In particular, the document includes in its objectives as achieving significant advances in water reuse.

Country or isolated communities outside the Perth Metropolitan area to do not always have access to a reliable groundwater source and municipal wastewater is currently being used for the irrigation of public open spaces and recreational areas, to boost water supplies for industrial processes and agriculture (i.e. irrigation of vineyards and woodlots). To achieve the proposed 20% reuse of treated wastewater it is hoped to widely use these methods within the metropolitan area. Another opportunity to be investigated is the utilization of treated wastewater to recharge groundwater aquifers, see Figure 3.1 below.

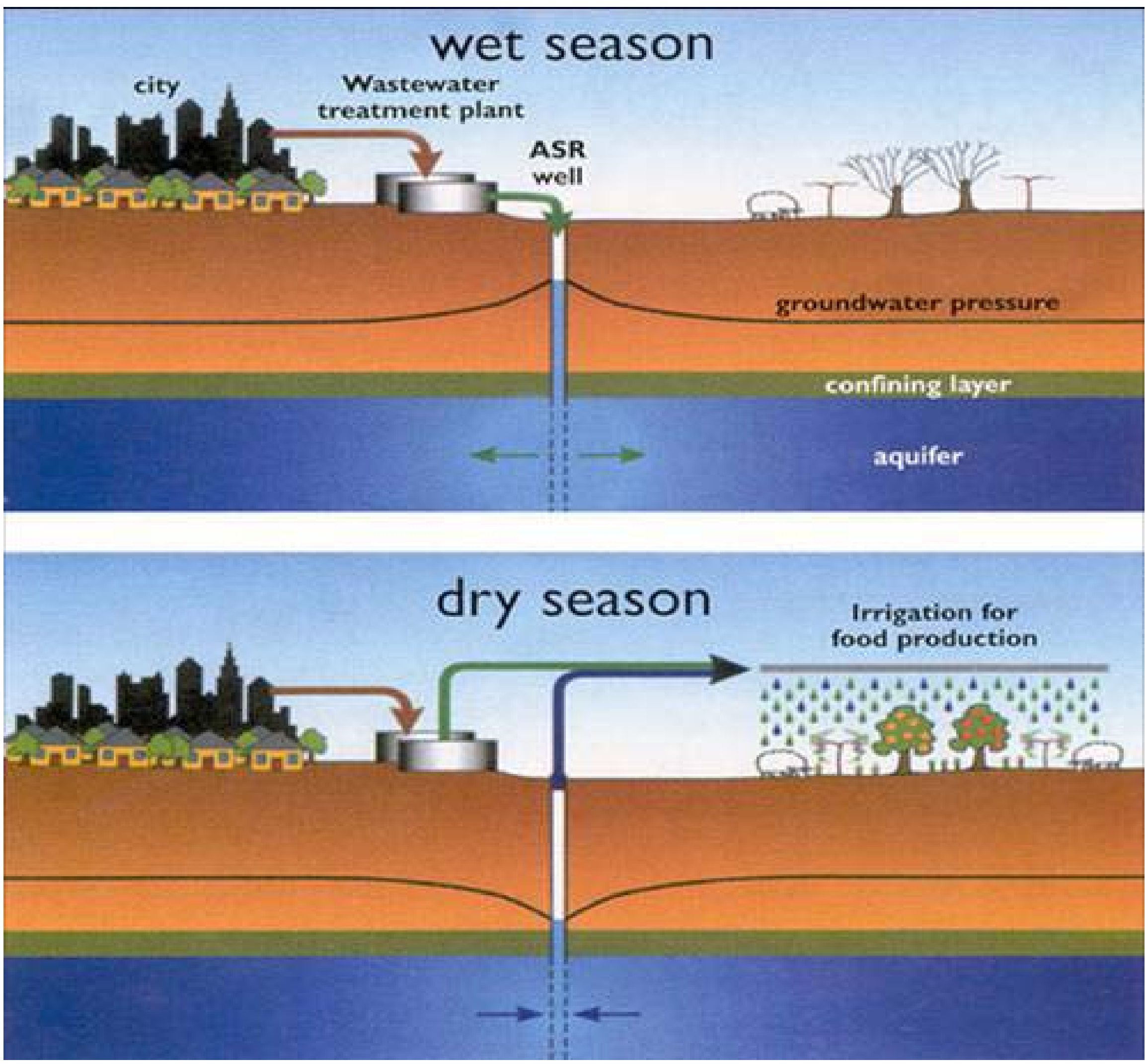

Figure 3.1 – Diagram showing aquifer replenishment and drawdown utilizing recycled water
Source:
WA Water Corp, Available: http://www.watercorporation.com.au/wastewater/wastewater_reuse_where.cfm

The hierarchy in Western Australia for the management of water resources can be illustrated by the following table:

GOVERNMENT		
CABINET SUB COMMITTEE		
POLICY/FUNDING	**SERVICE PROVIDERS**	**REGULATORS**
Water Task Force Treasury	Water Corporation Aqwest, Busselton Irrigators	Department of Environment (DOE) Economic Regulation Authority (ERA) Department of Health (DOH)
CUSTOMERS		

Table 3.1 Heirarchy of water management in Western Australia

Source: WA Water Corporation presentation at Water Symposium, 2004, author Mike Hollet

Of the above departments the Water Corporation, Department of Environment and the Department of Health are responsible for the issues associated with water reuse or recycling. The roles these departments play in the regulation of water reuse are now discussed in turn.

3.1 WATER CORPORATION

The role of the Water Corporation within Western Australia is to ensure the provision of a sustainable water supply into the future. Of the three departments mentioned, the Water Corporation plays the most active role in encouraging water reuse activities within the state. The Water Corporation through its ‘Security through Diversity’ program is promoting water recycling as ‘an essential component of total water cycle management’ and aim to achieve 20% reuse by 2012. (Source: Presentation at the Water Symposium: *Include Details*). Currently Water Corporation figures show that 40.3% (8.5 GL/pa) of water used in country areas is recycled but only 3.6% (3.6 GL/pa) in the metropolitan area. The Water Corporation will drive activities to achieve the target of 20% increase in the use of recycled water by 2012.

Grey water system approval is the responsibility of the Department of Health but the Water Corporation issues rebates for customers who install an approved grey water system (see copy of Rebate Form in Appendix E).

3.2 DEPARTMENT OF ENVIRONMENT

On July 1 this year the Water Services Planning Branch within the Department of Environment officially commenced operations. The functions performed by this unit continue the role formerly undertaken by the Office of Water Policy. The role of the Department of Environment is to provide the Minister Assisting the Water Resources Minister with advice on the assessment, planning and management of water resources within the state and ensuring that the Government meet the obligations of current legislation. This includes the approval of major works such as water tanks and mains, the approval of prices set in by-laws and the appointment of members to the regional water boards. (Source: Department of Environment).

Any risks to the environment in the use of recycled wastewater are assessed. An example of this is the current practice of using treated or recycled wastewater by agriculture to irrigate crops. An agroforestry scheme in Albany, in the South West of the state, currently uses 4 ML/d to irrigate 575 hectares of land used to grow eucalypts. The use of treated wastewater to grow trees of this magnitude requires a large area of land to ensure that the effects to the local environment are minimized. This includes preventing runoff to adjacent surface waters and minimizing the effect of infiltration to groundwater sources to ensure that the local environment is not compromised.

There are other ways that recycled water is providing a way to improve on current environmental conditions. In areas where the over use of groundwater has resulted in saltwater intrusion into the local area, it has been proposed to use treated wastewater to alleviate the problem. The treated wastewater would be pumped into the ground to form a barrier to prevent the saltwater levels rising further. This would involve a system of storage tanks and distribution pipes. Feasibility studies by the Water Corporation and with approvals from the Department of Environment have been conducted. The limiting factor to this scheme is that the cost of treated wastewater is more expensive than other water sources.

3.3 DEPARTMENT OF HEALTH

The Western Australian Department of Health is responsible for ensuring that all water recycling schemes are operated and reclaimed water used in a way that does not have a detrimental affect on public health. As part of these responsibilities the Department of Health assess applications for new grey water reuse units. Currently there are six approved brands of greywater 'reuse' systems that are available for purchase by private residents (see Appendix D for details of these systems). They are:

- Nylex
- Ecomax Waste Management

- Eco-Care
- Greywater Reuse Systems (GRS)
- Advance Waste Water Systems
- Niimi Absorption Trench

All these systems are filter units, with discharge being directed underground for irrigation purposes. There are no greywater recycling units suitable for above ground irrigation, as they do not provide for disinfection of the greywater.

It is a requirement of all greywater systems, that the resultant water be discharged below the ground surface unless treated and disinfected to an appropriate standard. The following table illustrates the allowable uses dependent on the type of treatment applied.

Treatment	**Greywater Reuse Application**
Untreated greywater	Bucketing
Primary treated greywater (i.e. sedimentation tank)	Below ground trench irrigation
Secondary treated to a 20 mg/L BOD_5, 30 mg/L SS and possible disinfection to achieve 10 cfu theromotolerant coliforms/100 mL	Micro drip and spray irrigation and below ground trench irrigation.

Table 3.2 Treatment methods and greywater reuse applications
Source: WA Department of Health, 2005

It is also a requirement of the Department of Health that the following standards are applicable:

- All systems must exclude human and animal contact with the greywater during operation, except as required to maintain the system.
- No cross connection with the potable water supply is allowed.
- Greywater must not be allowed to enter any stormwater drainage system.
- Greywater shall not be used in a manner that will result in direct contact with vegetables or other edible plants. It may be used to irrigate fruit plants where the fruit does not make contact with the greywater.
- No opportunity for mosquito breeding is to exist in any part of a greywater system, i.e. in conveyance, treatment, storage, soil application.
- If irrigated via sub-strata drippers or above ground sprays each irrigation area shall have signage effectively cautioning those entering the area that greywater is being using for irrigation.

The application for Product Approvals of Wastewater Disposal/Reuse Systems requires the following information:

- Concept Report of the system

- Description of the proposed treatment and/or technology
- Hydraulic and pollutant loading of the system
- Engineering Calculations regarding the sizing of the system
- Technical specifications for the components within the system
- Engineering calculation regarding the structural soundness of the system
- Two sets of scaled minimum of A4 size plan-view engineering drawings
- Two sets of scaled minimum of A4 size cross-sectional engineering drawings
- A copy of the installation manual/details
- A copy of the servicing manual/details
- A copy of the operation manual/details
- Contingency measures for malfunctions of the system
- Evaluation report from appropriate authority (where applicable)
- Laboratory analysis reports (NATA registered, where available)

(Source: Health Department of Western Australia)

The Environmental Health Directorate, within the Department of Health, has a branch devoted to Wastewater Management. The aim of this branch is ensure the protection of public health by '*ensuring the safe onsite treatment of sewage and disposal/reuse of wastewater, and providing advice on the intensification of land use on unsewered land.'*. The branch lists it's core functions as:

- Monitoring of aerobic treatment units
- Assessment of apparatus for the treatment of sewage
- and disposal of wastewater
- Assessment of unsewered land use intensification statewide at rezoning,
- subdivision and development stages
- Planning schemes and amendments
- Assessment of wastewater reuse schemes
- Administration of the government sewerage policy for
- the metropolitan region
- Assessment and approval of applications for the installation of onsite
- wastewater treatment and disposal systems
- Country government sewerage policy
- Guidelines for the reuse of greywater

3.4 CURRENT PRACTICES

Water recycling has been recognized as an essential component in managing the state's water future. In regional areas of the state, water recycling has been undertaken for many years, but to date recycling within the metropolitan area has been limited (see Figure 3.2).

Figure 3.2 Areas where recycled water is utilized in WA
Source: WA Water Corporation, Water Recycling, 2003.

The types of water recycling schemes currently in use in Western Australia include the following:

- Kwinana Water Reclamation Plant (commenced November, 2004)
- Shenton Park Sustainability Project
- Irrigation of playing fields, parks and golf courses (mainly country areas)
- Irrigation of Horticulture/Agriculture crops
- Irrigation of Woodlots – Albany, SW Western Australia (see section 3.2)
- Aquifer Replenishment
- Rebates offered for approved domestic grey water recycling units

Kwinana Water Reclamation Plant – the plant is the largest of the kind in Australia and will reduce industry demand by 6 GL/year. Previously industry in the area accessed their total water supplies from groundwater sources (23.5 GL per year) and mains drinking water (7.3 GL per year). The plant provides recycled water to nearly industrial customers using a process of ultrafiltration and reverse osmosis. Commissioned in late 2004, it has provided the immediate benefit to the environment by reducing the amount of industrial wastewater discharge into Cockburn Sound (directly adjacent to the Kwinana Industrial Area, see Figure 3.3) by 6 million litres a day.

Several companies are using or have committed to use the water produced by the plant including HIsmelt, CSBP, Kwinana Co-generation Plant and BP. New industries to the Kwinana Industrial Strip will be required to access water from the plant as groundwater allocations are at their maximum and potable water use will be discouraged. (WA Water Corporation, 2005 ATSE, 2003).

Figure 3.3 Kwinana Reclamation Plant Location
Source: WA Water Corp http://www.watercorporation.com.au/publications/7/kwrp-brochure.pdf

Shenton Park Sustainability Project – the project consists of three main components arranged around the existing Subiaco WWTP, these are a research facility and technology complex, demonstration activities and Interperative Centre and City Farm. The aim of the project is to utilize waste entering the area to produce useful by-products. The waste water component from the Subiaco WWTP will be further treated so that it can be used to irrigated hydroponic greenhouses to grow flowers and plants, used in aquaculture ponds for ornamental fish and aquatic plants and used to irrigate parks and playing fields. To date the Water Corporation has completed a feasibility study into the project and, at the time of the report, is seeking community input and involvement in further developing the project.

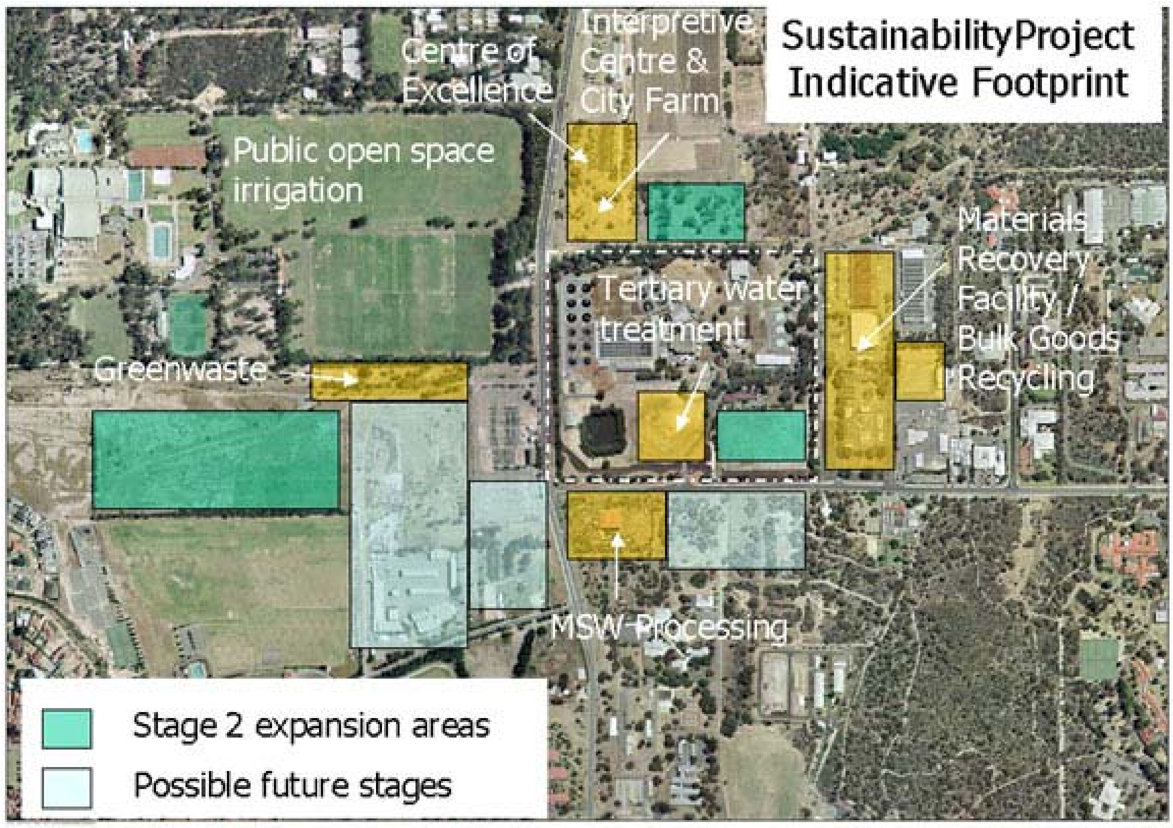

Figure 3.4 Shenton Park Sustainability Project Indicative Footprint
Source: WA Water Corporation
http://www.watercorporation.com.au/community/community_shenton_map.cfm

McGillvray Oval University of Western Australia (UWA) – The Sports Park located at UWA has been receiving recycled water as part of a two year water recycling demonstration project. The project receives the recycles water from the Subiaco WWTP (also utilized in the above project) at a rate of 2 million litres per day for 6 – 9 months of the year (irrigation is not necessary in the winter months). Funding was provided for the project by the WA Water Corporation and the Federal Government's Coast and Clean Seas Program.

There was some concern by the players using the oval that the recycled water used was causing ill health affects. The Water Corporation and Health Department met with members of the UWA Rugby Club to assure members that the water used was of high quality and that regular independent testing was conducted to monitor water quality (King, R. 2005).

Figure 3.5 Site map of McGillvray Oval, UWA and Subiaco WWTP
Source: WA Water Corporation http://www.watercorporation.com.au/graphics/mcgillvray-plan.jpg

CHAPTER 4

REVIEW OF OTHER AUSTRALIAN STATE GOVERNMENT'S POLICIES AND PRACTICES INFLUENCING WATER RE-USE

The following sections give a brief outline of the current recycling initiatives being undertaken by other Australian State and Territories and in particular the government policies and practices influencing water re-use. This is essential to compare the practices which are successful within Australia to guide development in Western Australia.

What the following information shows is that there is a wealth of experience and historical data to support water recycling projects of various sizes, treatment types and quality, private and public applications and regulations. Table 4.1 gives an indication of the percentage of wastewater recycled within each state and territory, of which Western Australia compares favorably.

Region	Wastewater (GL/yr)	Reuse (GL/yr)	Percentage
Queensland	339	38	11.2
New South Wales	694	61.5	8.9
Victoria	448	30.1	6.7
South Australia	101	15.2	15.1
Tasmania	65	6.2	9.5
Northern Territory	21	1.1	5.2
Australian Capital Territory	30	1.7	5.6
Western Australia	126	12.7	10.0
Australia Total	**1824**	**166.5**	**9.1**

Table 4.1 Estimates of water reuse by State and Territory from water utility sewage treatment plants in Australia 2001-2002 in gigalitres (GL).
Source: (Radcliffe, 2003 presented in Dimitriadis, S., 2005 p. 19)

4.1 QUEENSLAND

An article in the Queensland Courier Mail newspaper on Saturday 17th September, 2005 (Johnstone, 2005), reports that authorities predict that up to half of the region's water supply needs could be met by recycled water but few authorities have moved to change their systems to accommodate recycling. It is claimed the major barrier is social acceptance rather than the limits of technology.

The Queensland Government has prepared the Queensland Water Recycling Strategy to encourage water recycling within government departments, industry and the community. The aim of the strategy is '*to encourage and support the use of water recycling that is safe, environmentally sustainable and cost-effective'* (Wells, 2001). The strategy was a result of the involvement of representatives from the community, peak industry bodies, educational institutions and local and state government agencies. The strategy development was managed by an interdepartmental steering committee. An independent reference panel was established to ensure community and industry input and four advisory groups to address the following issues:

- Recycling of urban stormwater;
- Consultation and awareness;
- Demonstration and research; and
- Reuse applications.

The key to the strategy are seven action plans to be implemented by the Queensland Government, with the Environmental Protection Agency acting as lead agency, in partnership with all stakeholders. These are:

1. Change laws to support water recycling.
2. Provide guidance for using recycled water.
3. Provide technical training and information for the workplace.
4. Increase community awareness and participation in water recycling.
5. Encourage further research into key aspects of water recycling.
6. Use demonstration projects to raise community awareness of water recycling.
7. Support water recycling projects.

As mentioned above, the greatest challenge facing authorities in implementing water recycling initiatives, is overcoming social views relating to the everyday use of recycled water. Use of greywater, treated or untreated, is not allowed in sewered areas as dictated by current legislation. Regulated trials are proposed, to be allowed by amending this legislation, but no change will be made with regards to the use of treated or untreated blackwater in sewered areas. The use of treated wastewater for direct potable purposes is not supported by the Queensland Government and there no intention to change this stance (ATSE, 2004).

Despite the cautious approach to implementing water recycling there are a two areas in Brisbane where demonstration water recycling projects have been established. The first project is located between Brisbane and Ipswich at a location named Springfield. Currently it is anticipated that there will be a total of 18,000 home sites and a final population of approximately 60,000. The development receives recycled water from Ipswich Water's Carole Park Sewerage Treatment Plant (STP). This recycled water is used within the development for irrigating public open spaces including road verges and median strips and the sporting oval, grassed areas and gardens at the local Woodfield College. Pipes carrying the recycled water are identified by their purple colouring and tap handles are removable to prevent access by children. Watering occurs during the specific hours of 10 am and 3 pm and children have limited access to the irrigated areas, particularly during meal times.

Provision has been made within twenty homes to use recycled water that has undergone further treatment using microfiltration and UV and chlorination for disinfection. Thirteen of these houses have had a 'third pipe' system retrofitted so that the recycled water can be used for toilet flushing and accessed by outdoor taps for uses such as garden watering and car washing. Reticulation infrastructure, to carry recycled water, has also been directed to an industrial park development nearby but is yet to be accessed (Queensland EPA, 2002).

The Pine Rivers Shire Council, from mid 2000 to 2002 hosted a small scale Advance Water Recycling Demonstration Plant at the South Pine Sports Complex, Brendale to test various component trains using treated effluent from the Brendale STP. The unit consisted on nine modules each testing a different commercially available treatment process. The processes included:

- Lime clarification

- Dissolved air filtration
- Dual media filtration
- Ozonation
- Biologically Activated Carbon (BAC) filtration
- Microfiltration
- Reverse Osmosis
- UV Disinfection
- Chlorine Disinfection

The unit was constructed by Aquatech Maxcon Pty Ltd at a cost of $1 million and is being relocated for use on the Gold Coast south of Brisbane. Other areas of Southern Queensland are pursuing water recycling schemes including a development near Bundaberg which is completely self contained and does not require to be connected to the standard community water infrastructure. Other initiatives are being conducted in the areas of Hervey Bay and Toowoomba. In Hervey Bay, stormwater is being directed through sewerage lines and treated to boost local area water supplies.

In Toowoomba, south east of Brisbane, the council is proposing a first for Australia where lower quality recycled wastewater will be treated using reverse osmosis, ultra filtration and ultra violet disinfection technology and used for drinking water within the city. It is hoped that approximately 5,000 ML/annum will be purified and introduced to Cooby Dam north of the town. There is currently some community opposition to the proposal, but the Toowoomba City Council is working with CSIRO to conduct testing to ensure that the scheme is completely safe to provide drinking water.

4.2 NEW SOUTH WALES

In 2000, the New South Wales (NSW) Department of Land and Water Conservation published the NSW Water Conservation Strategy. As part of this document, one of the strategies listed was that the reuse of stormwater and sewerage effluent was to be encouraged to contribute to the reduction of demand of existing and new water supply sources. Estimated costs were given as $700/ML for reuse options for large scale industrial and agricultural projects and $3000/ML to implement dual reticulation systems.

The preparation of least cost planning analyses, of recycling options for Sydney, lead to the observation by Gregory (2000) that it would be more cost effective and environmentally sound to reduce demand for water within the community than pursue recycling options. Despite this a number of recycling schemes have been developed which includes 13 reuse schemes of which five are regulatory-driven and eight customer-driven (Gregory 2000). Some of these are summarized as follows:

1. **Dunheved Golf Course** – located at St Mary's 50 km west of Sydney, recycled water from St Mary's STP (up to 1ML per day) is used for irrigation and is repaying the capital cost of the distribution system as a monthly fee over 20 years (Sydney Water, 2003).

2. **Picton** – located 60 km south west of Sydney, the scheme uses recycled effluent used to irrigate Lucerne crops, ryegrass/clover pastures and a woodlot at Carlton Farm. The area irrigated covers 134 ha and requires 0.8 – 4 ML/d (Sydney Water, 2003).

3. **Gerringong-Gerroa** – located 103 km south of Sydney, utilize recycled effluent that has been treated secondary and tertiary treated using a biological reactor, clarification, sand filtration and disinfection using ozonation, biologically activated carbon, microfiltration and UV. A minimum of 80% is required to be used and is applied to pasture production on an adjacent dairy farm (Boake and Ovens 2003, Kidd 2003).

4. **Richmond Golf Club and University of Western Sydney (UWS)** – located 50 km north west of Sydney, recycled water from the Richmond STP is used for irrigating the grounds at the golf club, pasture production for the dairy, horse and grazing unit at UWS and irrigation of horticultural crops, orchards and playing fields at UWS (Boothe *et al.* 2003).

5. **Rouse Hill** – located 40 km north west of Sydney, once the development is fully developed it is hoped it will save up to nine million litres per day. The project is designed to protect the Hawkesbury Nepean River and includes areas of Sydney's south west including Rouse Hill, Parklea, Stanhope, Glenwood, Kellyville and Castle Hill. The scheme provides recycled water at 67c per kilolitre cheaper than drinking water and is delivered via a dual reticulation system (recycled water in lilac pipes, as shown below). The system is designed to ultimately supply recycled water to 100,000 homes. The recycled water will be used for toilet flushing, car washing, garden watering, park and golf course irrigation and industry. The only negative is that water use in the area has sometimes registered 20% above the Sydney average. Residents will continue to use the supplied drinking water for showering, cooking and drinking (Sydney Water, 2003).

Figure 4.1 - Deliver scheme using dual reticulation pipes, recycled water delivered in lilac pipes and fittings with warning signs
Source: ATSE, Water Recycling in Australia, p. 57

6. Georges River project – located west of Sydney (see map below), this proposed development would provide up to 100 ML/day of recycled water through 50 km of pipelines which link the Glenfield and Liverpool STPs to the Malabar outfall. It is planned that the scheme will be fully commissioned by 2008 (ATSE, 2003).

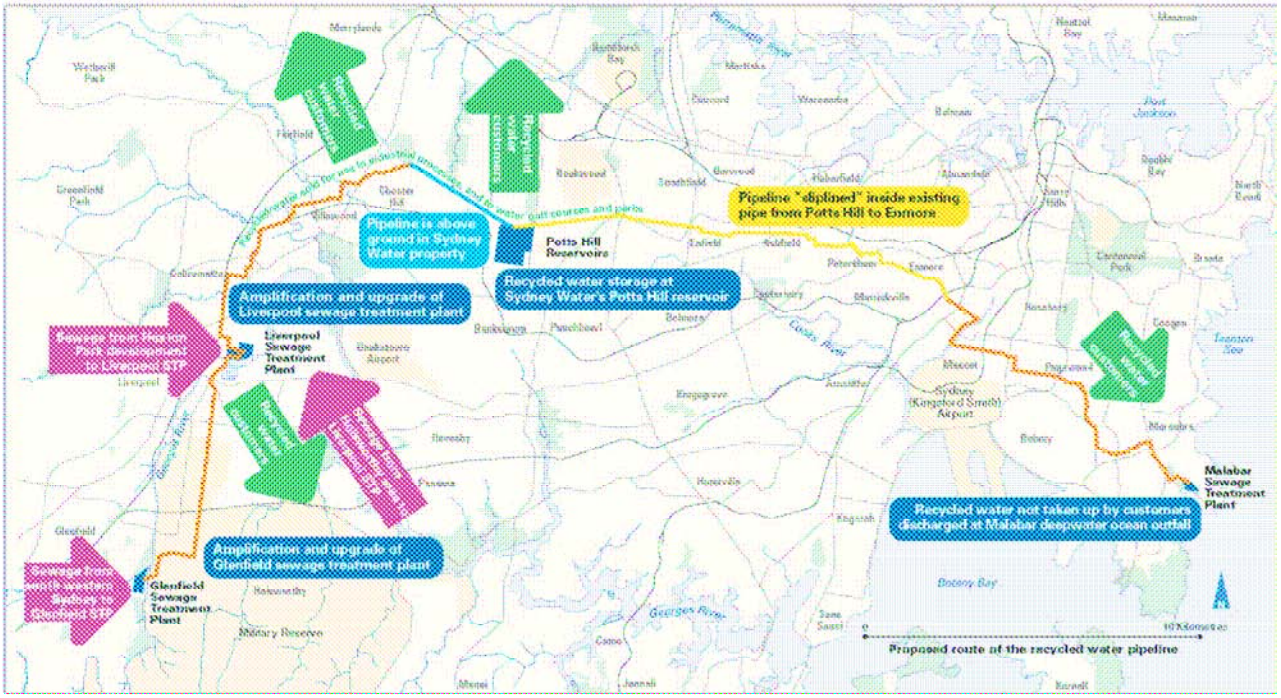

Figure 4.2 - Representation of the Georges River pipelines recycled water scheme
Source: (ATSE, Water Recycling in Australia, p. 59)

7. Illawarra wastewater strategy – located 70 km south of Sydney, the upgrade of the Wollongong, Port Kembla and Bellambi STPs will represent one of Australia's largest and most advance water recycling treatment facilities as part of the Illawarra wastewater strategy. The BlueScope Steel's Port Kembla facility will initially accept up to 20 million litres per day of recycled water, with other local industries being targeted for future opportunities. It is estimated that this project will reduce drinking water usage by 17% in the Illawarra region (Sydney Water, 2003).

8. Sydney Olympic Park – The water recycling facility at the Sydney Olympic Park integrates stormwater collection and sewage treatment and was prepared for the 2000 Olympic Games as a showcase facility. Recycled water is provided for all non-drinking purposes to residents, commercial residents, sporting venues and irrigation of parklands and playing fields at the site. The advanced tertiary treatment system has advanced biological treatment using two sets of sequencing batch reactors. It is designed that one set of the reactors can be disconnected at periods of low flow through the Olympic Park STP. UV disinfection is used once all the pollutants and nutrients have been removed.

   The recycling facilties also support the nearby suburb of Newington, which is supplied recycled water through a dual reticulation system similar to that used at Rouse Hill. The water supplied has been assessed to be suitable for toilet flushing, washing clothes, cars, pets, buildings and brickwork, ornamental water features, fire fighting, watering gardens (including vegetables), lawns, parks and playing fields. Estimated savings include 850 ML of drinking water per year, elimination of sewage effluent discharge to waterways or the sea and control and use of stormwater.

9. Liverpool Golf Course – Sydney Water are currently installing a system that will provide approximately 80 million litres of recycled water per year to irrigate fairways and greens (Sydney Water, 2003).

Regional New South Wales also has a number of recycling schemes including Newcastle, Barwon Region, Port Macquarie and Shoalhaven. Reticulated water is provided to 1.5 million people in 375 towns and reticulated wastewater to 1.3 million people in 264 towns through corporatised Shire Council water entities. The Country Towns Water and Sewerage Program provides technical and financial assistance of up to 50 per cent of capital costs of approved new works (minus developer contributions). This program is administered by the Ministry of Energy, Utilities and Sustainability.

The effluent recycling schemes recorded 26% reuse of a total of 171 GL/year through 109 NSW Local Government STPs. Of these 109 STPs, 56 recorded recycling of more than half of their total effluent flow. The number of country Council STPs recycling water and their uses is reproduced in the table below. (ATSE, 2003).

Uses of Effluent	No. of country Council STPs recycling (includes multiple uses)
Golf Courses	46
Pastures (Dairy, beef, Sheep)	32
Sports fields and Ovals	19
Woodlots, Trees, Forestry	14
Racecourse	10
Landscaping, parks, amenities	9
Schools	4
Lucerne irrigation	4
Fodder and Hay	4
Cotton irrigation	3
Cemetery	3
Horticulture	2
Mining processes	2
Showgrounds	2
Dust suppression	2
Nursery	2
Timber Mill	1
Bowling Club	1
Hydroponics	1
Wetlands	1
Dune stabilization	1
Truck Wash	1
Power Station	1

Table 4.2 - Uses recorded of effluent from New South Wales country STPs, 2000
Source: (ATSE, 2003 p. 66)

4.3 VICTORIA

Melbourne Water is owned and operated by the Victorian Government and in June 2003 produced the Recycled Water Handbook providing information to on how recycled water may be safely used and to provide guidance for those individuals or corporations wishing to start their own recycling scheme. Melbourne Water have committed themselves to achieving 20% recycling by 2010 to reduce discharges to marine environments and replace water currently sourced from groundwater bores, streams and rivers thus restoring natural flows in the State's waterways (Melbourne Water, *Recycled Water Handbook,* 2003).

Environmental Protection Agency (EPA) Victoria is responsible for providing guidelines on the management of recycled water use, ensuring that the recycled water is "fit for purpose". Applications for new recycled water uses or schemes are accepted by Melbourne Water and forwarded to EPA Victoria for approval. These approvals are in accordance with EPA Victoria's *Guidelines for Environmental Management: Use of Reclaimed Water*.

Once approval is obtained the recycled water is approved to be used for the purpose that is appropriate to the level of treatment that the water has undergone. Where the use is deemed to be sensitive, such as recreational water bodies, industrial processing, residential third pipe systems and aquifer recharge, project-specific submissions are required and assessed on a case-by-case basis by EPA Victoria. Other recommended uses for recycled water include agricultural/horticultural irrigation, watering parks and recreational areas, toilet flushing and garden watering, and in new suburbs as part of water-sensitive urban design (Melbourne Water, *Recycling Water for a Greener Future,* 2003).

Two major sewage treatment plants are operated by Melbourne Water. These are the Western Treatment Plant at Werribee and the Eastern Treatment Plant at Bangholme, which combined treat approximately 855 million litres of sewage per day. Currently about 11% of this water is recycled and used either on-site or utilized by customers for irrigation of agricultural crops, golf courses or open spaces. The Eastern Treatment Plant has been selling recycled water since the 1970s and in 2004/2005 approximately 1389 million litres of recycled water was used by customers along the plant's 56 kilometre outfall pipeline. A feasibility study is being undertaken to determine the viability of transferring recycled water from the Eastern Plant to Latrobe Valley. If undertaken, this project is estimated to potentially use up to 80% of the plant's treated effluent.

In addition to this project, it is aimed to deliver about 5000 million litres of recycled water to the Cranbourne-Five Ways area each year to be used for irrigation of market gardens, golf courses and a racetrack. Melbourne Water also provides recycled water to TopAq, a private sector operator, who further treat the water using ultrafiltration membranes. TopAq then delivers this highly treated water to customers via a transfer and distribution pipeline 50 kilometres long.

With many golf courses, recreational reserves, vineyards, high value vegetable crops and orchards in eastern Victoria, Melbourne Water is working with South East Water, EPA Victoria and key stakeholders to source potential recycled water schemes.

The Western Treatment Plant is capable of providing enough recycled water to replace 25% of Melbourne's drinking water currently used for non-drinking purposes. A recent upgrade costing $160 million has improved the capacity of the plant and implemented treatment processes to reduce the level of nitrogen previously found in the recycled water. Recycled water from the plant is currently used to irrigate pasture within the boundaries of the treatment plant and has been supplying recycled water to the Werribee Tourist Precinct since 2003. Recycled water has also been supplied to the Werribee Irrigation Project since January 2005. This project involves the supply of around 3000 million litres of Class A recycled water each year to 130 farmers in the district by 2006/2007 and increasing to 8500 million litres after 2009. Previously water for irrigation was drawn from the Werribee River and underground aquifers in the area.

Melbourne Water is now working with City West Water, neighbouring water authorities and appropriate government departments to extend the supply of recycled water to residential developments north-west and north-east of the Western Treatment Plant. A new development comprising 2000 homes is planned for Werribee Fields. It is hoped that this development will showcase market-leading sustainable water and energy use methods and will include 'third pipe' recycled water systems.

Other initiatives being investigated by Melbourne Water include trialling onsite water recycling plants in parks around Melbourne, using conventional filtration, activated carbon treatment and membrane systems/micro filtration processes. It is anticipated that 1% of the flows that usually go to Melbourne's treatment plants could be treated onsite to be used to irrigate parks and gardens. Key projects being targeted by City of Melbourne, City West Water and Melbourne Water include Melbourne Zoo, 2006 Commonwealth Games Athletes Village, Royal Park, Princes Park, Melbourne University open space and Fitzroy Gardens.

Aquifer recharge and domestic water recycling are areas being investigated by Melbourne Water for their viability as water recycling uses and schemes. Aquifer recharge is an opportunity to store recycled water and assist aquifer recovery where water has been overdrawn (Melbourne Water, *Recycling for a Greener Future,* 2003).

Domestic water recycling in Victoria is the responsibility of the retail water companies – City West Water, South East Water and Yarra Valley. Domestic water that is acceptable for recycling includes greywater from baths, showers, basins or washing machines. '*Reuse Options for Household Wastewater'* is part of the domestic wastewater management series provided by EPA Victoria and details regulations, legislation and policy and treatment options for treating and reusing wastewater form single households.

4.4 SOUTH AUSTRALIA

Adelaide was the first Australian capital to treat all wastewater to a secondary quality and currently has a wastewater system consisting of a 6800 kilometre network of sewer pipes and four major wastewater treatment plants in the metropolitan area serviced by SA Water. In country areas SA Water is responsible for 19 of the 20 treatment plants while the remaining plant at Aldinga is privately owned and operated. South Australia has been developing recycling practices since 1944 and boasts the highest per capita level of recycled water use in Australia. The amount of wastewater being recycled has increased from 4.7% in 1997/98 to 20.5% in 2003/04 and South Australia aims to increase this to 30% by 2025. In addition to the reuse of treated wastewater, SA Water is also investigating the use of biosolids, the organic solid residue produced by the wastewater treatment process (SA Water, 2005).

The South Australian government have pinpointed areas where there is potential to expand or develop further large-scale recycled water schemes. Figure 4.2 on page **??** highlights those areas where there is potential for consumption of non-drinking water or recycled water and the location of Waste Water Treatment Plants in the water proofing Adelaide boundary. Extraction of groundwater resources in the Northern Adelaide Plains and the Willunga Basin have reached or exceeded their sustainable limits and the continuation and expansion of irrigated agriculture in these areas represents an opportunity to increase recycled water schemes.

This year the South Australian government released a document titled *'Water Proofing Adelaide – A Thirst for Change 2005 – 2025'* which sets out the current actions being undertaken within South Australia and what the government has determined to be the best course of action to that the water '*is used in the best possible way for the combined benefit of our people, our industries and our environment'* (SA Government, 2005). Part of this strategy is the commitment to looking at new and innovative ways to re-use and recycle water. In particular the following strategies for water recycling have been set out in the above document and are reproduced here:

1. The Adelaide Coastal Waters Study will provide information on the extent to which the discharge form stormwater and from wastewater treatment plants is still affecting the marine environment in Gulf St Vincent. This may lead to additional interventions to reduce impacts.
2. National health guidelines for water reuse, including greywater, will be developed by the SA Government, in conjunction with the Australian Government and other States and Territories.
3. Further opportunities for large-scale recycled water projects including the expansion of existing schemes will be implemented where they are viable according to an economic, environmental and social impact assessment.
4. Localised reuse of recycled water and/or stormwater will be considered for new land divisions as part of water-sensitive urban development requirements.
5. Regulations relating to sewer mining and greywater reuse systems will be reviewed to ensure that restrictions on reuse justified by the public health and urban amenity criteria.

In early 2005, a dual pipe system was commissioned to deliver recycled water from the nearby Bolivar Wastewater Treatment Plant and reclaimed water from Salisbury wetlands to 1000 homes at Mawson Lakes. The project was made possible through the involvement of the South Australian government and the City of Salisbury and Delfin. Recycled water is used for toilet flushing and the watering of parks and gardens in the development.

Another development at New Haven Village, located 20 km northwest of Adelaide at Le Fevre Peninsula, has 65 medium density dwellings on 2 Ha. The development was implemented by the South Australian Housing Trust with the input of private and public participants in 1995. An onsite wastewater treatment system allows the re-use of household sewage (black and grey water) and a stormwater system which collects the first 50000 litres of each individual rain event. The remaining rainwater is directed to a retention basin which also acts as a sporting field. The management system ensures that virtually no wastewater leaves the site with recycled water being used for house gardens, toilet flushing and sub-surface irrigation of sporting ovals. The development has experienced problems with the water system not meeting health requirements. A recent survey, although initially positive, highlighted some concerns from residents. These concerns involve noticeable odours, murky colour and/or sediment in the toilet flushing water. Disruptions to the water service and water approved for sub-surface irrigation being used for above ground micro sprays leading to clogging of irrigation fixtures are also issues for the residents.

In country areas, 10% of households are not serviced by the SA Water Corporation and rely on the Septic Tank Effluent Disposal Scheme (STEDS) to treat wastewater and protect public health. This scheme is comprised of a network of gravity drains which is connected to individual septic tanks and is conveyed to a common treatment and disposal facility. This facility is owned, operated and managed by the local government agency and is usually a simple oxidation lagoon providing secondary treatment. The costs advantages are that the costs associated with the provision and maintenance of the septic tank are the responsibility of the owner. The scheme has been in operation since 1972 and was handled by the State Government up till 1995. Over 18 ML of effluent is treated each day by STEDS and 50% of the recycled effluent is used to irrigate sports fields, town commons and wood lots. Some towns use the wastewater and stormwater conjunctively and others have altered the treatment process to combat high salinity by deepening ponds and adding mechanical aeration. The scheme services 130,000 residents with a further 68,000 waiting to link up to the system. Schemes servicing more than 1000 people (100 in water protection areas) are required to be licensed under the *Environment Protection Act (1993)* (ATSE, 2003).

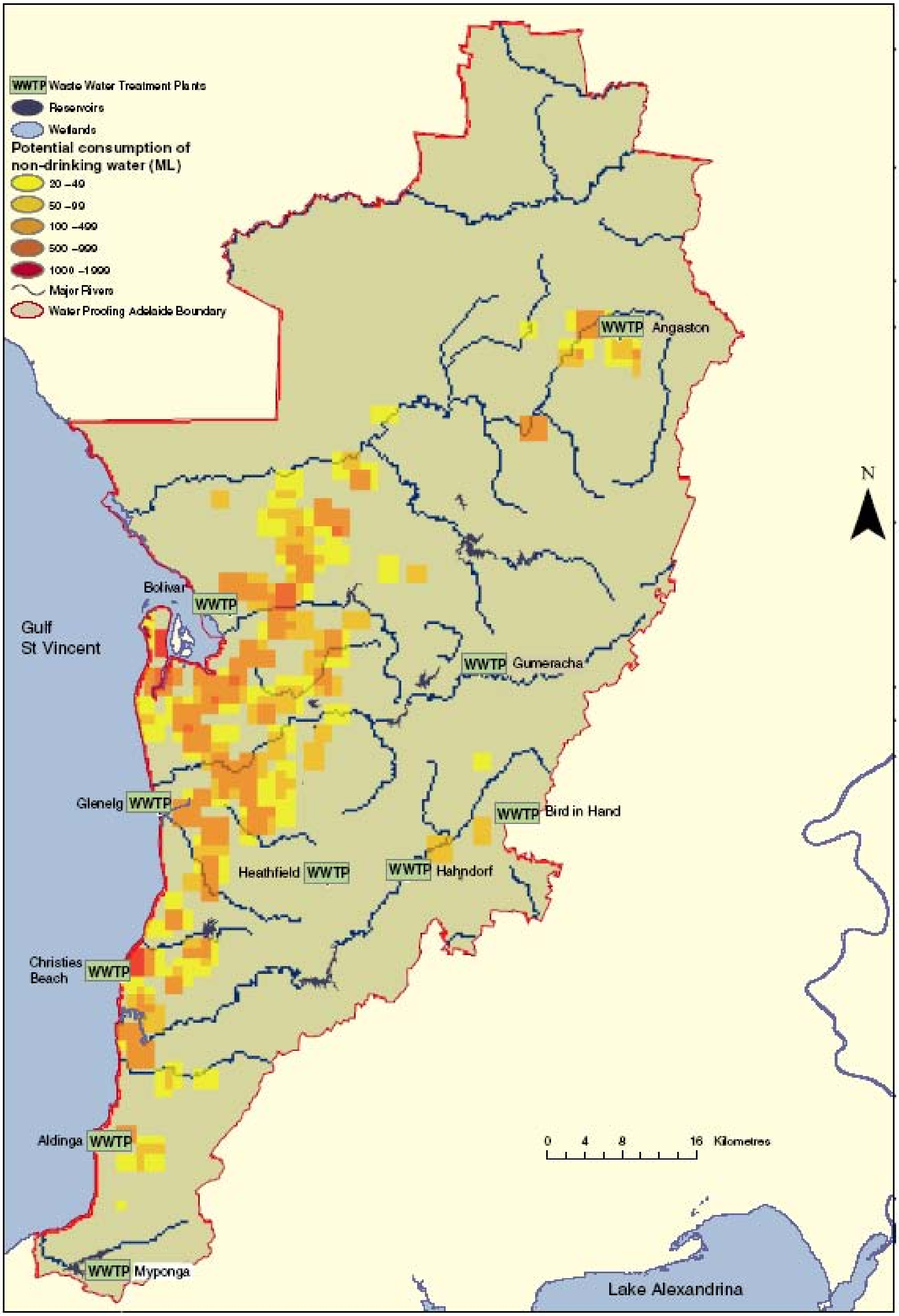

Figure 4.3 Areas within the Water Proofing Adelaide boundary where there is the greatest potential for water reuse

Source: (SA Water, 2005)

4.5 TASMANIA

Tasmania's water and wastewater services are provided by Local Government with the management of water quality governed by the *State Policy on Water Quality Management 1997* (SPWQM) and the *Environmental Management and Pollution Control Act 1994*. Producers of wastewater use wastewater reuse or water recycling to manage the amount of liquid wastes being disposed in aquatic ecosystems. Tasmania's sewage treatment plants, and other wastewater producers, use the key components of reduce, reuse and recycle to limit emissions from point source discharges.

In 2002, the Tasmanian Government released the *Environmental Guidelines for the Use of Recycled Water in Tasmania* to assist with facilitating water recycling, particularly agricultural irrigation. This document gives comprehensive guidelines in the following areas:

- Ground rules for Developing a Sustainable System
- Regulatory Framework
- Wastewater Quality Requirements
- Wastewater Treatment and Distribution
- Site Requirements
- System Requirements
- Operational Requirements for Wastewater Reuse

(Tasmanian Government, 2002)

Due to high rainfall, the key drivers in Tasmania for water recycling are reducing environmental impacts resulting from discharges to inland and estuarine waterways, cost effectiveness of water reuse compared to upgrading STPs and the economic development of agriculture in the state. It is anticipated that by 2005 70-80% of wastewater treatment systems in Tasmania will utilize some form of water recycling and all new wastewater system's central strategy should include recycling to minimize or avoid discharges to aquatic ecosystems.

In the drier areas of Tasmania, to the south, there is the potential to use at 2.5 GL/year through major schemes at Brighton and the Coal River Valley. Farmers near Brighton were seeking access to irrigation water and in a jointly funded project by the Brighton Council, NHT Coasts and Clean Seas program a recycled water distribution network was established. Although wastewater was being used for irrigation 12 months after funding was announced the project faced some barriers highlighting the need for stakeholder involvement and community consultation. The barriers included the lack of consistent national guidelines, lack of community awareness of the risks involved and lack of awareness by regulatory bodies.

Coal River Valley has the largest secondary treatment reuse in Tasmania and sources the wastewater from the Rosny Park STP. Over 500 farms are serviced by this scheme, using an available 2.7 GL/year, to irrigate extensive horticulture, viticulture and turf growing. The majority of funding was sourced from the Commonwealth Government and the

National Heritage Trust has facilitated the funding of 30 water-recycling schemes in Tasmania between 2000 and 2002. (ATSE, 2004)

4.6 NORTHERN TERRITORY

In the Northern Territory multiple irrigation schemes are supplied reclaimed water by the Power and Water Corporation. The Power and Water Corporation is also responsible for ensuring the protection of public health, and ensuring that all reclaimed water use is socially acceptable, environmentally sustainable and commercially viable. Power and Water, in 2003, issued a customer information handout titled – *'Applying Reclaimed Water for Irrigation Schemes – Management and Safeguards'* to provided guidance for new and existing schemes. The Chief Health Officer of the Department of Health and Community Services (DHCS) in the Northern Territory is responsible, however, for the approval of all water recycling proposals. The reclaimed water assessment and management of individual projects by Power and Water is performed according to the *National Water Quality Management Strategy, Guidelines for Sewerage Systems, Use of Reclaimed Water, November 2000 (ARMCANZ, ANZECC and NHMRC)*.

The end use of the reclaimed water is determined by the degree of treatment and Power and Water recommend that this be taken into consideration at the design or land acquisition stage. Routine sampling is carried out by Power and Water on all existing water treatment schemes, with the primary focus being the protection of public health. All assessment results are passed to DHCS for further consideration.

Each reclaimed water scheme is managed by a Customer Agreement which sets out the terms and conditions governing the supply of reclaimed water for irrigation. Depending on the nature of the irrigation scheme, the agreement will cover supply charges, safeguards and controls to be followed by the customer. Safeguards include limitations on public access and irrigation scheduling, plumbing requirements (to prevent cross contamination with potable supply) and signage requirements.

There several reclaimed water use project currently being undertaken in the Northern Territory. These are summarized as follows (ATSE, 2003):

Darwin Golf Course and Marrara Sports Complex – Darwin Golf Course STP supplies 450 ML/year to the two developments with water for the Marrara Sports Complex drawn directly from the golf course pond. Safeguards include restricting customer access from 11 pm to 5 am to facilitate watering and mains are flushed prior to each irrigation cycle to prevent odour generation.

Humpty Doo Waste Stabilisation Ponds – 10 ML/yr of effluent from the ponds are directed onto nearly natural bushland by spray irrigation. The effluent has elevated levels of *E.*coli and as a safeguard human contact is prohibited, the areas is completely fenced and a buffer area maintained between human dwellings.

Pine Creek Waste Stabilisation Ponds – 8 ML/yr of high quality recycled water is produced and directed to sports ovals and rail corridor for irrigation. The Ponds also implement flushing of the system prior to irrigation to prevent odour generation.

Katherine Waste Stabilisation Ponds – 45 ML/yr of high quality recycled water is produced and used on pasture and fodder harvested for a cattle feed lot. Extended retention times have contributed to the high quality of the recycled water produced.

Alice Springs – 580 ML/yr system currently used to irrigate open spaces, sports ovals and a tree lot. Power and Water, at the time of the report, were undertaking negotiations with Alice Springs Town Council and the Blatherskite Park regarding the management of the system and safeguards currently in place to determine if the measures are adequate in protecting public health.

Kings Canyon – reclaimed water is used to irrigate tree lots and resort grounds at Yulara. Safeguards include restricting public access and implementation of filtration and chlorination on water that is accessible to the public.

4.7 AUSTRALIAN CAPITAL TERRITORY

In April, 2004 the ACT government released the document *'Think water, act water'* which detailed the government's long term strategies and directions for water resource management through to 2050. Water reuse has been identified within this strategy as a way to reduce water consumption within the state. Currently high class drinking water is used for irrigation and other purposes that potentially could be serviced by recycled water. At the time of the report, only 1.8 GL of water was recycled in the ACT. As part of the strategy it is hoped to increase this figure by 20% by 2013. It is intended that further research will be conducted to determine the feasibility of reaching this target sustainably. In the short term the following reuse measures will be pursued:

- Develop guidelines for use of domestic greywater and include information in community awareness programs
- Reticulate reclaimed water from the Fyshwick treatment plant to irrigate ovals in North Canberra
- Investigate the opportunities for sustainable reuse in greenfield and re-development areas
- Ensure that any building the Government builds or procures for its use will incorporate features to maximize efficiency of water use and reduce the demand on mains water through alternative supplies, such as stormwater, rainwater and reclaimed water

(Think water, act water, ACT Government, 2004)

As mentioned above the ACT currently recycles approximately 1.8 GL of wastewater. Duntroon Military College has been utilizing reclaimed water, which has been secondary treated by the Fyshwick STP, to maintain playing fields for the last ten years. The Fyshwick STP, is currently scheduled for upgrade to incorporate microfiltration membrane filtration to ensure that reclaimed water is of very high quality. This water will be used to irrigate 60 Ha of public parks and sporting fields in adjacent suburbs, Australian National University and the Australian Defence Force Academy. The plant has been designed so that it can be upgraded with the potential to supply water for all of inner North and South Canberra.

The main wastewater treatment facility for Canberra is the Lower Molonglo Water Quality Control Centre (LMWQCC) and is the largest in Australia. The facility treats 90ML of effluent daily and provides high quality tertiary treated water for the local golf course, vineyards and treatment processes. The remaining treated water is discharged to Molonglo River which flows on to the Murrumbidgee River to enter Burrinjuck Dam maintaining environmental flows and a water source for downstream users.

Greywater treatment systems are not formally approved by the ACT government, but ACT Health are able to provide advice and recommendations pertaining to effluent guidelines for treatment systems. The two Acts covering treatment systems is the Public Health Act 1997 and Environment Protection Act 1997. These Acts can be invoked if the operation of the system is deemed to create an offence under these Acts, even if the system demonstrates that the water is treated to recommended effluent guidelines (ATSE, 2003).

CHAPTER 5

PUBLIC PERCEPTIONS AND THE ROLE OF WATER RE-USE IN INDIVIDUAL HOMES

Probably the most important consideration when contemplating the introduction of recycled water use within our communities is the role the public perceptions will play in its introduction or the opposition to it. The following chapter looks at the reasons for this community opposition and what factors will be involved in recycled water being successfully introduced as a regular water source.

5.1 SURVEY OF PUBLIC PERCEPTIONS OF GREY WATER REUSE

As part of this assessment into the factors affecting water reuse opportunities in Western Australia, it was decided to conduct a survey to determine the current awareness of the general public to grey water reuse and their willingness to use recycled grey water within a private residences. Other information requested was demographic data including age, state of residence and sex. Demographic data was considered important to ensure that the focus group covered a wide range of age groups, areas of Australia (Tasmania being the only state where data was not obtained) and approximately equal spread of males to females. Questions also included whether the persons surveyed currently recycled grey water, the maximum cost they would be prepared to pay for a recycling unit, and the motivation behind installing a grey water recycling system.

Appendix B contains a copy of the information that was sent by email to various friends and family with a request to forward on to other contacts. The use of email was considered to be a more efficient method of collecting the required survey data, rather than approaching people in a shopping centre environment. The benefits of the email survey included being able to access people in nearly every state of Australia, with a wide range of ages and a large number of people in a short period of time. A large majority of responses came from people that were unknown to the author, and therefore garnered answers that were not weighted by a previous knowledge of the project.

The email was initially sent to eleven family and friends and resulted in 51 responses being obtained. A larger data set would have been preferred, but the results showed that the survey respondents represented a wide range of age groups and areas of Australia. Results for the non-demographic questions are also showed that the responses obtained were fairly uniform with clear trends able to be seen.

The results obtained from this survey can be seen in the table on the following page. A summary of the results indicates the following:

- Most people are aware of GW recycling
- Most people currently don't recycle GW
- Most people would like to use recycled water for above ground watering
- Most people would not pay more than $500
- Monetary savings and Environmental concerns are the greatest motivations

The questions asked and the response percentages are included below:

1. Age Group

A	18 – 25	22%
B	26 – 45	64%
C	46 – 65	10%
D	65 and over	4%

2. Home State or Territory

A	Western Australia	37%
B	South Australia	4%
C	Victoria	2%
D	Tasmania	0%
E	New South Wales	4%
F	Queensland	45%
G	ACT	4%
H	NT	4%

3. Sex

A	Female	57%
B	Male	43%

4. Were you aware that it is possible to recycle grey water within a private residence?

A	Yes	80%
B	No	20%

5. Do you currently recycle grey water within a private residence?

A	Yes	18%
B	No	82%

(If yes can you include the sources of the grey water, i.e. laundry, kitchen)

6. If you answered no to the previous question, would you consider installing a system to recycle grey water within a private residence?

A	Yes	87%
B	No	13%

7. If yes, how much would you be prepared to pay for a grey water recycling system?

A	up to $500	75%
B	up to $1000	21%
C	up to $2500	2%
D	over $2500	2%

8. Which applications would you be prepared to use recycled water for? (pick more than one if applicable)

A	Above ground garden watering	39%
B	Below ground garden watering	31%
C	Toilet Flushing	30%

9. What would be the greatest motivation to install a grey water recycling system?

A	Monetary savings	36%
B	Environmental Concerns	64%
C	Gadget Factor	0%

These results reflect a growing consciousness within the general community that changes in the way we use water within the home will be necessary. However, the majority of respondents were only prepared to pay up to $500 for a system and would desire a system where the results were visual available. Above ground water allows the user to see the direct results of the money invested, whereas uses such as toilet flushing and below ground watering would yield less visible results.

QUESTION	A	B	C	D	E	F	G	H	TOTALS
1	11	33	5	2					**51**
2	19	2	1	0	2	23	2	2	**51**
3	29	22							**51**
4	41	10							**51**
5	9@	42							**51**
6^	41	6							**47**
7^	35	10	1	1#					**47**
8*	45	36	35						**116**
9*	23	41							**64**

Table 5.1 - Survey on Public Perception of Grey Water Recycling in Private Premises

This respondent lived just south of Toowoomba, Queensland where he was required to have a treatment plant installed to treat all wastewater.
* These questions may have one or more answers.
^ Some respondents who have answered yes to question 5 chose not to answer 6 & 7.
@ Laundry direct onto grass, kitchen water for watering. Only one respondent has indicated an installed GW system.

5.2 PUBLIC PERCEPTIONS

A presentation at the Environmental Health Symposium hosted by the Department of Health, Western Australia in December, 2004 titled 'Public Perceptions of Wastewater Reuse' (McGuinness, N. and Van Buynder, P., 2003), made the following observations. The closer that recycled wastewater is to human contact or ingestion, the more people are apposed to it and public acceptability decreases dramatically when it changes from external usage to uses within the home. They list the follow points as being the key factors influencing public perception of wastewater reuse.

- The disgust or "yuk" factor;
- Perceptions of risk;
- Specific uses of recycled wastewater;
- Sources of recycled wastewater;
- Ability to have choice to reuse;
- Trust and knowledge;
- Existing environmental attitudes;
- Environmental Justice Issues;
- Cost of wastewater reuse;
- Socio-demographic factors.

It was highlighted that those people with a positive and active attitude towards environmental concerns and conservation were more likely to be accepting of wastewater reuse. This is also highlighted by the results obtained by the above survey for question nine. The exception to this was likely to be when recycled water was directed towards cooking and drinking. The disgust or "yuk" factor is also mentioned in a report by the CSIRO, issued in April 2004, titled 'Australian Conservation and Reuse Research Program'. This included a literature review of the factors influencing public perceptions of water reuse. It refers to a psychological barrier that most people have to wastewater reuse and literature as far back as the 1970's has used the term. To overcome this barrier, McGuinness and Van Buynder (2004) suggest that trust in the authorities responsible for water recycling, in particular their integrity and ethics is essential.

A research brief for the Parliament of Australia, prepared by Dr Sophia Dimitriadis, titled *'Issues encountered in advancing Australia's water recycling schemes'* issued August 2005, comments that the most prominent public concerns are over cost and health but also include concerns for environmental justice and impacts from urbanization. The brief uses the example of Toowoomba City Council who intend to treat approximately 5000 ML/year using ultrafiltration, reverse osmosis and ultra-violet light disinfection to replenish their rapidly diminishing water supplies. The brief comments that there has been little opposition but project developers are cautious as similar projects have been halted due to an outcry of public opposition. However, a story in the local newspaper The Chronicle (Donaghey, K. 4/10/2005) reports that the introduction of recycled drinking water will be delayed three years longer than planned to allow further testing by CSIRO to confirm its safety to public health. This change is due to community concerns on the quality of the drinking water and comments from community leaders that Toowoomba would be used as guinea pigs for the nation.

The source of the recycled wastewater will also impact how well the water is received by the general public. McGuinness and Van Buynder (2004) suggest that the "yuk" factor is reduced if the source is closer to home, i.e. recycled greywater. This gives the user a higher perceived level of control over the quality of the wastewater then they would have over combined treated wastewater from secondary sources. It is anticipated that the level of human exposure to recycled wastewater will be directly proportional to the time it will take to introduce the source into mainstream usage. That is, the greater the human contact the longer it will take to establish. The use of recycled wastewater for industrial applications represents an area where there is very little human contact.

The level of concern and misunderstanding within the community in Perth is highlighted by a recent incident where members of the University of Western Australia raised concerns about recycled water used to irrigate playing fields (King 2005). Players were attributing slow healing cuts and grazes and two cases of staph infection to the treated wastewater from the WA Water Corporation's Subiaco treatment plant. The state Health Department and the Water Corporation issued statements to the effect that the water used was of a better quality than was required for the purpose of irrigating sporting fields. The wastewater used was subjected to standard primary, secondary and tertiary treatment, followed by additional filtration and chlorine disinfection. The recycled water was also subjected to regular independent testing to verify the quality of the water.

This newspaper report highlights the need for greater education of the persons who will be direct or indirect contact with recycled water. A further report in the Queensland newspaper, The Courier Mail, suggests that '*almost half the demand for water in booming southeast Queensland could be met through recycling'* (Johnstone, 2005). The report accessed by the author concludes that technology is sufficiently advanced to support recycling infrastructure, but that social acceptance remains the main barrier to widespread introduction.

In Western Australia, social research shows that there is an acceptance of water recycling, with 61% of respondents believing that water reuse would greatly benefit Perth. The Water Corporation is currently conducting a high profile media compaign to introduce the 'Security through Diversity' program. This program is aimed at highlighting the importance of water in our way of lives and educating the general public in the steps being taken to conserve water. This includes the various water recycling endeavours and aims to involve the community in water recycling schemes. This involvement is essential in working towards the 20% reuse target set by the state government.

CHAPTER 6

TYPES AND AVAILABILITY OF WASTE WATER FOR RE-USE

Only 2.5% of the earth's water is classified as freshwater, with the remainder of water is classified as saline, see figure below. This illustrates the very small proportion of the earth's water that is accessible and available for use and re-use. The figure also points out that only 0.3% of the total global freshwater is renewable. With the rate that the world's population is increasing, the potential water availability per person dropped from 12.9 to 7.6 thousand cubic metres per person from 1970 to 1994. These figures highlight the importance of water recycling (Water Resources Engineering Study Book, p. 2.2, 2004).

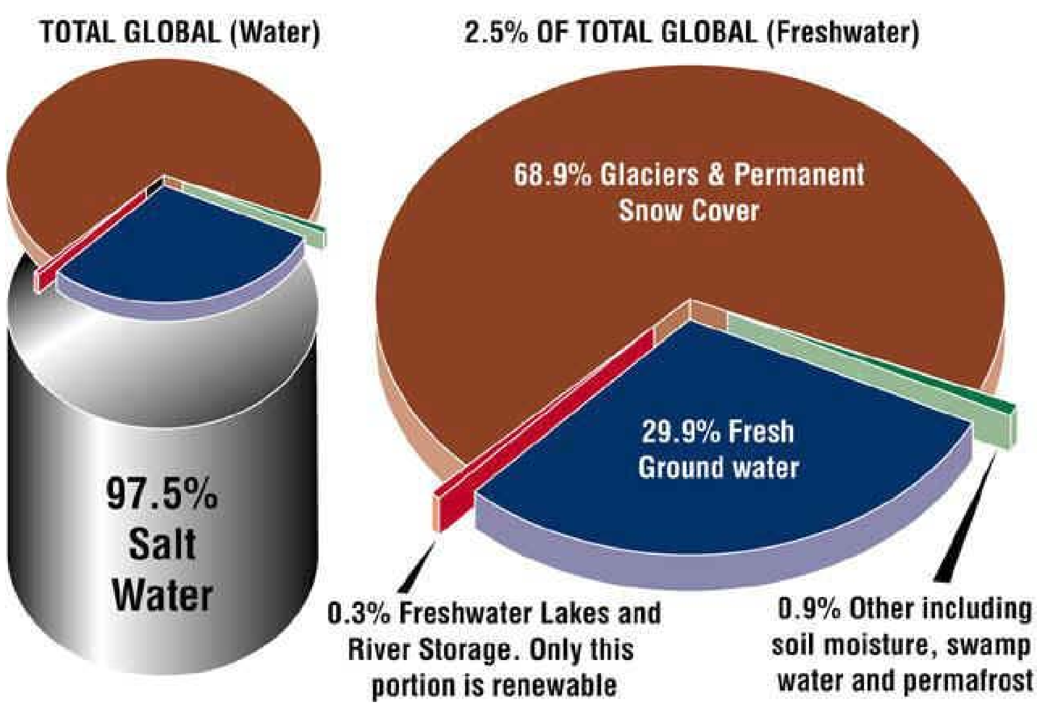

Figure 6.1 Pie graph showing the distribution of the world's water resources
Source: http://www.unesco.org/science/waterday2000/Cycle.htm

Waste water is generated from a number of sources, including domestic waste water, industrial waste water and stormwater runoff. Seawater has not been considered in this project nor the process or desalination, rather focusing on wastewater reuse. Each of these wastewater streams are now discussed below:

6.1 GREYWATER AND BLACKWATER

Domestic wastewater is characterized as either greywater or blackwater. Greywater is all wastewater excluding toilet water, including wastewater from showers, baths, spas, hand basins, laundry tubs, washing machines, dishwashers and kitchen sinks. Blackwater is the wastewater expelled through toilets, urinals or bidets. It is characterized by a high level of human excrement and requires an intense treatment process before it is able to be reused.

Disinfection of greywater is also required due to the presence of pathogenic microorganisms including bacteria and viruses in concentrations high enough to cause a health risk. Greywater also contains oils, fats, detergents, soaps, nutrients, salts and particles of hair, food and lint, which will have impacts on operational performance and life of a greywater irrigation system. The three main streams of greywater are:

Bathroom greywater – this makes up approximately 55% of the greywater produced by an average household. The chief contaminants consist of hair, soaps, shampoos, hair dyes, toothpaste, lint, body fats and cleaning products. Some faecal contamination is also possible due to body washing and will therefore have a level of bacteria and viruses.

Laundry greywater – 34% of household greywater originates in the laundry. Contaminants consist of lint, oils, greases, chemicals, soaps, nutrients and other compounds. There is also the possibility of faecal contamination due to nappy washing.

Kitchen greywater – 11% of household greywater originates in the kitchen. This wastewater is contaminated with food particles, cooking oils, grease, detergents and dishwashing powders. Kitchen greywater is not suituable for most greywater systems.

The average house (based on 3.3 persons per house) uses approximately 1000 litres per day, including the following activities:

Non – recyclable	**Recyclable**
Garden watering 47%	Shower 16% (Greywater)
Swimming pool 2%	Washing machine 13% (Greywater)
Leaks 2%	Toilet 10%
Taps 8%	
Total Other 2%	
61% or 610 litres per day	**39% or 390 litres per day**

This means that there is approximately 390 litres produced per day per average household that is available for recycling, of which 290 litres could be treated and utilized directly on site using a greywater recycling unit. As mentioned in Chapter 6, the Western Australian Department of Health sets out treatment levels and greywater reuse applications that are suitable for those treatment levels. Currently the guidelines restrict the reuse of recycled greywater to below ground trench irrigation and only allow micro drip and spray irrigation when the wastewater has been treated to an acceptable level. Department of Health have approved the use of several greywater systems in Perth, but these only treat the water to a standard that is suitable for below ground irrigation.

The Department of Health, in its '*Guidelines for the Reuse of Greywater in Western Australia'* also recommends against the use of kitchen wastewater in greywater systems due to the high level of fats and grease and solid food particles that in a basic recycling unit would lead to blockages and is incompatible with irrigation purposes also. They also suggest that kitchen wastewater is incompatible with bucketing onto the garden due to this high level of contaminants.

The two tables below has been reproduced from the Department of Health's Greywater Guidelines and shows the levels of Faecal Coliform numbers in the various types of greywater and how the composition of greywater compares to the composition of raw sewage. These figures show that most types of greywater will have some faecal coliform contamination, and treatment is required before the greywater can be safely used.

SOURCE	**FAECAL COLIFORMS (cfu) / 100 ml**			
	Rose et al (1991)	Calif. DHS (1990)	Brandes (1978)	Kapisak et. Al (1992)
Bathing/Shower	6×10^3 cfu	4×10^5 MPN	<10 to 2×10^8	6×10^3 cfu
Laundry Wash Water	126 cfu	$2 \times 10^3 – 10^7$ MPN		
Laundry Rinse Water	25 cfu			
Kitchen			<10 to 4×10^6 9×10^5	2×10^9
Combined Greywater	6 to 80 cfu[A] 1.5×10^3 cfu[B] 1.8×10^5 to 8×10^6 cfu		8.8×10^5[CD] 13×10^6[D]	1.73×10^5

Table 6.1 Faecel Coliform Numbers in Greywater prior to Storage
Source: Jepperson and Solley (1994) as reproduced in the Western Australian Department of Health '*Guidelines for the Reuse of Greywater in Western Australia, p. 3*

A - families without children
B - families with children
C – other study quoted
D – kitchen and bath only

cfu – colony forming units / 100 ml
MPN – most probable number

Parameter	Unit	Greywater[a]		Raw Sewage
		Range	Mean	
Faecal Coliforms	(cfu)/100ml	$25 – 2 \times 10^9$	1×10^9	$10^6 - 10^{10}$
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	<0.1-25.4	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

Table 6.2 Greywater composition compared with Raw Sewage
Source: Department of Health, 2005, *Guidelines for the Reuse of Greywater in Western Australia*

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

If greywater recycling is to be successful on a large scale then community education on use of low nutrient detergents, washing of nappies in the toilet, filters on the kitchen drain to prevent large amounts of food stuff entering the drainage system and caustic cleaners is essential. The Department of Health's guidelines recommend the following points:

- Washing powders that contain sodium slats as bulking agents should be used sparingly. High levels of sodium can produce saline greywater. Sodium can damage soil structure, reducing the air space, giving it a greasy texture and poor drainage capability. Products which use potassium salts or liquid concentrates should be used as they produce better quality, less saline greywater.

- Detergents and powder cleansers contain boron and should be used sparingly, as boron can be toxic to plants in high concentrations and can also be toxic to animals. The USA Environmental Protection Agency (1992) recommends the maximum concentration of boron be 0.75 g/L for long term use on sensitive plants.

- The use of the following should be avoided:

  - Bleaches or softeners
  - Detergents that advertise whitening, softening and enzymatic powers
  - Detergents with ingredients which include: boron, borax, chlorine, bleach, sodium perborate and sodium trypochlorite (salts), acids, etc.

- The following materials should not enter a greywater system

  - Paints, automotive oils and greases etc
  - Any matter designated as trade waste or industrial liquid waste

Other factors to be considered when considering the installation of a greywater recycling units, particularly in the instances where the recycled water is to be utilized for garden watering or large scale irrigation (community greywater recycling units), is the type of soil and the proximity to environmentally sensitive areas. Soils with greater leaching rates, such as sandy soils and gravels, will increase the risk of greywater flowing into groundwater or surface water bodies.

6.2 INDUSTRIAL WASTEWATER

Industrial wastewater can be defined as any liquid waste, other than domestic waste, that has been generated by businesses, industries or manufacturing processes and is acceptable for discharge to sewer. It is also commonly referred to as trade waste. Industrial wastewater is a broad category, some examples included fats, oils, grease, pulp and paper waste and food manufacturing waste. Small businesses that produce a large amount of oil and grease including restaurants and service stations, are required to install grease and oil interceptors traps to store the waste. These traps capture any solid waste and help to prevent blockage to the municipal wastewater systems and treatment plants. (WA Water Corporation, Gippsland Water)

The WA Water Corporation requires that businesses complete an Industrial Waste Application prior to discharging commercial and industrial wastewater to sewer. Details that are required prior to approval include the following:

- List of all chemicals and commercial formulations used in each process, including those used in cleaning routines. This includes the strength, supplier, daily quantity used and Material Safety Data Sheets (MSDS) for each commercial formulation used in significant quantities showing the composition of the formulations.
- Pretreatment Details – including a schematic diagram and process flow diagrams of any existing or proposed facilities for the treatment of industrial waste prior to discharge.
- Final Discharge Characteristics – this includes maximum rate of discharge to sewer (L/s), hours of the day when discharge is likely to take place, peak period of discharge, 5 day Biochemical Oxygen Demand maximum figures, maximum

suspended solids, maximum oil and grease, temperature range of discharge and pH range of discharge.

These characteristics allow the receiving waste water treatment plant to plan for increases in demand and different levels of contaminants and adjust the treatment process if necessary.

6.3 STORMWATER

Stormwater can be defined as collected rainfall from areas such as roofs, pavements, carparks, roads, gardens and vegetated open space. Increased urban development has led to the dramatic increase in runoff due to an increase in non-pervious surfaces. This means that there is greater run-off created during storm events and therefore greater runoff into our waterways. Integrated with this runoff is the pollution that has been washed off from the urban surfaces. This may include oil and grease, litter, heavy metals associated with road surfaces and nutrients from fertilizer used on gardens and parks. Recycling stormwater helps to prevent this pollution from entering our waterways and also provides an avenue to ease pressure on potable resources.

There are risks associated with recycling stormwater that are related to the collection source. An information sheet produced by the Australian Government discusses some of the issues affecting stormwater reuse. These are:

- Health Risks – rainfall can wash contaminants from urban surfaces as mentioned above and therefore increase the need for pretreatment before the stormwater can be reuse. The information sheet gives the general guideline that the more human contact with the water, the higher level of treatment required.

- Environmental Risks – the contaminants that can be found in stormwater can also pose an environmental risk in sensitive areas. It is important that the area to receive the treated or non-treated stormwater is assessed for its suitability prior to a long term application program.

- Flow Variability – in Australia it is very hard to predict when we will receive rainfall and how much. Very often it is either too much or too little, resulting in floods and droughts respectively. This factor needs to be taken into consideration when planning storage facilities or storage times.

- Treatment Levels – the treatment level required depends of the area and application that the reused stormwater is to be used and the level of exposure that the water will have to the general public and wildlife. Secondary treatment may be adequate, but some stormwater will require tertiary treatment prior to reuse.

- Safeguards and Controls – It is important that safeguards and controls are implemented to ensure that public health is not placed at risk. These include higher level treatment processes, reliable disinfection, well maintained infrastructure, application suitability and restrictions on crop irrigation.

- Management and Monitoring – The easiest way to ensure that safeguards and controls are implemented and prevent or better handle contamination impacts is a comprehensive management and monitoring program. A program run by local landcare groups in the metropolitan area in Perth, enlists school and community groups to conduct regular water monitoring of local waterways.

Source: Information Sheet 5, Stormwater Reuse, Australian Government Water Fund

There are many ways the recycled stormwater can be utilized and stored. These include the following:

- Aquifer storage and recovery;
- Urban lakes;
- Wetlands;
- Rainwater tanks;
- Water sensitive urban design;
- Water harvesting;
- Industrial reuse; and
- Unplanned reuse.

CHAPTER 7

WASTEWATER TREATMENT TECHNOLOGY AND PRIVATE AND PUBLIC SECTOR CAPABILITIES

Recycled water can be defined as '*the output or product from wastewater, stormwater or effluent that is usually treated to some extent, and redirected back into a water use scheme'* (Dimitriadis, S., 2005, p. 13) and '*is treated to stringent health regulations to meet a standard that is appropriate for its intended use'* (WA Water Corporation, 2005). It is obvious then, that the treatment process forms a very important part in the success of any water recycling program. The cost, availability, level of treatment, treatment capacity (L/s), environmental impacts and maintenance requirements of the wastewater treatment technology are essential factors to be considered when designing a system.

Due to advancements in the technology of wastewater treatment there is not a lack of appropriate systems available to treat all types of wastewater streams. These treatment types range from primary, secondary and tertiary levels. Primary treatment refers to basic filtration and sorting processes to removes large solids from the wastewater. Secondary treatment can be described as the removal of organic matter using aerobic biological processes. Tertiary treatment is the further processing of wastewater to further remove nutrients, micro filtration and higher levels of disinfection (Melbourne Water, 2005). A range of treatment technologies, in particular disinfection methods, that are relevant to recycling wastewater will now be discussed.

7.1 COAGULATION, FLOCCULATION AND SEDIMENTATION

The process of coagulation/flocculation is used in traditional water treatment by adding chemicals to cause particles that are slow to settle or are non-settling to settle out more readily. These chemicals are called coagulants. The coagulants react with the particles in the water, to form larger particles called flocs, which settle quickly and can be removed via filtration along with any residues of the chemicals used in the process. The process whereby particles settle out of solution without the aid of chemical intervention is simply referred to as sedimentation.

The process of wastewater treatment using coagulation/flocculation/sedimentation and filtration technology has been widely used around the world since the early part of the 20^{th} century.

7.2 FILTRATION

Processes using sand or fine particles to aid filtration is the oldest and simplest way to treat wastewater. In the early 20^{th} century, sand filters were developed that could treat wastewater at high flows and allowed for backwashing to prevent the sand filters from becoming clogged and remove trapped contaminants. Pretreatment of the water using coagulation and flocculation is necessary to increase the efficiency of the sand filters in removing fine particles.

The continued development of plastics have led to the design of a new range of filter materials and methods. More recent advances in filtration technologies have resulted in membrane filtration using microfiltration, ultrafiltration and nanofiltration and reverse osmosis. Figure 7.1 is a representation of the different stages of membrane filtration and results in water being passed through materials with smaller and smaller pore sizes. The tube represented in figure 7.1 is actually an enlargement of a single hollow fibre that is normally in one-metre long bundles containing many of the fibres. This process is known as microfiltration and a plant using this technology would have many of these bundles (CRC, 2002).

Reverse osmosis is based on the natural process of osmosis, which occurs in all living cells. The natural process would see pure water flow through the membrane to a solution high in salt. Reverse osmosis, as the name suggests, reverses this process by adding pressure to the salty or contaminated water to force it through the membrane. This process removes all contaminates from the water and continues until the osmotic pressure of the increasingly salty solution equals the applied pressure. Continually flushing the membrane allows the process to continue to uninterrupted.

In Western Australia, membrane filtration and reverse osmosis is used in a number of it's water treatment plant. The most notable being the Kwinana Reclamation Plant opened in November of last year and described in chapter 3.

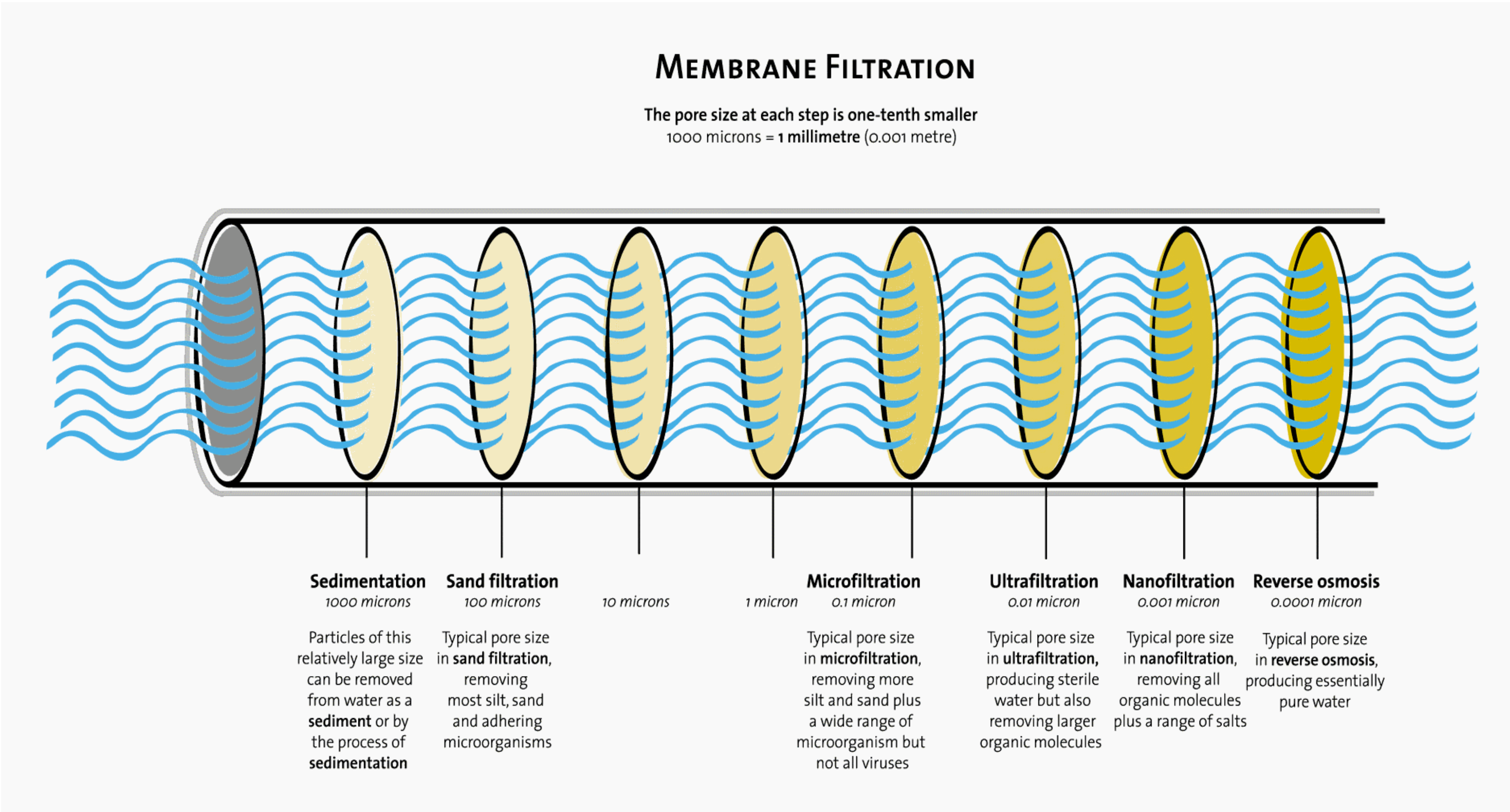

Figure 7.1 Graphic representation of the different levels of membrane filtration
Source: CRC, 2002, http://www.waterquality.crc.org.au/consumers/Consumersp9.htm

7.3 CHLORINE DISINFECTION

Chlorine disinfection is the most common method used to disinfect wastewater in Australia's wastewater treatment plants. Chlorine is available in gas form, or as the hypochlorite of sodium or calcium. Chlorine's oxidizing characteristics enables it to react with both organic and inorganic matter in water. Chlorine is relatively cheap and is readily available, however it is corrosive and requires special handling. Other disadvantages is that chlorine is only effective as a disinfectant in a pH range 6.5 to 7.5 and requires monitoring to ensure that levels remain at effective levels. It is also important to monitor chlorine residuals after the disinfection process to confirm that the water is within human health and environmental guidelines.

7.4 IODINE

Iodine is a well know medicinal approved disinfectant that is less sensitive to pH variations than chlorine. This reduces the need for complex pH monitoring and adjustment. Iodine is also less corrosive and is currently being considered as a replacement for chlorine disinfection in the Kalgoorlie/Boulder area. Current chlorine usage is causing corrosion to occur in the steel pipelines which carry the areas water supply. A Sydney based company has patented Iodine technology that will allow large dosages of Iodine to be applied to treat the water to an appropriate level, while removing any residuals through a resin exchange unit at pipe outlets (SLS Technology Pty Ltd, 2005).

Iodine disinfection technology has been used to treat water on all of NASA's space shuttle missions using beads impregnated with Iodine and the same technology is now being tested to provide safe drinking water in third world countries. It is claimed that large and portable units can provide high quality recycled water at approximately 1c/litre (Beyond Tomorrow, Channel Seven, 19^{th} October, 2005).

7.5 ULTRA VIOLET DISINFECTION

Ultra Violet (UV) disinfection involves passing water close to a lamp (eg. Mercury vapour, quartz tubes), which emits UV light at specific wavelength (at approximately 254 nanometers (nm)), killing pathogenic bacteria and viruses present in the water. Critical factors when determining whether UV technology is suitable for its applications are the following:

- UV Lamp Skin temperature – at a temperature of 42◦C the maximum lightwave emission occurs and disinfection is 99.9% successful. Reductions in this temperature will lead to a dramatic decrease in the lamp's effectiveness.

- Air temperature – an air temperature that is considerably less than the required temperature of the lamp will cause a change in the lamp's ability to maintain that temperature.

- Water temperature – as above, a cool or hot water temperature will affect the temperature of the lamp and therefore it's effectiveness.

- Flow rate – to effectively destroy the pathogenic bacteria and viruses there must be a certain amount of contact time. This contact time is controlled by the flow rate and is individually calculated depending on unit size, lamp size and level of contamination.

- Water colour and turbidity – the colour and the level of turbidity or murkiness of the water will impact the ability of the UV light to penetrate the water and disinfect the wastewater. Dirty water can also lead to the build up of grime on the lamp reducing the amount of light emitted. Wastewater must be pretreated to reduce the water colour and turbidity.

- UV transmission of the fluid being disinfected at a wavelength of 254 nm.

Source: UVTA, 1999

Research by the author into home greywater treatment systems determined that UV technology was generally inappropriate due to the level of pretreatment required to reduce turbidity levels common in household greywater, the level of maintenance required to ensure lamp is operating at peak capacity and the cost of the technology. However, UV technology has proven to be very effective on a large scale and is currently used by Busselton Water in the state's south.

Other advantages of UV disinfection include the lack of residuals or hazardous by-products, water taste, odour and colour are not affected and offers an alternative to hazardous disinfectant chemicals (WEDECO, 2005).

7.6 IONISATION

An ionizing unit is made up of two components, a power source and a set of anodes. It is a simple system that results in an electric current being passed through the water. This has the affect of giving the water molecules a positive charge and results in the loss of metal ions from the anodes. By giving the water molecules a positive charge, this attracts bacteria which naturally have a negative charge. When the bacteria 'meets' the positively charged water molecules, the outer membrane of the bacteria ruptures resulting in their destruction. The dead bacteria flock together and can be removed through filtration.

The use of metals such as copper and silver on the anodes of ionisers allows the ions of these metals to be released into the water when the electrical current is applied to the system. Silver ions are affective in destroying bacteria and copper is affective in destroying algae. The positive water molecules and released metal ions will remain in the water until a level equilibrium is reached and neutralization occurs due to the increase in negatively charged bacteria. The life of the anode can be protected by reversing the current from one anode to another (Aerated Sewage Systems, 2005).

A large fountain and reflection pool at Parliament House in Canberra was refurbished in 1997. As part of this refurbishment it was decided to replace the original salt-chlorine unit with a copper-silver ionization disinfection system. The salt-chlorine unit was replaced due to concerns that it has having a detrimental effect on the environment (Source: http://downloads.nationalcapital.gov.au/corporate/publications/annual_reports/ar_00-01/entire.pdf).

7.7 OZONE

The Co-operative Research Centre for Water Quality and Treatment (CRC) state in their '*Consumer's Guide to Drinking Water'* that ozone is the most powerful disinfectant used in water treatment. It has been proven to effective against hard to treat protozoan parasites, *Cryptosporidium* and *Giardia*. Ozone has only been recently introduced to Australia and is able to destroy soluable contaminants such as algal toxins, taste and odour components and trace levels of insecticides.

Ozone is generated onsite at the water treatment plant using the technology. It is an unstable gas whose generation is achieved by passing an electric discharge through clean, dry air or oxygen. Its very reactive characteristics means that ozone decays rapidly in water and for this reason is usually used with other disinfection agents such as chlorine to ensure treatment levels are maintained (CRC, 2002)

Manufacturers of ozone disinfection technology recommend the system as a environmentally friendly alternative to the commonly used chlorine. Ozone can be generated by fully automated systems, so that quantities are exactly matched to wastewater flow and demand, reducing the amount of maintenance and monitoring required (WEDECO, 2005).

Despite the assurances of the manufacturers that ozone is an environmentally friendly treatment option, CRC warns that ozone use can have some negative health effects. The use of ozone does not lead to chlorinated disinfection byproducts, but can lead to the generation of other possible oxidation products including bromate, formed from naturally occurring bromide found in some water sources.

7.8 DISTILLATION

Distillation treatment of wastewater involves heating the water to boiling point and then collecting and condensing the water vapour that is produced. In larger, commercial desalination plants the vapour pressure is lowered allowing the boiling point to be reduced thus saving on energy costs. Reducing the boiling point also has the added benefits of reducing the build up of scale and corrosion caused when saline waters are heated to high temperatures. There are a number of advantages in using distillation technology including:

- The initial quality of the wastewater does not impact the capital or operational costs of the treatment plant
- Treatment process produces high quality water
- Distillation is a proven and reliable technology
- Lower maintenance costs compared to some other treatment technologies

The disadvantages of the distillation treatment process is that the plants are expensive to build and operate and they have a high energy consumption due to the requirement to boil large quantities of feedwater (Hostetler, S. et. al, 2005).

Any of these disinfection options would need to be tested for effectiveness, maintenance times and safety requirements prior to approval by the Western Australian Health Department. Effects on garden watering and minimum residuals permissible would also need to be explored prior to product being marketable as a greywater recycling system capable of treating water to a capacity where it is safe for above ground irrigation.

CHAPTER 8

FEASIBILITY ASSESSMENT AND PRESENTATION OF FINDINGS AND STRATEGIES OF WATER RE-USE IN WESTERN AUSTRALIA

This report does not accurately reflect the enormous amount of information that is available on the issues affecting water re-use in Australia. Australia holds the unenviable title as one the driest continents in the world, and with our increasing population the pressure on our water resources continues to grow. In response every state in Australia has recognized the need to implement long term strategies to manage water shortages. The Western Australian Government released *'A State Water Strategy for Western Australia'* in 2003 with the aim of preserving the current lifestyle enjoyed by residents and securing the state's water future. The main push is finding a balance between the development of new sources, such as desalination plants and canals, and educating the general public and industry in using water more efficiently. Country areas of Western Australia have experienced dwindling water supplies due to geological remoteness and dryness in the north of the state. They have responded by recycling up to 40.3% of the water used in these areas. In metropolitan area, the awareness of the water situation does not seem to be as honed and currently only 3.6% of wastewater is recycled. This trend is reflected in most Australian states. There is, however, an awareness of the part that water recycling can play in Western Australia's future water security.

The state government is actively promoting projects such as the desalination plant currently in construction, feasibility studies into the sourcing of water from underground aquifers and ways to transport water from the state's north and an advertising program to promote responsible water use. Water recycling was included as part of the WA Water Corporation's '*Security through Diversity'* initiative but is not as actively promoted in the media as the above projects. Following are the main issues that would affect the large scale introduction of water recycling and address the requirements of triple bottom line objectives of Economic, Environmental and Social responsibilities.

8.1 COSTS

It would be fantastic to be able to say that the government and community should embrace water recycling based solely on environmental concerns, but reality tells us that any decision needs to consider the economic point of view as well. If there is a cheaper way of sourcing water, that also represents an environmentally and socially acceptable alternative, then this water source should be viewed more favourably.

Currently the cost of recycling water in Western Australia is more expensive than the alternatives of processing seawater using desalination technology and pumping of groundwater resources. However, whether these alternatives are more acceptable from an environmental and social point of view is speculative and will be discussed in more detail in the section to follow.

A presentation at an environmental health symposium by Neil McGuiness and Paul Van Buynder noted the following about the cost of recycled wastewater:

- General expectations are the recycled wastewater will cost less as it is considered to be of a "lesser quality" than other water sources.
- Economic advantages are easier to sell to industry rather than the general public.

In the survey conducted as part of this research, results of which are shown in chapter 5, most people (87%) would be prepared to accept and support greywater recycling within the home. When questioned about what costs that would be prepared to commit to installing a recycling unit, 75% were only prepared to pay up to $500 and a further 21% up to $1000. Of the greywater recycling units that are approved for use in Western Australia for the Department of Health, the average cost is $60 for a basic filter unit and up to $2000 for a larger sedimentation and storage unit. The WA Water Corporation does offer a rebate to consumers installing approved greywater recyling units. This rebate is up to $500 or 50% of the purchase/installation cost, which ever is the lesser amount.

There are home greywater recycling units that are manufactured in Australia that provide a disinfection process, but they range in price from $6000 - $7500 (Aqua reviva, 2005, Survey Response, 2005). As mentioned, currently there are no units capable of disinfection that are approved for use in Western Australia. A paper prepared by Dr Robert Patterson and Michael Brennan, and presented at the 1st International Conference on Onsite Wastewater Treatment and Recycling in Perth, titled *'Economic analysis of greywater recycling'* report that the '*current benefits/costs resulting from greywater use are prohibitive and generally exclude the low socio-economic sections of the community'*. (Patterson & Brennan, 2004).

The reason for this deduction was due to the cost effectiveness of the units and was dependent on the available water resources or where the landscape being irrigated carries a higher price than the cost of recycling.

Recycling initiatives on a large community scale, similar to those developments at Rouse Hill, Sydney and Mawson Lakes, Adelaide, where recycled water is delivered to individual homes through a dual reticulation network is likely to be more cost effective than installing individual units. Capital and maintenance costs are eliminated, as is the reliance on the homeowner to ensure that the recycled water produced is of an acceptable or safe level.

Acceptance of water recycling costs by industry and agriculture, as mentioned above, is not so much an issue. The success of water recycling in the industrial and agricultural environments can be illustrated by the number of recycling initiatives in these industries currently operating in Western Australia (chapter 3).

8.2 PUBLIC ACCEPTANCE

The most important factors to help overcome community concerns is ensuring that accurate information is provided and that community involvement is assured from the outset of any new development. The incident where Perth football players became concerned that recycled water used to irrigate their playing fields was affecting their health, highlights how lack of information can breed a lack of trust in the organizations implementing these schemes.

As discussed in chapter 5, public acceptance will be greatest for those schemes that have the least human contact such as industrial applications, aquifer recharge and agricultural schemes. Trust in the recycled water suppliers is essential for people to overcome the 'yuk' factor. A focus on the quality of the water after it has been treated, rather on where the water has come from will help people to deal with and eventually overcome the 'yuk' factor. To date, there has not been a suggestion of using recycled water for human consumption (as being suggested for Toowoomba, Queensland) and therefore has not been contentious issue in Western Australia.

It is expected, that even with the most comprehensive of education programs and assurances, that there will still be people who will have misgivings and be apposed to the use of recycled water.

8.3 ENVIRONMENTAL IMPACTS

A number of positive environmental impacts have been realized through the recycling of wastewater in Western Australia. These include reducing wastewater flows into the ocean and other waterways and the proposed use of recycled water to prevent saltwater intrusion into over allocated aquifers in the Perth metropolitan area. The recycling of wastewater at the Kwinana Reclamation plant has meant that there has been a decrease in the treated wastewater discharge pumped offshore by 11 million litres a day.

It is important, however, to ensure that all negative impacts to the environment from water recycling are also investigated and taken into consideration at the planning stage for any new scheme. This may include the environmental impacts at the construction stage, as well the impacts likely once scheme is fully operational. Factors to consider would include:

- Chemicals used in treatment process
- Waste products and emissions generated
- Noise levels generated
- Use of non-renewable fossil fuels to power treatment plant
- Proximity and possible affects to environmentally sensitive areas and waterways
- Application of recycled water is compatible with the level of treatment that has been applied
- Continual monitoring and maintenance of processes and reuse applications to ensure high levels of quality are maintained and environmental impacts are prevented or minimized
- Implementation of statutory regulations and guidelines on environmental stewardship relating to water recycling initiatives

The Department of Environment are responsible for the assessment and approval of all environmental impact studies related to new developments but lack clear guidelines on the environmental issues surrounding recycled water. For example, the Tasmanian Government have issued the *Environmental Guidelines for the Use of Recycled Water in Tasmania*.

8.4 HEALTH ISSUES

An update on Water Reuse – the other side of the water saving story by Colin Vickers, Vice President of the Backflow Prevention Association of Australia reports that Environmental and water agencies in Victoria are promoting water reuse schemes. This is due to their importance in reducing the reliance on unreliable rainfall. The Association however is concerned that there is inadequate knowledge within the general community and building industry due to the absence of policies and guidelines. This lack of knowledge has led to incidents where potable water has become contaminated through cross connections both in Australia and overseas.

The above report highlights the need for strict guidelines and regulations to protect human health, as with environmental impacts. The Department of Health has taken a cautious approach to the approval of greywater recycling units for individual homes, with lengthy and detailed application requirements (Chapter 3). Currently recycled greywater can only be used for below ground irrigation or above ground watering where the treatment process has included disinfection to within required limits.

The Western Australian state government is watching with interest new developments in Sydney and Adelaide where there is a greater level of usage allowed for such things as toilet flushing, watering with a hose, washing cars and filling of ornamental ponds. Recycled water in these developments is transported via a dual reticulation system from nearby waste water treatment plants and allows a greater degree of control by authorities on the quality of water used compared to home recycling units.

Chapter 3 outlines the role of the Wastewater Management branch with the Department of Health in regulating water reuse technologies and their affects on human health. However despite the fact that there are published guidelines covering greywater reuse there is a lack of guidelines for large scale water reuse programs and therefore information for private enterprises who may wish to implement schemes in the state. For example the Queensland government have prepared a Water Recycling Strategy to encourage water recycling within the state and sets out guidance for using recycled water in one of its seven action plans. Also, EPA Victoria has issued *Guidelines for Environmental Management: Use of Reclaimed Water* and Melbourne Water has issued the *Recycled Water Handbook*.

8.5 TECHNOLOGY

The quality, amount and types of technology available to treat wastewater is endless. The issues surrounding the choice of the right or appropriate technology will depend on the type of wastewater being treated, the flow rate or scale of the plant required, the geological position of the plant, budget requirements and quality of recycled water required.

The different types of treatment technologies are detailed in chapter 7, each with their own advantages and disadvantages depending on the intended use. The future of water recycling is not limited by technology.

8.6 SUCCESS OF WATER RECYCLING INITIATIVES IN OTHER AUSTRALIAN STATES AND TERRITORIES

The implementation of advanced recycling schemes in other Australian states and territories gives Western Australia the perfect opportunity to observe and learn from them without having to implement the schemes themselves. It allows both positive and negative outcomes to be assessed and decisions to be made on whether similar developments would be workable or appropriate to Western Australia.

Attention should also be paid to the level of documentation available through other states, as mentioned in section 8.4 of this chapter, to provide private and public stakeholders guidelines on environmental and health regulations to be followed.

CHAPTER 9

CONCLUSIONS

The Western Australian State Government has recognized the important part that water recycling can play in securing it's water future. Water recycling is an essential component of the total water cycle and is generally seen as environmentally friendly alternative water source. Western Australia has made significant advances in pursuing water recycling programs but is yet to reach the level of commitment to this alternative water source as shown by other states and territories in Australia. There is a lack of regulatory guidelines for the public sector, private industry and the general public to spearhead any large scale introduction of water recycling schemes. The majority of the current recycling schemes in Western Australia are supported and managed by the Water Corporation of Western Australia.

Despite the enthusiasm that is shown for embracing water recycling technology, there is a greater focus on pursing other water sources. This focus is definitely politically driven, with major parties at the last election each pushing high profile, elaborate ideas that would magically deliver the 'silver bullet' solution to Western Australia's water crisis and therefore winning the support of the community for saving the day. To date there are still feasibility studies being undertaken to investigate ideas such as building canals from the state's north, boats towing huge plastic bladders filled with water from the state's north, pumping of the large underground aquifer (Yarragadee Aquifer) and multiple desalination plants. While these ideas are floated or sunk, as the case may be, the Water Corporation continues on a steady path to water security. Their '*security through diversity'* program recognizes the need for multiple initiatives to solve water shortages, and recognizes water recycling as an extremely important part of that program.

The reality is that Western Australia is well behind other states in integrating recycling into the water cycle, though the Kwinana reclamation plant and irrigation schemes throughout the state are a good start. Western Australia now needs to take the next step and follow developments such a Springfield in New South Wales and Mawson Lakes in South Australia in implementing self contained communities. Already we have self contained community land developments that have their own schools, shops, parks and community recreation centres. These developments would be well suited to the water recycling initiatives of dual reticulation pipes from the larger waste water treatment plants and community sewerage treatment plants that provide treated wastewater directly back into the local area.

The widespread acceptance of home recycling units will be limited and it is doubtful that they will gain popularity in the near future. Their installation is confined to those that can afford them, those willing to accept the maintenance responsibilities or those who have a positive attitude to the environment that neither of the first two factors are of consequence. Their use is also limited given the unavailability of any Department of Health approved units that include disinfection in the treatment process. This technology is available, at a cost, from several Eastern States manufacturers and I would envisage their introduction in the long term future as water recycling is embraced more fully by Western Australians.

Finally, as mentioned in the previous chapter, the factors that will have the greatest influence on water reuse opportunities in Western Australia are:

- Cost of recycled water compared to other water sources;
- Environmental impacts, positive and negative;
- Health Issues from the inclusion of recycled water in the wider community;
- Technology available now and advancements in the future to alleviate the issues surrounding the first three factors;
- The success of water recycling initiatives currently underway in other states and territories in Australia to provide guidance and ideas; and
- The most important factor to be overcome is the willingness of the general public to accept the use recycled water in everyday life.

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APPENDIX A - PROJECT SPECIFICATION

FOR: **ROBYN ELIZABETH BABIN**

TOPIC: **ASSESSMENT OF FACTORS INFLUENCING WATER REUSE OPPORTUNITIES IN WESTERN AUSTRALIA**

SUPERVISOR: **Dr Ernest Yoong**

ENROLMENT: **ENG 4111 – S1, Ext, 2005;**
ENG 4112 – S2, Ext, 2005.

PROJECT AIM: The purpose of this project is to identify factors that have led to the current water crisis in Western Australia, examine water re-use opportunities that are available to Western Australians and recommend a solution that is consistent with triple bottom line objectives. That is, environmental, economic and social issues are addressed.

PROGRAMME: **Issue C, 15th May 2005**

1. A review of current Government department policies, technology availability and an assessment on the reasoning behind past, current and future planning decisions and initiatives in place to encourage water reuse;
2. A review of other Australian states and their policies and practices
3. A review of public perceptions and the role of water reuse in individual homes
4. A review of the types and availability of waste water for re-use opportunities
5. A review of the technology available to treat black water, grey water and stormwater and various private sector initiatives
6. Assessment of the feasibility of water reuse opportunities from economic, environmental and social viewpoints.
7. Assessment of private sector capabilities and public sector capabilities
8. Assessment of private sector involvement in water reuse intitiatives
9. Presentation of findings and strategies for water reuse in Western Australia.

As time permits:

10. Recommendations for future planning to promote and achieve future sustainable water use and reuse in Western Australia.

AGREED: ___________________ (student) __/__/__

___________________ (internal supervisor)__/__/__

APPENDIX B - SURVEY OF PUBLIC PERCEPTIONS TO GREY WATER REUSE IN THE HOME

(Distributed mainly by email, but some responses sourced in person in local area.)

Hi Everyone

Please find below some questions regarding grey water reuse and treatment. As part of my final project in Environmental Engineering I am investigating water reuse opportunities in Western Australia and comparisons to other states. An important part of this research is determining public perceptions of grey water reuse within the home.

I would be very grateful if you would take 5 mins to answer the questions below and email your responses back to me. If you know anyone else that you could forward this email to gain a wide variety of responses, this would also be great.

All responses will be confidential and only general information provided by answering the questions will be included in the final report.

Thank you in advance for your help with this.

Robyn Babin
University of Southern Queensland

For the purpose of this study greywater refers to waste water from the following sources within the home:

- *Kitchen Sink*
- *Washing Machine*
- *Bathroom sink and shower (toilet waste water is not included)*

10. Age Group

A 18 – 25
B 26 – 45
C 46 - 65
D 65 and over

11. Home State or Territory

A Western Australia
B South Australia
C Victoria
D Tasmania
E New South Wales
F Queensland

G ACT
H NT

12. Sex

A Female
B Male

13. Were you aware that it is possible to recycle grey water within a private residence?

A Yes
B No

14. Do you currently recycle grey water within a private residence?

A Yes
B No

(If yes can you include the sources of the grey water, i.e. laundry, kitchen)

15. If you answered no to the previous question, would you consider installing a system to recycle grey water within a private residence?

A Yes
B No

16. If yes, how much would you be prepared to pay for a grey water recycling system?

A up to $500
B up to $1000
C up to $2500
D over $2500

17. Which applications would you be prepared to use recycled water for? (pick more than one if applicable)

A Above ground garden watering
B Below ground garden watering
C Toilet Flushing

(Current legislation does not permit recycled grey water to be used elsewhere in the home.)

18. What would be the greatest motivation to install a grey water recycling system?

A Monetary savings
B Environmental Concerns
C Gadget Factor

APPENDIX C - CURRENT REGULATORY CLASSES OF TREATED WATER FOR REUSE

Class	*Water quality objectives - medians unless specified* [1, 2,]	*Treatment processes* [a]	*Range of uses– uses include all lower class uses*
A	Indicative objectives • < 10 *E.coli* org/100 mL • Turbidity < 2 NTU[4] • < 10 / 5 mg/L BOD / SS • pH 6 – 9[5] • 1 mg/L Cl_2 residual (or equivalent disinfection)[6]	Tertiary and pathogen reduction[7] with sufficient log reductions to achieve: <10 *E.coli* per 100 mL; <1 helminth per litre; < 1 protozoa per 50 litres; & < 1 virus per 50 litres.	Urban (non-potable): with uncontrolled public access Agricultural: eg human food crops consumed raw Industrial: open systems with worker exposure potential
B	• <100 *E.coli* org/100 mL • pH 6 – 9[5] • < 20 / 30 mg/L BOD / SS[8]	Secondary and pathogen (including helminth reduction for cattle grazing) reduction[7]	Agricultural: eg dairy cattle grazing Industrial: eg washdown water
C	• <1000 *E.coli* org/100 mL • pH 6 – 9[5] • < 20 / 30 mg/L BOD / SS[8]	Secondary and pathogen reduction[7] (including helminth reduction for cattle grazing use schemes)	Urban (non-potable) with controlled public access Agricultural: eg human food crops cooked/processed, grazing/fodder for livestock Industrial: systems with no potential worker exposure
D	• <10000 *E.coli* org/100 mL • pH 6 – 9[5] • < 20 / 30 mg/L BOD / SS[8]	Secondary	Agricultural: non-food crops including instant turf, woodlots, flowers

Source: EPA Victoria, Guidelines for Environmental Mangement, p. 20, 2002

APPENDIX D – GREYWATER REUSE SYSTEMS APPROVED BY THE DEPARTMENT OF HEALTH

Department of Health
Government of Western Australia

Updated: 4 October 2005
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GREYWATER REUSE SYSTEMS APPROVED by the DEPARTMENT OF HEALTH

SYSTEMS APPROVED FOR SEWERED and NON SEWERED AREAS

BRAND	MODEL	APPROVAL NUMBER	DATE APPROVED	Capacity / Greywater Flow Volume (Litres/day)	Able to be installed in sewered areas?	MANUFACTURER
Nylex	Greywater Diverta Greywater Saver GS50/L Greywater Saver GS50/S Greywater Saver GS80	GW0202	9/3/05	Up to 5 bedrooms (no kitchen greywater allowed)	YES	Nylex Water Conservation 50-70 Stanley Drive Somerton VIC 3062 Ph: 1300 139 569 www.nylexwater.com.au
	Nylex Greywater Irrigation System	GW0501	14/6/05	To be used with Nylex Greywater Diverta		
Ecomax Waste Management	Greymax	GW0303	30/1/03	Up to 5 bedrooms (no kitchen greywater allowed)	YES	Ecomax Waste Management Systems Pty Ltd 116-118 Bannister Road Canning Vale WA 6155 Ph: (08) 9335 1600
Advance Waste Water Systems	G-Flow Laundry Greywater Reuse System Wall mounted Gravity Unit	GW0401	23/4/04	Up to 5 bedrooms (Laundry greywater only)	YES	Advance Waste Water Systems 262A Salvado Road Floreat WA 6014 Ph/Fax: 9383 9220 Mobile: 0405 459 533
	Grey-Flow Greywater Interception and Reuse System	GW0402	9/9/04	Up to 5 bedrooms (all greywater)	YES	
Eco-Care	Greywater Diverter System	GW0502	28/9/05	Up to 5 bedrooms (no kitchen greywater allowed)	YES	Plastic Plumbing Products Pty Ltd 71F Matthews Ave AIRPORT WEST VIC 3042 Ph: (03) 9335 6666 Fax: (03) 9335 6611 Email: atindal@plasticplumbing.com.au www.plasticplumbing.com.au

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GREYWATER REUSE SYSTEMS APPROVED by the DEPARTMENT OF HEALTH

SYSTEMS APPROVED FOR SEWERED and NON SEWERED AREAS

BRAND	MODEL	APPROVAL NUMBER	DATE APPROVED	Capacity / Greywater Flow Volume (Litres/day)	Able to be installed in sewered areas?	MANUFACTURER
Greywater Reuse Systems (GRS)	GT Series Innotech Plastic Tanks (GT 500, GT 700, GT 900)	GW0309	31/3/03	500L, 700L or 900L	YES	Greywater Reuse Systems PO Box 1125 Midland Business Centre WA 6936 Ph: (08) 9294 4141 Mobile: 0439 971 213 www.greywaterreuse.com.au
	GRS Concrete Tanks (CT 175, CT 225, CT 400, CT 740, CT 1080, CT 1450)	GW0308	31/3/03	175L, 225L, 400L, 740L, 1080L, or 1450L	YES	
	GRS Watersave Filter	GW0307	13/3/03	Up to 5 bedrooms (no kitchen greywater allowed)	YES	
	GRS Watersave Mini Piped Trench GRS Watersave Standard Piped Trench	GW0307	13/3/03	To be used with approved tank or GRS Watersave Filter	Not applicable	
	GRS Watersave Dripper System	GW0403	8/11/04	To be used with an approved tank or GRS filter system. Up to 5 bedrooms* (*See minimum length of pipe in approval)	YES	

SYSTEMS APPROVED FOR NON-SEWERED AREAS ONLY

BRAND	MODEL	APPROVAL NUMBER	DATE APPROVED	Capacity / Greywater Flow Volume (Litres/day)	Able to be installed in sewered areas?	MANUFACTURER
Greywater Reuse Systems (GRS)	GRS Standard Piped Trench	GW0304	29/1/03	To be used with a 1800L sedimentation tank	NO	Greywater Reuse Systems PO Box 1125 Midland Business Centre WA 6936 Ph: (08) 9294 4141 Mobile: 0439 971 213
Niimi Absorption Trench	Niimi Absorption Trench	GW9601	3/5/96	To be used with a 1800L sedimentation tank	NO	Mr Michael Ward PO Box 2 Glen Forrest WA 6071 Ph: (08) 9295 1039

APPENDIX E – REBATE FORM, WA WATER CORPORATION

Rebate Form – for Greywater Re-use Systems and Aerobic Treatment Units.

Rebates for Domestic Greywater Re-Use Systems and Aerobic Treatment Units Only.

(PLEASE PRINT CLEARLY)

Name ________________________________

Telephone ________________________________

Property address where item was installed _____

____

____

____

Postal address (if different) ________________

____

____

____

Name to appear on the rebate cheque _______

____

____

Item purchased (PLEASE TICK)

Greywater Re-Use System ☐

Aerobic Treatment Unit ☐

Place of purchase ________________________

Purchase price ________________________

Information request for GRS and ATU Rebate.

Name, Make and Model/Serial No. of System/Unit installed ________________________________

____

____

Original tax invoice for the product purchased included (PLEASE TICK) ☐

Details and tax invoices are required to process your rebate.

Capacity of system/unit installed (litres/day)_____

Property is: Sewered ☐ Non-Sewered ☐

Copy of "Permit to Use Apparatus" included (PLEASE TICK) ☐

Name of licensed plumber that installed the unit ____________________

Plumber's licence No. ____________________

Original tax invoice from plumber included (PLEASE TICK) ☐

Details and tax invoices are required to process your rebate.

Please sign below and send completed form together with all original tax invoices (these will be returned) to:

Water Corporation
Waterwise Rebate
Locked Bag 2
OSBORNE PARK DC WA 6916.

For further information on the Waterwise Rebate Program, or for additional forms call the Water Corporation on 1300 133 646.

I have read the Terms and Conditions on the back of this brochure.

____

(Signature Required)

Terms and conditions apply to the Waterwise Rebate Program and can be found on the back pages of this brochure. Please read these carefully before purchasing products and applying for your rebate.