



water forever

TOWARDS CLIMATE RESILIENCE

OCTOBER 2009





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FOREWORD

Water, the lifeblood of Perth and Western Australia, is no longer taken for granted.

To ensure that there is enough water for all, we need to address the challenges of our drying climate, increasing population and minimising our environmental impact by using less water. We cannot meet water demand for the next 50 years from the development of new sources alone.

Water Forever provides a portfolio of options to manage our demand and supply balance to 2060 by:

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

Water Forever has become a catalyst for change in how the Water Corporation provides sustainable water services across the State. We are already identifying ways to reduce water use in industry and making recycled water free on an “as-is-where-is” basis for community benefit. We believe that by focusing on helping communities become more climate resilient, we can fulfill the promise of ensuring the security of our water supplies for present and future generations.

Our final plan, *Water Forever: Towards Climate Resilience*, is only the beginning of this shared journey. The true test of this plan will be how well we as a community embrace this framework to reduce water use, increase water recycling and be open to new ways of sourcing water. In times of climatic uncertainty, adapting our lifestyle to reflect the needs of the environment we live in will ensure a more sustainable future.

The enthusiasm and interest of the Western Australian community throughout the *Water Forever* project has shown that there is a strong willingness to accept this challenge. It is now up to each and every one of us to make it happen.

I take this opportunity to thank everyone who contributed to the development of our 50 year plan. While individual contributions are too numerous to mention, the support from the community, stakeholders, staff and particularly the *Water Forever* Science Panel was invaluable and greatly appreciated.



The richness and diversity of views has resulted in a well balanced strategic plan which provides a strong platform to ensure the security of our State’s water supply well into the future.

I hope this dialogue continues as we work together to deliver on the promise of climate resilience.

Sue Murphy
Chief Executive Officer

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EXECUTIVE SUMMARY

TOWARDS CLIMATE RESILIENCE

EXECUTIVE SUMMARY

CLIMATE RESILIENT COMMUNITIES

Western Australia is a dry State in a dry continent. Water is vital to life and our quality of life. Water supports the natural environment, public health, the economy, community amenity, recreation and sporting activities.

The Water Corporation wants to ensure that Perth and surrounding areas can adapt to the drying climate and ensure enough water for future generations.

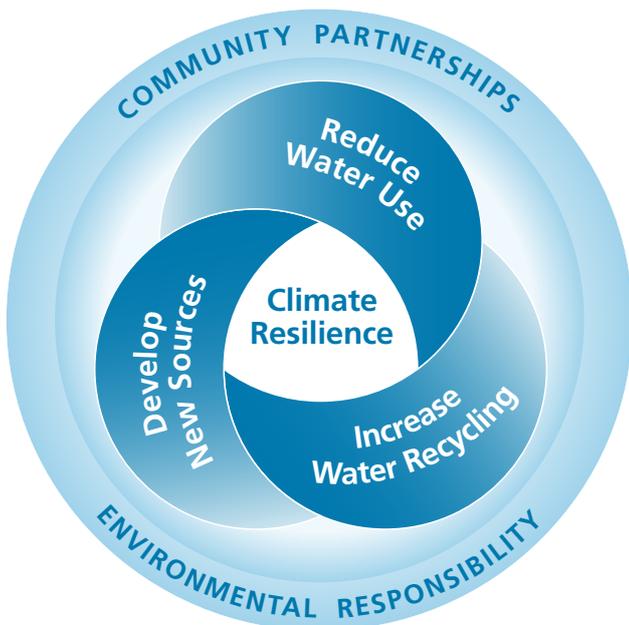
A major finding as a result of the work undertaken by *Water Forever* is the need for a portfolio approach to address increasing water demand, with less rainfall. To do this we will need to reduce water consumption, recycle more water and develop new sources to supplement existing supplies (figure 1).

Advancements in technology, the actual rate and impact of climate change, fluctuations in population, increased energy prices and changes to the way water services are delivered will all impact how water is used over the next 50 years.

Simply developing new sources of water will not be enough to sustain Perth and surrounding areas, particularly if the climate continues to dry as projected. A concerted effort to reduce water use is crucial to making Perth and surrounding areas resilient to climate change by taking a flexible and adaptive approach.

Portfolio of water options

(figure 1)



This transition to climate resilience is a shared journey, with the Water Corporation working in partnership with households, business, industry, mining, agriculture, schools, State and local governments and academic and research institutions.

THE CHALLENGE AHEAD

The challenge for *Water Forever* is to provide water for all:

- in an even drier climate;
- with twice as many people; and
- with less environmental impact.

Based on work completed by CSIRO and the Bureau of Meteorology, the south west of Western Australia is expected to experience further declines in rainfall due to climate change. This will have a significant impact on water availability for households, business and industry, local government, mining and agriculture.

For the purposes of this plan, a climate scenario that projects a 20% decline in rainfall by 2030 from the 1990 baseline, has been adopted. A rainfall reduction of this magnitude is estimated to reduce yields from existing dams and groundwater sources to about 165 gigalitres a year, from average yields of 260 gigalitres a year since 2001.

Further, the scenario considers a 40% decline in average annual rainfall by 2060 from the 1990 baseline to less than 500mm a year. This would further reduce yields from existing dams and groundwater sources to an estimated 55 gigalitres a year. At these levels, dams would cease to be a reliable part of Perth's water supply.

A drop in water availability of this magnitude would have a broader impact than just reductions in existing public water supplies. Other changes that may result from a drier climate include:

- the failure of some domestic and other private bores used to irrigate gardens, public open space and horticulture;
- a change in the spread and type of native vegetation;
- further drying of wetlands and lakes; and
- loss of soil moisture, impacting on plant selection and viability.

It is expected that we will need to progressively change the way residential gardens, public parks and ovals are landscaped to adapt to changing conditions. If a significant decline in rainfall occurs, the overall area of irrigated land in Perth and surrounding towns will need to reduce. It is apparent that some of these impacts are already occurring, particularly where ecosystems are dependent on shallow groundwater for survival.

Managing the overall water balance in Perth, for both public and private use, is critical to our water future. The water supplied by the Water Corporation (public water supply) represents less than half of all water use in Perth.

The majority of water used in Perth is accessed privately and managed by the Department of Water for use in irrigated horticulture and other agriculture, for public open space, by industry and by householders from garden bores. Public water supply shares groundwater with all other users.

The careful use of shared groundwater resources by all sectors is critical to ensuring that groundwater in Perth is available for future water needs. If these resources fail, this not only risks the Water Corporation's supply, but also increases the likelihood that public water supply will be required to provide water for agriculture, industry and public open space.

An increased investment in metering, monitoring, reporting and targeted reductions in water use across the board is required. Our water future is interconnected.

CREATING A PORTFOLIO OF WATER OPTIONS

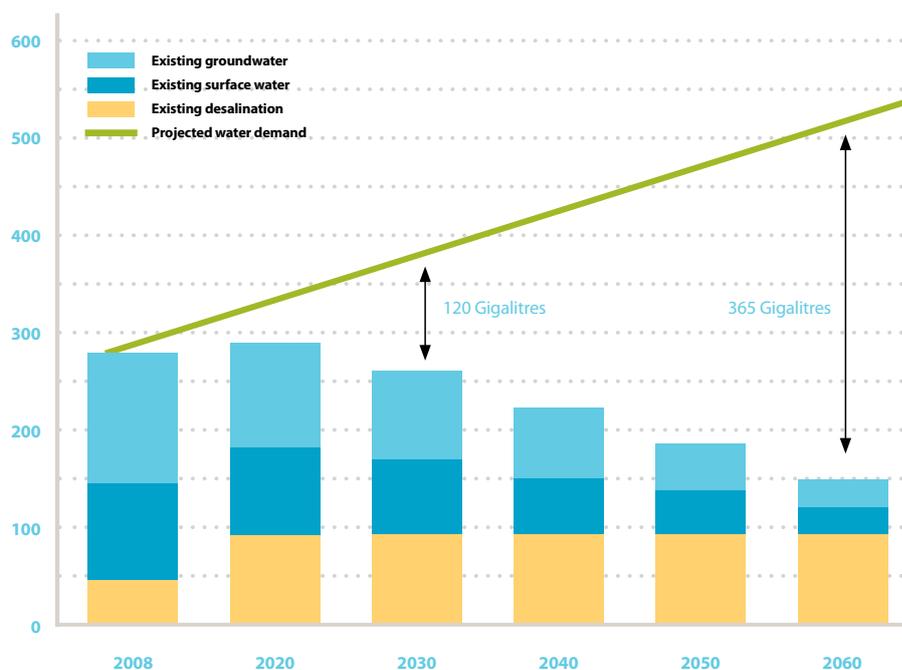
There are many ways to maintain a reliable balance between supply and demand. *Water Forever* has created a portfolio of water options to help make Perth more climate resilient (figure 1).

By 2060, working in partnership with the community, the Water Corporation will:

- help to reduce water use, so we all use a quarter less water than we do now;
- support the recycling of up to 60% of wastewater in the Perth-Mandurah area; and
- prepare a diverse array of potential water sources for future development.

The targets and goals set through the portfolio are challenging. The Water Corporation is committed to meeting these milestones and, where it makes sense, even surpassing them to secure our water future.

Based on a planning assumption of reduced rainfall combined with a growing population, it is estimated that an additional 120 gigalitres of water will be required by 2030 – more than 40% of current annual water use (figure 2).



Gap between water supply and demand to 2060 (figure 2)
(Gigalitres per year)

By 2060 it is forecast that Perth and connected towns will need an additional 365 gigalitres of reticulated drinking water supply. Some of this will need to replace existing sources affected by declines in rainfall and the balance will be needed to meet the projected growth in demand.

By reducing the amount of water used, recycling more water and developing new water sources, the Water Corporation will ensure that there is enough water to meet future needs, even in a drying climate.

Table 1 provides an overview of the portfolio of new options that have been identified for the next 50 years and their estimated maximum yields.

Summary of water options that could be implemented by 2030 and 2060 (table 1)

(Gigalitres per year)

Portfolio of new water options	Yields 2030	Yields 2060	Portfolio total
Reduce water use	74	102	176
Increase water recycling	39	48	87
Develop new sources	218	335	553
Total options to meet future supply – demand	331	485	816

REDUCE WATER USE

Most people in the community believe that a long term, sustained focus on using less water is central to living with less rainfall. Since 2001, the average water use per person has decreased by 20%.

Even with these savings however, Perth remains one of the highest water using cities in Australia. While people have made considerable effort to reduce water use in homes, business and industry, more can be done to adapt to the changing climate.

The Water Corporation will help Perth households and businesses to reduce water use and ultimately use a quarter less water. This begins with reducing per person water use from 2007/08 levels of 147 kilolitres a year to 125 kilolitres a year by 2030.

This reduction in use can be facilitated by:

- influencing urban planning for increased density, water sensitive urban design, climate resilient gardens and making better use of stormwater and drainage water in local areas;
- working one-on-one with households and businesses to help them use a quarter less water;
- helping business and industry to reduce water use and make better use of 'fit for purpose' water; and
- reviewing metering, pricing and billing practices to ensure they send appropriate signals to support water conservation.

Using less water has many benefits. In the short term it will defer the immediate need for a new water source once the Southern Seawater Desalination Plant is commissioned (scheduled for 2011). Reducing water use also has substantial environmental benefits including reduced energy use, greenhouse gas emissions, land clearing and an increase in water left in the environment.

Using less water also helps to maintain the affordability of this essential service, as it saves an equivalent investment in infrastructure.

INCREASE WATER RECYCLING

Currently, only 6% of treated wastewater is recycled in the metropolitan area. By 2030 it is estimated that water recycling in Perth will exceed 30%. In the longer term the Water Corporation believes that most of Perth's wastewater can be recycled. This will require collaboration between the Water Corporation, State and local governments, business and industry.

Major advances in water recycling can be made through large scale recycling schemes such as:

- groundwater replenishment, where high quality recycled water is stored in groundwater for use in drinking water supplies;
- recycling to industry; and
- providing recycled water to irrigate public parks, gardens and for horticulture.

Recycling water at a household level still has a role to play, although the water savings made through individual recycling systems are relatively small. Water recycling at household and community levels is supported where risks to human or environmental health are carefully managed in accordance with national guidelines and local regulation.



DEVELOP NEW SOURCES

While reducing water use and recycling more water will take us a long way to becoming climate resilient, they are not enough to overcome the significant reductions in rainfall that are projected.

New sources of water will eventually be required to supply a growing population in a drying climate. The system capacity of the Integrated Water Supply Scheme (IWSS) water grid was 280 gigalitres in 2008. By 2030, 70 to 100 gigalitres of additional water will be required, subject to the targets for reducing water use and water recycling being achieved. If these targets are not achieved, the need for new sources will increase even further.

As a community, we cannot rely on a single source of water. As a result, the Water Corporation has considered a range of new water sources that could be developed. These new sources of water include:

- groundwater replenishment;
- building new desalination plants north and south of Perth to serve these growth corridors;
- optimising the use of existing dams by completing the catchment management trial, which aims to increase streamflows into dams by thinning forest regrowth;
- investigating opportunities for trading groundwater on the Gnangara Mound;
- expanding the Southern Seawater Desalination Plant by a further 50 gigalitres; and
- developing new groundwater sources.

It is inevitable that water will need to be moved to areas of demand, with almost all new source options located outside of the study area of this plan.

Further work needs to be undertaken to determine which sources will be developed and in what order. Investigative work has commenced on some sources but all require more detailed work to determine their viability.

Over the next 50 years, it is expected that existing surface water and groundwater sources will comprise an increasingly smaller portion of public water supply. As the climate dries the focus of new source development will continue to favour rainfall independent sources, such as recycling and desalination.

ENVIRONMENTAL RESPONSIBILITY

Using less water lessens our physical impact on the environment. Other ways the Water Corporation is committed to improving environmental outcomes include:

- decreasing the average amount of groundwater taken from the Gnangara Mound, after the second desalination plant is operational;
- becoming more energy efficient;
- investing in renewable energy such as wind, wave, solar and biomass;
- caring for bushland under Water Corporation ownership;
- monitoring ocean discharge to ensure it is an appropriate quality;
- increasing the recharge and use of stormwater and drainage water locally; and
- remedial treatment of contaminated sites.

COMMUNITY PARTNERSHIPS

Perth can only become resilient to the drying climate if everyone is involved in changing the way we use water.

The commitments proposed in this document will be achieved by working with all sectors of the community, including residents, business and industry, schools, indigenous communities, academic and research institutions, State and local governments, environmental groups and many others.

The Water Corporation is committed to continuously engaging with all Western Australians on water issues that affect them. This includes ensuring the public can have input into plans like *Water Forever*, educating everyone on how to reduce water use and engaging with local communities that may be impacted by, or benefit from, new water or wastewater infrastructure.

To deliver on these commitments, the final section in this plan outlines the actions to progress towards climate resilience. Public reports on progress will be provided periodically, with the first report in 2012.

Additionally, *Water Forever: Towards Climate Resilience* will be reviewed by 2015 to continue to engage with and update the community on our goal to become more climate resilient.



PLANNING APPROACH

PLANNING APPROACH

The south west of Western Australia was one of the first regions in Australia to experience the impact of climate change on the environment, including reduced rainfall.

The CSIRO predicts that this region is most likely to continue drying over the next 50 years. The Water Corporation's purpose statement is the "sustainable management of water services to make Western Australia a great place to live and invest." The challenge ahead is to provide sustainable water services in an even drier climate, to twice as many people.

Water Forever is the Water Corporation's 50 year plan to tackle this challenge. It is a strategic plan for public water supply, prioritised by *State Water Plan 2007* (figure 3). The objective of *Water Forever* is to develop a plan to supply sustainable water and wastewater services to Perth and surrounding areas for the next 50 years.

The Department of Water is responsible for managing private (or self supply) water use by local government, horticulture, industry, mining, agriculture and other users. In Perth, these users generally own and operate their own groundwater bores.

The Department of Water also licences public water supply, managed by the Water Corporation. *Water Forever* focuses on the needs of customers serviced by the network of water infrastructure known as the Integrated Water Supply Scheme or IWSS.

This public water supply scheme provides drinking quality water to over 75% of Western Australians and a significant proportion of businesses, schools, hospitals and other services.

Listening to the views of the community was an integral part of this project.

Developing sustainable water options for the future requires consideration of a number of scenarios which are influenced by rainfall trends, population growth and water consumption. *Water Forever* has considered how these variables might influence the way water and wastewater services are provided over the next 50 years.

Climate change, population growth and water consumption scenarios have been projected to 2060 to provide data necessary to plan for the community's future water and wastewater needs.

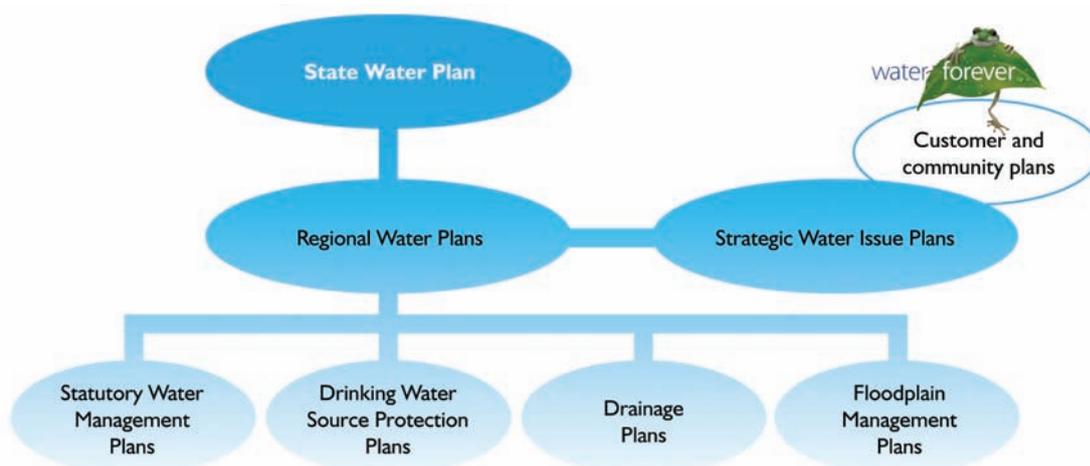
This document outlines the ways in which the Water Corporation intends to meet future water and wastewater needs, taking into account community input, outcomes from a robust sustainability assessment process and technical planning.

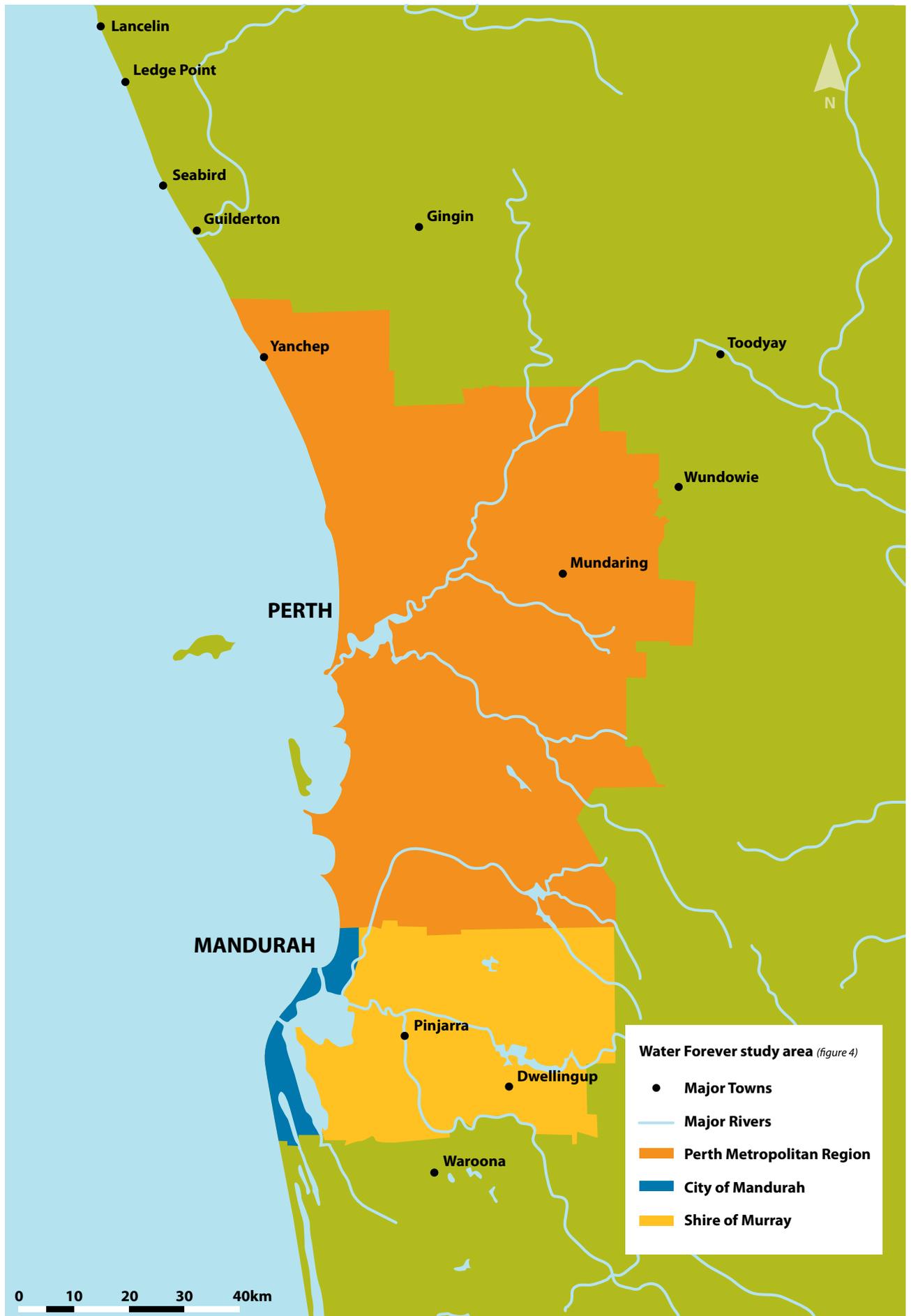
STUDY AREA

Water Forever is planning for water, wastewater and drainage services for Perth and surrounding areas. The study area (figure 4) takes into account:

- water supply for the cities of Perth, Mandurah, the Shire of Murray and the pipeline supplying water to the Goldfields and Agricultural region;
- wastewater services for the cities of Perth, Mandurah and the shire of Murray; and
- main drains serviced by the Water Corporation in the Perth metropolitan area.

Western Australian Water Planning Framework (figure 3)





WATER FOREVER PROCESS OVERVIEW

Water Forever: Options for Our Water Future was released for public comment in April 2008 in one of the most comprehensive community engagement processes undertaken by the Water Corporation. The Options Paper set the context for delivering sustainable water services for the next 50 years. It provided a high level overview of the various options available to meet future water and wastewater needs, in the context of a drying climate and rapidly growing population.

Under the themes of *Conserve, Create* and *Connect*, the Options Paper summarised the Water Corporation's commitment to conserving the natural environment, delivering safe and reliable water services and the opportunities to create new sources to meet future needs.

Engagement on the Options Paper was supported by a number of communication tools including a comprehensive website and over 40 information sheets to promote more detailed understanding of water, wastewater and drainage issues.

Over 2,350 people participated in this phase which culminated in the publication of *Water Forever: Reflections*. This report, released in August 2008, summarised the feedback obtained from the Perth community and stakeholders.

The following major themes emerged from the engagement process and were outlined in this report: healthy ecosystems, water conservation and efficiency, fit for purpose water supplies, water recycling, climate resilience, community education, pricing, energy and integration with land planning.

The need to deliver sustainable outcomes in planning for water services underpins *Water Forever*. The Water Corporation has developed business principles to build awareness and encourage sustainable thinking in the organisation. Criteria based on these business principles were developed to assess the sustainability of 35 water efficiency and source options that could potentially be developed over the next 50 years.

The *Water Forever: Sustainability Assessment* was released in December 2008. This assessment provided a structure for assessing a range of issues and impacts affecting future source decisions. Through the use of decision support tools, modelled scenarios and risk assessments, these options have been further refined and are reflected in this plan.

The outcomes from the sustainability assessment have been used to develop this plan. They are closely aligned with community priorities to reduce water use and recycle water.

Water Forever: Directions for Our Water Future was released for public comment in February 2009 and proposed a portfolio of options to meet the gap between supply and demand. This paper summarised the long term goals, targets and actions to reduce water use, increase water recycling and develop new sources by 2030 and 2060. Input from the public comment period helped to shape this plan.

Phase	Intent		Publication	Timing
1	Do you want to be involved in making decisions about water and wastewater services for Perth?	Get involved	Invitation to Participate	October 2007
2	What are the major issues that need to be addressed in relation to water and wastewater services for Perth?	Have your say	Options for Our Water Future	April 2008
3	Here is a summary of your input into planning to date.	What you said	Reflections, Community Engagement Report	August 2008
4	Here is a draft plan that indicates where we are heading and proposes actions on how we will reach our targets and goals.	What we plan to do	Sustainability Assessment Directions for Our Water Future	December 2008 February 2009
5	Developed with your input, here is our final plan and how we will implement the strategy.	How we will do it	Towards Climate Resilience	October 2009

WATER FOREVER SCIENCE PANEL

Following the release of *Water Forever: Options for Our Water Future*, a Science Panel was formed with eminent members of the local and national scientific community. Professor Robert Harvey, a member of the Water Corporation Board of Directors and Executive Dean at Edith Cowan University, convened the Panel. The Science Panel provided independent advice on *Water Forever*.

The Panel encouraged the investigation of a broader suite of options and robust planning to address the risks and uncertainties associated with providing water services into the future.

In addition, the Panel ensured that the project was informed on the latest science and national debate and trends in climate and water policy. The major advice from the Panel was received on the final plan, an excerpt of which is reproduced below.

For more information about the Panel, and for a full transcript of their advice visit www.watercorporation.com.au/waterforever.



Members of the Panel (clockwise from left): Dr Tom Hatton (Director, Water for a Healthy Country, CSIRO); Dr John Marsden (Director, Marsden Jacob and Associates); Dr Jenny Pope (Director, Integral Sustainability); Professor Robert Harvey - Convener (Member of the Water Corporation Board and Executive Dean at Edith Cowan University) and Mr Ross Young - Chair (Executive Director, Water Services Association of Australia) (seated).

SCIENCE PANEL ADVICE EXCERPT

The final meeting of the *Water Forever* Science Panel was held on 4 August 2009 to review the comments and submissions received from the community and key stakeholders following the release of *Water Forever: Directions for Our Water Future*.

The members of the *Water Forever* Science Panel have extensive experience in water resource management all over Australia and bring to this process expertise in the following areas:

- Water resource planning including the development of a portfolio approach to mitigate climate risks
- Adaptation to climate change
- Decision making in uncertainty
- Real option analysis
- Cost benefit analysis
- Sustainability assessment
- Ecological and environmental assessment
- Community and stakeholder consultation
- Experience in operating and managing water utilities.

The *Water Forever* Science Panel undertook a thorough and methodical review of the planning process undertaken by the Water Corporation including:

- Validity of underlying assumptions particularly on the demand and supply sides
- The robustness of the sustainability assessment framework
- The appropriateness of future scenarios
- The extent to which risk has been factored into options
- Reviewing the comments received during the community and stakeholder consultation process to ensure that these comments have been incorporated into the final document or appropriately dealt with.

Given the drying climate and Perth's rapidly growing population nothing could be more important than having a robust long term water plan.

As panel members we feel as though we have been able to add value to the process and also bring different views and broader perspectives which has resulted in what we believe to be one of the most thorough water resource planning projects from technical, sustainability and stakeholder engagement perspectives.

Nationally and increasingly so internationally, Water Corporation has a reputation of being at the forefront of urban water planning, as the south west of Western Australia has been the 'canary in the coal mine' in relation to the impacts of climate change on water resources. As climate change touches all aspects of urban water management, the *Water Forever* Science Panel believes that the measures and initiatives contained in *Water Forever* will enhance Western Australia's reputation as being at the cutting edge of adaptation to climate change and managing climate risks in a period of great uncertainty.

The panel commends *Water Forever* to the Water Corporation Board for publication.

Yours sincerely

Ross Young Chair, Water Forever Science Panel

WATER SOURCES AND WATER USE IN PERTH AND SURROUNDING AREAS

The Department of Water estimates that in 2008, about 650 gigalitres of water was abstracted for all uses in the Perth metropolitan area. In addition to this water, a further 6 gigalitres of recycled water was also supplied to industry in Kwinana from the Water Corporation's Kwinana Water Recycling Plant (figure 5).

Private water supply

In 2008 about 370 gigalitres, or 57%, of all water use in Perth and surrounding areas was used for private water supply. Private water supply is managed directly by the Department of Water.

Almost all of this water came from groundwater drawn from the Perth Basin, which underlies much of the city. This supply provides water for a number of uses including garden watering, domestic bores, irrigation of public open space and use by industry and agriculture.

Understanding the water use of the whole system, not just the amount used in public water supply by customers of the Water Corporation, reveals other opportunities to conserve local groundwater resources for the environment and future generations.

The Department of Water is overseeing a considerable investment in metering for irrigated agricultural users and local government to help manage the resource. Where private water use is not licensed or metered (garden bores for example) an investment in sampling would help to improve estimates of use.

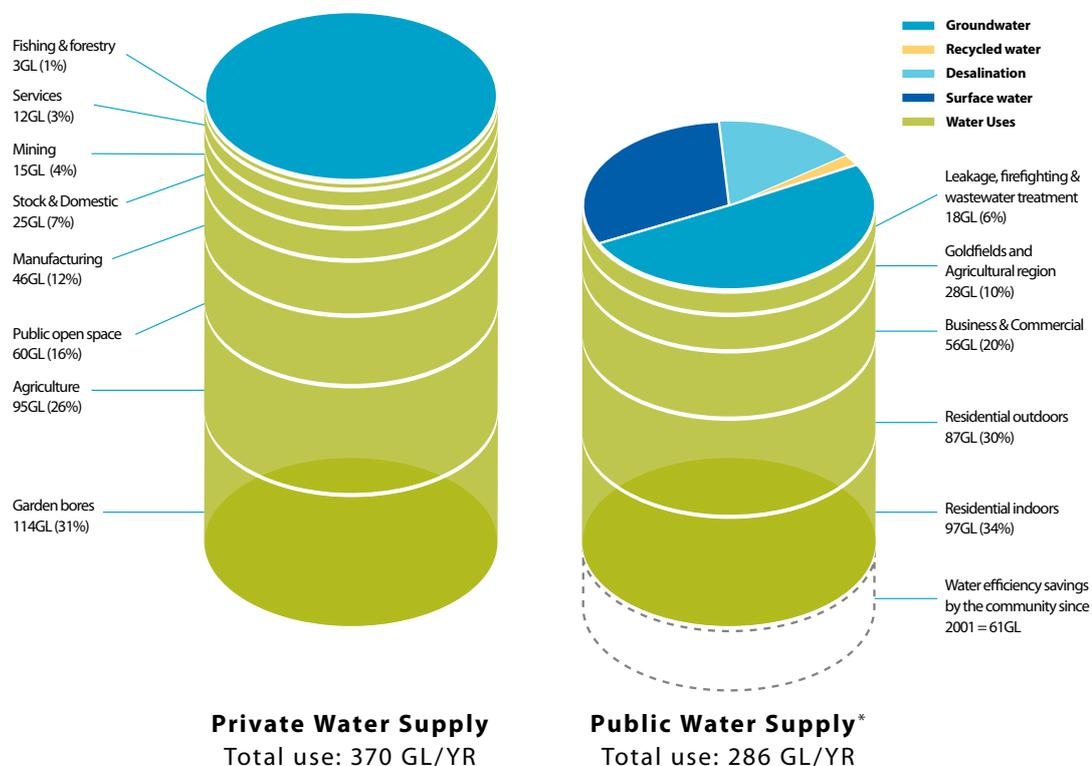
Over time, increased reporting of licences, metered use and estimates of unmetered use is encouraged to assist in the long term management and sustainability of shared groundwater resources.

The Department of Water is working with private water users to seek to improve water use efficiency. A range of water efficiency measures were introduced in October 2007 to assist in the management of these uses.

The Water Corporation estimates that the productivity of water for private water use could be improved by at least 20% from current levels.

Estimated total water sources and use in Perth and surrounding areas in 2008 (figure 5)

(Gigalitres per year)



* The percentage of water use does not include water efficiency savings. Total water use includes water from the Kwinana Water Recycling Plant used for industrial purposes.

Public water supply

The balance of water, 280 gigalitres or 43% of all metropolitan use, is currently supplied by the Water Corporation to customers. The Water Corporation's allocation of groundwater and surface water is also licensed by the Department of Water.

Perth is unique from most other capital cities in Australia due to the presence of large volumes of groundwater used for both public and private water supply. This supply of groundwater, combined with dams and the construction of Australia's first desalination plant, has ensured that Perth has not experienced the severe water restrictions of the Eastern States.

High quality recycled water is supplied from the Kwinana Water Recycling Plant to the Kwinana Industrial Area.

In addition, the community has worked with the Water Corporation and the State Government to save over 60 gigalitres of water a year since 2001, through various water efficiency initiatives.

This range of water supply and efficiency measures help to meet the need for water services, for a variety of uses. Most water is used by households, followed by business and industry. Some water is supplied without charge for public uses including firefighting and wastewater treatment. Water supplied through the Goldfields and Agricultural Water Supply scheme is accounted for separately.

CLIMATE CHANGE

Background

Global warming over the past 30 years is now an accepted scientific trend and is evidenced by increasing atmospheric and ocean temperatures, rising sea levels and loss of snow cover, particularly in polar regions. Further global warming and changes in climate are predicted into the future due to continued increases in greenhouse gas emissions.

The CSIRO and the Australian Bureau of Meteorology (BOM) have undertaken the most recent work on climate change; *Climate Change in Australia, Observed Changes and Projections*, 2007. The conclusions drawn in this report have been used by the Water Corporation to project a future climate scenario for the south west of Western Australia.

ABOUT THE 1990 BASELINE

Across Australia, the CSIRO has adopted a benchmark for climate projections known as the "1990 baseline."

This is the average of the rainfall for the period from 1980 to 1999. When a reference is made to, say a 20% reduction in rainfall, it is taken from this benchmark.

This has been adopted by *Water Forever* to align with national terminology and approaches. It provides a consistent reference point for forecasts for rainfall and streamflows. Rainfall records from Jarrahdale for the period 1980 – 1999 have been used in this report and are referred to as the 1990 baseline.

VOLUMES OF WATER

One litre	1 litre	1 litre	1 L
One thousand litres	1,000 litres	1 kilolitre	1 KL
One million litres	1,000,000 litres	1 megalitre	1 ML
One billion litres	1,000,000,000 litres	1 gigalitre	1 GL

One gigalitre, or a billion litres is enough to supply 10,000 people, or over 4,000 households with water for one year.

Impacts on the south west of Western Australia

In summary, it is predicted that temperatures will continue to increase and rainfall will continue to decrease over the next 50 years.

The historical rainfall records at Jarrahdale, south-east of Perth are a current example of how the climate has dried over the past 100 years. Jarrahdale is centrally located in a relatively high rainfall area within the Water Corporation's dam catchments.

The Jarrahdale annual rainfall history is shown in figure 6. It shows a decrease in the order of 30% since the early 1900s. The trend line on the graph indicates the extent of decline. The decline from the 1990 baseline to the average of the last seven years is 12%.

The reduced rainfall in the south west of Western Australia has had a significant negative impact on the Water Corporation's surface and groundwater sources. Streamflows into dams have been particularly impacted (a 12% decline in rainfall has resulted in a 50% reduction in streamflows). Groundwater is more resilient to annual fluctuations in rainfall, but levels on the Gnangara Mound have also reduced as a result of the prolonged drying trend.

Lower streamflows and groundwater levels have reduced the amount of water available for public water supply (figure 7).

The partial loss of these traditional water sources has been addressed to date by two strategies, working with the community to reduce water use and the development of a diverse range of new sources.

Per person water use in Perth and the Goldfields has reduced by almost 20% since 2001 through the introduction of what are now permanent water efficiency measures. These measures are part of an extensive program that includes community education, investment in research and more water recycling initiatives among other innovations.

New sources have added over 35% to supply capacity since 2001. Some of these diverse and innovative sources include:

- new surface water sources such as Harvey Dam and Samson Brook Pipehead Dam;
- water trading with the Harvey – Waroona Irrigation District;
- new groundwater bores;
- an industrial water recycling plant at Kwinana; and
- the Perth Seawater Desalination Plant.

Future impacts on Water Corporation water sources

One of the CSIRO models projected that by 2030 rainfall could decrease by 20% from the 1990 baseline with further significant reductions possible. Given that Perth has already experienced a 12% reduction in rainfall since the baseline (figure 7), a further 8% loss in rainfall is foreseeable.

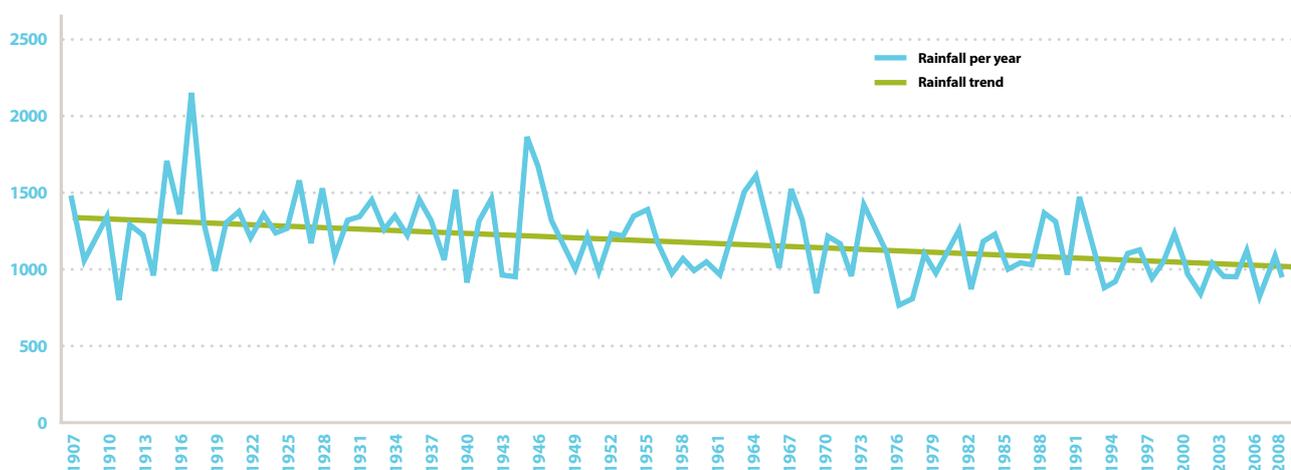
Accordingly, the climate scenario adopted by *Water Forever* for planning purposes is for rainfall to reduce by 20% by 2030 and then 40% by 2060 from the 1990 baseline (figure 8).

If rainfall reduces by 20% from the baseline, the likely yield from existing dams would be in the order of 75 gegalitres a year.

Further, if the rainfall reduces by 40%, likely yields would be reduced to only 25 gegalitres a year. At these levels, dams would cease to be a reliable part of Perth's water supply.

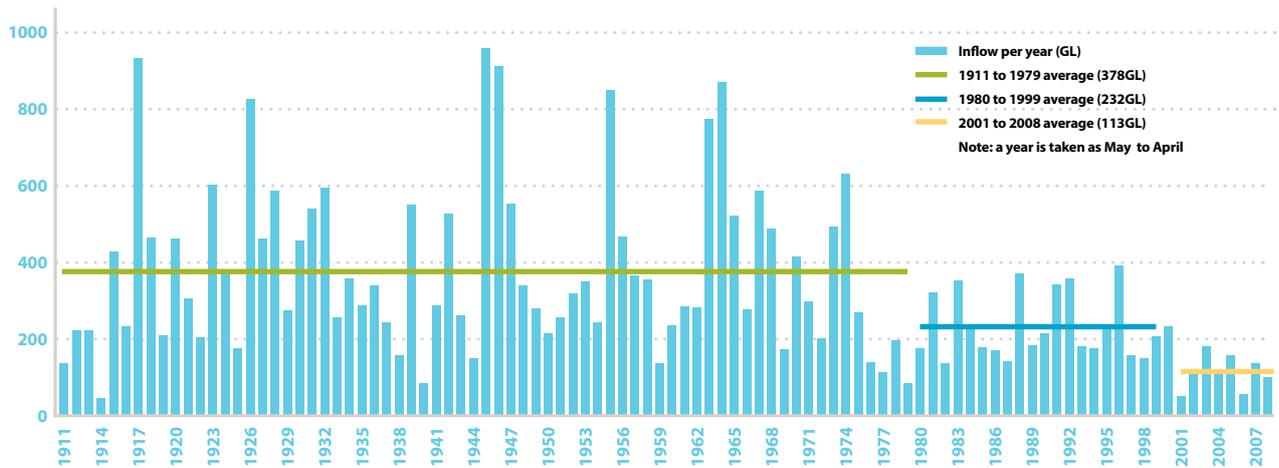
Historical rainfall patterns at Jarrahdale (figure 6)

(Millimetres per year)



Historical annual streamflows into Perth dams (figure 7)

(Gigalitres per year)



If the climate does not deteriorate as predicted and the rainfall improves, future source development can always be postponed. Similarly if the climate dries faster than anticipated, source development may need to be accelerated.

Groundwater levels on the Gnangara Mound have decreased over the last 30 years, primarily in response to this drying climate. The Water Corporation is currently abstracting groundwater from the mound at an average of 145 gigalitres a year, to meet the current supply-demand balance. Abstractions will reduce after the second desalination plant is commissioned in 2011.

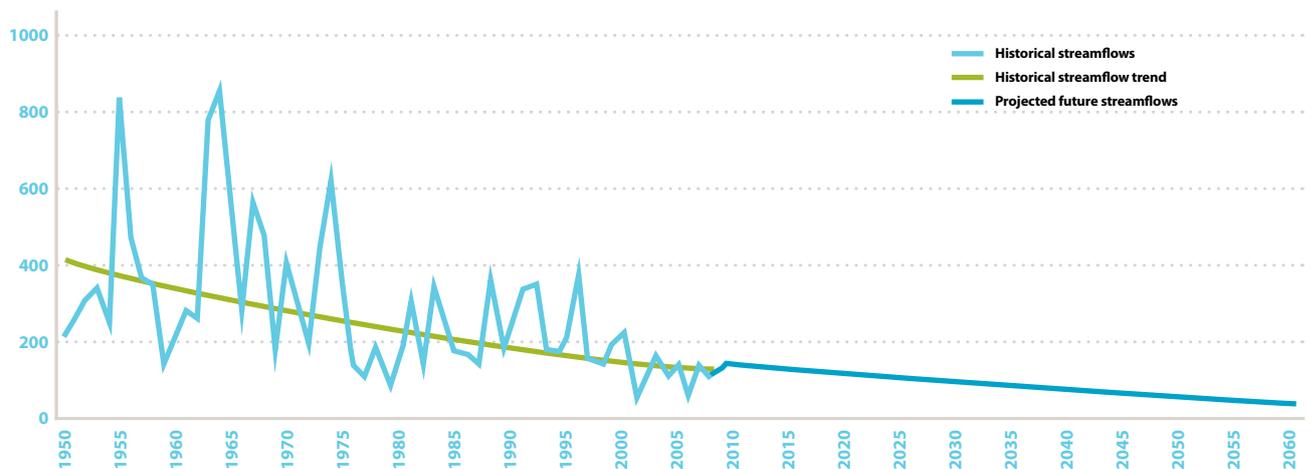
If rainfall continues to decrease, groundwater levels on the mound will similarly continue to decrease. This may impact the amount that can be taken for private and public water supply. The level of sustainable groundwater allocations for public and private water use is determined by the Department of Water.

The assumptions made in *Water Forever* are that the average groundwater allocation will progressively decrease from an average of 120 gigalitres a year (in 2012) to 90 gigalitres a year (by 2030) and 30 gigalitres a year (by 2060).

Table 2 outlines the yield expected from existing sources (including the second desalination plant) as a result of these projections. Note that the surface water yields reflect streamflows net of evaporation losses.

Historical streamflows 1950-2008 with projected streamflows from 2009 (figure 8)

(Gigalitres per year)



Currently, water use from the IWSS averages 147 kilolitres per person a year in Perth. This value has been decreasing steadily over the last few years as a result of a wide range of water efficiency initiatives.



Expected contribution from existing sources to 2060 (table 2)

Expected contribution from existing sources (GL / year)	2008	2020	2030	2060
Desalination sources	45	95	95	95
Surface water sources	90	85	75	25
Groundwater sources	145	110	90	30
Total	280	290	260	150

POPULATION FORECASTS

Population forecasts adopted by *Water Forever* have been based on data and advice received from the Australian Bureau of Statistics (ABS) and the Western Australian Department of Planning & Infrastructure (DPI) (now Department of Planning).

The population projections adopted in this document are greater than those stated in *Water Forever: Options for Our Water Future*, released in April 2008. This change is due to new data published by ABS from the 2006 Census which showed a bigger population increase than expected over the last few years. This revision provides a higher starting point for future projections.

DPI released a paper titled *Population Forecasts Initial Update*, in August 2008 which revised the long term population projections. Population projections from DPI have been adopted to 2031. The growth in population in Perth from 2008 to 2030 is projected to be in the order of 29,500 people per year.

State population planning forecasts are not available after 2030. The Water Corporation has projected population growth at a rate of 26,500 people per year from 2031 to 2060.

Population forecasts to 2060 (table 3)

Year	2010	2020	2030	2040	2050	2060
Perth population	1,640,000	1,910,000	2,180,000	2,420,000	2,660,000	2,900,000
Mandurah population	80,000	105,000	130,000	155,000	180,000	205,000
Total population	1,720,000	2,015,000	2,310,000	2,575,000	2,840,000	3,105,000

For planning purposes, the Water Corporation has assumed that the population of Perth and Mandurah will be in the order of 3.1 million people by 2060.

The population forecasts used in *Water Forever* are summarised in table 3.

WATER DEMAND FORECASTS

Currently, water use from the IWSS averages 147 kilolitres per person a year in Perth. This includes all residential, business and industrial demands. This value has been decreasing steadily over the last few years as a result of a wide range of water efficiency initiatives, including the introduction of permanent water efficiency measures.

Water Forever is forecasting water demand at 145 kilolitres per person for Perth. This is a base planning assumption that assumes that water demand will remain at 145 kilolitres per person with no additional investment in water efficiency.

This includes 100 kilolitres per person in households (as targeted in the State Water Plan 2007) and 45 kilolitres per person used in business and industry and non-revenue water (for firefighting, leakage and wastewater treatment operations).

Table 4 outlines how the supply - demand gap would increase without any further reductions in water use.

Table 5 outlines the approach proposed in this document - meeting the supply-demand gap with a 25% reduction in current levels of water use over time and the development of new water sources.

Water demand forecasts to 2060 with no further reduction in water use (table 4)

	2010	2020	2030	2040	2050	2060
Water use (KL per person)	145	145	145	145	145	145
Water supply from the IWSS (GL) (based on contribution from existing sources in Table 2)	280	290	260	225	185	150
Total annual demand (GL)	285	330	380	425	470	515
Supply - demand gap (GL)	5	40	120	200	285	365

Meeting the supply demand gap to 2060 (table 5)

	2010	2020	2030	2040	2050	2060
Water use (KL per person)	145	135	125	120	115	110
Water efficiency savings (GL)	5	25	50 (15%)	75	100	130 (25%)
New water sources required (GL)	0	15	70	125	185	235
Meeting the supply - demand gap (GL)	5	40	120	200	285	365

LEVEL OF SERVICE

The Water Corporation provides customers with water, wastewater and drainage services in accordance with the levels of service set out in an Operating Licence, issued by the Economic Regulation Authority. The levels of service are set for prescribed standards including:

- drinking water quality;
- drinking water pressure and flow;
- drinking water continuity;
- sewerage service;
- irrigation water quality and delivery;
- drains and drainage; and
- customer service and complaint handling.

The Economic Regulation Authority monitors the Water Corporation's performance against these standards. This means that schemes are planned, designed, built and operated to achieve externally regulated outcomes. The Department of Health requirements for drinking water quality are embedded in this licence.

In addition to providing the basic levels of service to customers, there is a much higher level of expectation from the government and the community that water will be available to maintain Perth as a "green" city.

Perth is fortunate to enjoy abundant green spaces; sporting ovals, parks, gardens and grass verges, all of which are highly important to the Western Australian lifestyle.

Perth is a hot city in comparison to eastern States capitals and the community wishes to maintain these amenities. More efficient use of water will assist both the Department of Water and the Water Corporation to maintain adequate supplies of water to retain green spaces that can be enjoyed by everyone.

RELIABILITY OF SUPPLY

As Perth grows, even with water efficiency measures, there will be a need to expand water source capacity to meet demand.

Over time there will not only be the question as to which new source to develop, but when is the appropriate time to develop it. In general, the IWSS water grid is designed to supply a certain water yield based on a 2% probability of more severe water restrictions. That means that more severe water restrictions would happen no more than once every 50 years.

The probability of more severe water restrictions is an average figure as it varies from year to year, especially when moving into a drought period.

There are currently seven levels of water restrictions that can be applied to reduce consumption.

Stages one to four are considered mild to moderate restrictions and generally involve reducing watering hours and days. Permanent water efficiency measures for the south of Western Australia roster sprinklers to two days per week (not in daytime). These water efficiency measures align with stage four restrictions.

Remaining restrictions are classified as stages five to seven (table 6).

This plan seeks to avoid the imposition of more severe measures during summer periods when there is insufficient rainfall and soil moisture to sustain most gardens.

Research undertaken by the Water Corporation indicates that more than 90% of the community support the maintenance of current water efficiency measures, including the two day a week sprinkler roster system.

Restriction stages 5-7 and impacts (table 6)

Stage	Impact
5	Scheme garden watering reduced to using reticulation only once a week
6	Scheme garden watering restricted to no garden watering using reticulation (hand held hose only)
7	No garden watering using hand held hose (watering can only) and no filling of swimming pools

For Perth, the decision to trigger the construction of a new water source can be driven by:

- a desire to reduce the short-term probability of water restrictions to avoid the associated impact on customers, leisure and garden industries and the loss of greenspace amenity in the city and parklands; and/or
- the need to manage groundwater use to an agreed average annual yield.

An aspect of water security in the IWSS is the variable groundwater abstraction rule regulated by the Department of Water. This rule allows for the amount of groundwater licensed for abstraction to vary on an annual basis, prescribed by formula.

Essentially, in low dam storage years, more groundwater can be abstracted. In high surface water storage years (generally following higher than average winter rainfalls), the groundwater abstraction is curtailed and water "banked" for future low rainfall years.

This licensing arrangement provides flexibility to manage the supply-demand balance and the sustainability of the resource over time, while providing greater security of supply.

WHAT IF PLANNING ASSUMPTIONS CHANGE?

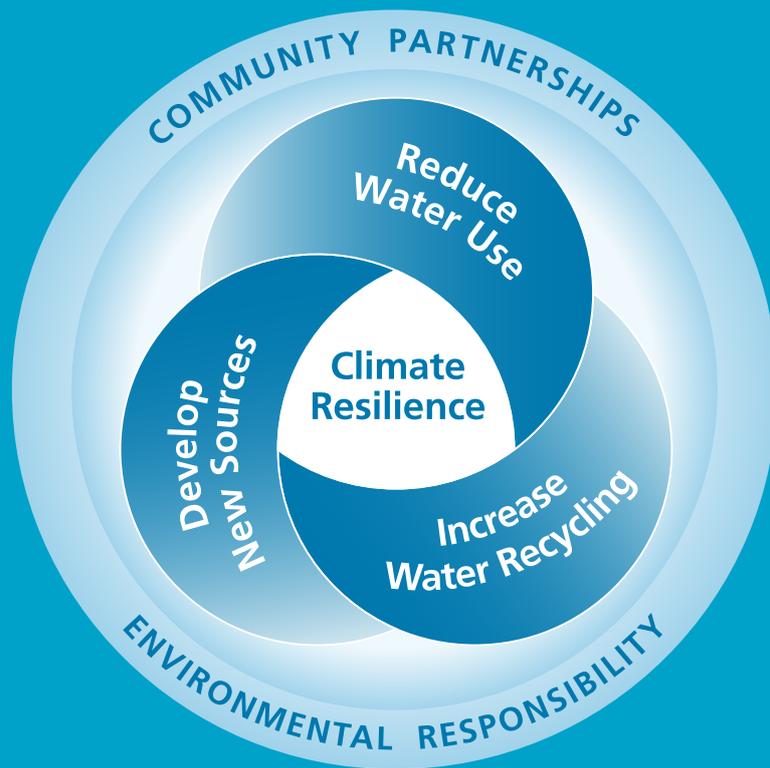
A section of this report, *Managing Risk and Uncertainty*, looks at the sensitivities surrounding key planning assumptions outlined in this section, together with other risks. It explores the relative impact of changes to any of them, as well as the cumulative risk if more than one is favourable, or unfavourable.

It then outlines planned responses to risks such as:

- changes to climate or rainfall patterns;
- population growth;
- water demand;
- water quality;
- energy; and
- sea level rise.



PORTFOLIO OF OPTIONS



PORTFOLIO OF OPTIONS

A portfolio of water options provides a framework to optimise decisions and allow for a focus on reduced water use and increased water recycling. It also positions the Water Corporation or the private sector to develop new sources in the future, in a timely and efficient manner.

The Water Corporation will develop a portfolio of water options to make Perth and surrounding areas more climate resilient.

Table 7 provides an overview of each option in the portfolio including rainfall independence and estimated yields by 2030 and 2060.

The value of each option will be adjusted over time as knowledge and conditions change. This allows for a more informed decision when considering any increase in water supply. It can also highlight specific areas where more certainty (through research, seeking regulatory approvals, securing land and other actions) would improve the value of the portfolio.

For example, a groundwater option could be improved by undertaking resource investigation. This would provide increased certainty of the nature and extent of the resource, which would be reflected in the portfolio.

Similarly, the portfolio of options can be expanded to include opportunities for private sector ownership and development.

The concept is particularly valid for water sources where scheme augmentation is undertaken in the context of

uncertain climate outcomes. A decision to build a new source is always made against the background that it could be followed by very wet seasons that could render the investment less useful. Equally, a decision not to proceed could be followed by drought conditions that result in severe water restrictions.

There is a balance between providing spare capacity to eliminate the chance of restrictions and the cost of providing that capacity. Security can be provided by building new sources (or reducing demand), but it can also be provided by being ready to deliver new sources (or reduce demand) in a short period of time.

An option value is created by being ready to deliver a new source in a short time that may or may not be needed, depending on the climate, rather than committing earlier to a nominally cheaper source with the possibility that it will not be needed.

A portfolio of water options provides a framework to optimise these decisions and allow for a focus on reduced water use and increased water recycling. It also positions the Water Corporation or the private sector to develop new sources in the future, in a timely and efficient manner.



Portfolio of water options that could be implemented by 2030 and 2060 (table 7)

(Gigalitres per year)

Reduce water use	Rainfall independence	Yields 2010 - 2030	Yields 2030 - 2060	Portfolio total	Page reference
Water efficiency programs					
• Homes and gardens	high	30	40	70	Pg 34
• Urban density	high	15	30	45	Pg 35
• Business, industry and services	high	5	10	15	Pg 36
Leakage and pressure management	high	5	10	15	Pg 37
Alternative water supplies					
• Rainwater tanks	low	13	7	20	Pg 40
• Garden bores	medium	4	0	4	Pg 40
• Community bores	medium	2	5	7	Pg 40
Subtotal		74	102	176	
Increase water recycling	Rainfall independence	Yields 2010 - 2030	Yields 2030 - 2060	Portfolio total	Page reference
Industry	high	20	20	40	Pg 52
Public open space	high	3	2	5	Pg 54
Agriculture (horticulture)	high	5	10	15	Pg 56
Residential greywater recycling	high	1	6	7	Pg 54
Residential dual reticulation systems	high	10	10	20	Pg 55
Subtotal		39	48	87	
Develop new sources	Rainfall independence	Yields 2010 - 2030	Yields 2030 - 2060	Portfolio total	Page reference
Groundwater replenishment*	high	35	80	115	Pg 70
Southern seawater desalination plant expansion	high	50	0	50	Pg 62
Wellington dam desalination	low	0	45	45	Pg 64
Esperance- Kalgoorlie desalination	high	0	12	12	Pg 62
New desalination sites	high	50	150	200	Pg 64
North West metropolitan coastal groundwater	medium	25	0	25	Pg 66
Gingin-Jurien groundwater	medium	0	48	48	Pg 66
Jandakot groundwater expansion	medium	3	0	3	Pg 66
Wellington dewatering	medium	10	0	10	Pg 67
Catchment management	low	25	0	25	Pg 68
Gnangara water trading	medium	20	0	20	Pg 68
Subtotal		218	335	553	
Total options to meet future supply - demand gap		331	485	816	

*Although a potential drinking water source, groundwater replenishment can also contribute to increased water recycling.

SUSTAINABILITY OF PORTFOLIO OPTIONS

The need to deliver sustainable outcomes in planning for water services underpins *Water Forever*. In developing this plan the sustainability of 35 water efficiency and source options that could potentially be developed over the next 50 years were assessed.

This comprehensive assessment was aimed at:

- assessing the sustainability of a broad range of water source options;
- integrating the assessment of water efficiency and water source options including the use of wastewater as a source;
- demonstrating transparency of data and analysis;
- incorporating community input; and
- investigating opportunities to improve the outcomes of the options.

Figure 9 summarises the outcomes from the sustainability assessment by source type. Water efficiency programs were found to be the most sustainable option, followed by large scale recycling schemes (such as recycled water to industry) and fit for purpose sources (such as rainwater tanks and garden bores). Source optimisation activities such as catchment thinning were followed by groundwater, desalination and surface water options.

Many of the options highlighted are already being implemented. For example, a range of water efficiency, recycling and fit for purpose measures have been adopted, particularly since 2001. Clearly however, there is room for greater focus in these areas.

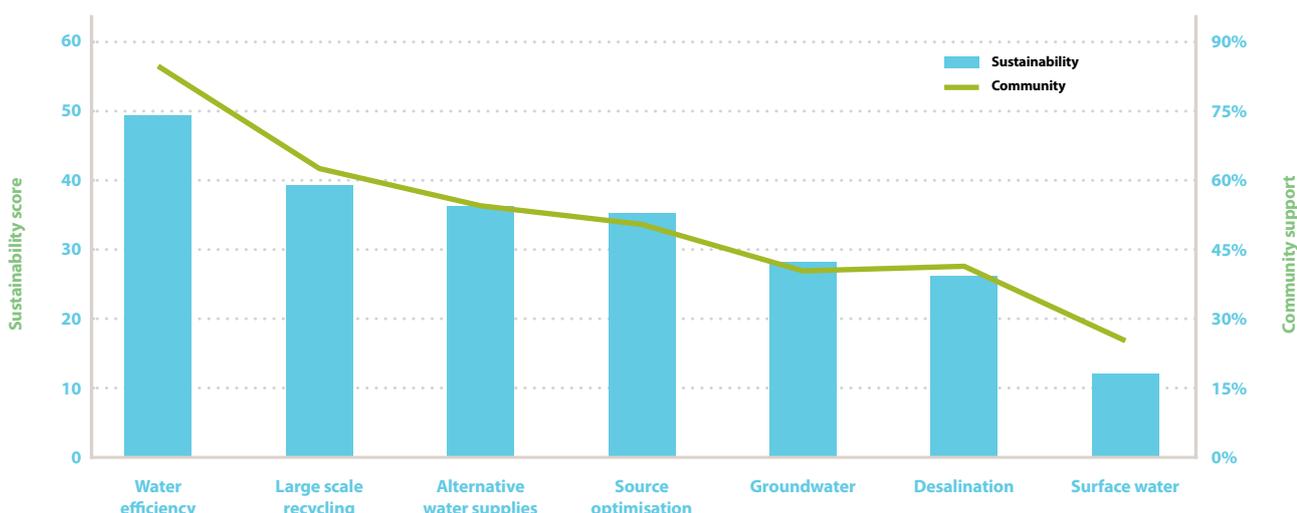
It is important to note that a lower sustainability score does not necessarily indicate that a water source is not sustainable. In fact, there may be situations where the lower ranked sources may still be required. These sources may require additional work to improve their sustainability ranking.

For example, the sustainability of a groundwater resource could be improved when it is underpinned by significant resource knowledge, an appropriate monitoring regime and a regulated water management plan. Significant work has been underway for a number of years on these issues, related to the Gngangara Mound.

Having a diversity of options available for consideration maximises the robustness of the water portfolio.

Interestingly, as figure 9 shows, there is a strong alignment between the outcomes of the sustainability assessment and community support for different options.

Sustainability rankings for water source options and level of community support (figure 9)



Alternative water supplies refers to rainwater tanks, garden bores and community bores.

Source optimisation refers to catchment management, water trading, cloud seeding and reducing evaporation from dams.

RELATIVE COST OF PORTFOLIO OPTIONS

In considering which options to progress in the portfolio, an analysis of the relative cost per kilolitre to produce and deliver the water to the IWSS is taken into account. Figure 10 outlines the cost and yield of options in the portfolio.

Generally water efficiency programs are the least expensive while decentralised options including sewer mining, rainwater tanks and greywater systems are the most costly.

The cost of options will change due to factors such as potential advances in membrane technology, expected increases in energy costs, movement of water to demand centres and site specific considerations for new sources. These costs will be revised as planning and delivery is advanced.

OPTIONS ACTIVELY BEING DEVELOPED AND IMPLEMENTED

In determining which options should be implemented, many of them require further investigation or testing.

In some instances trials are being conducted, such as for groundwater replenishment and catchment management.

Other options require a collaborative approach through identification and development of policy and regulatory gaps. The final section in this plan identifies actions where the Water Corporation will 'continue to', 'commit to' and 'explore' options in the portfolio.

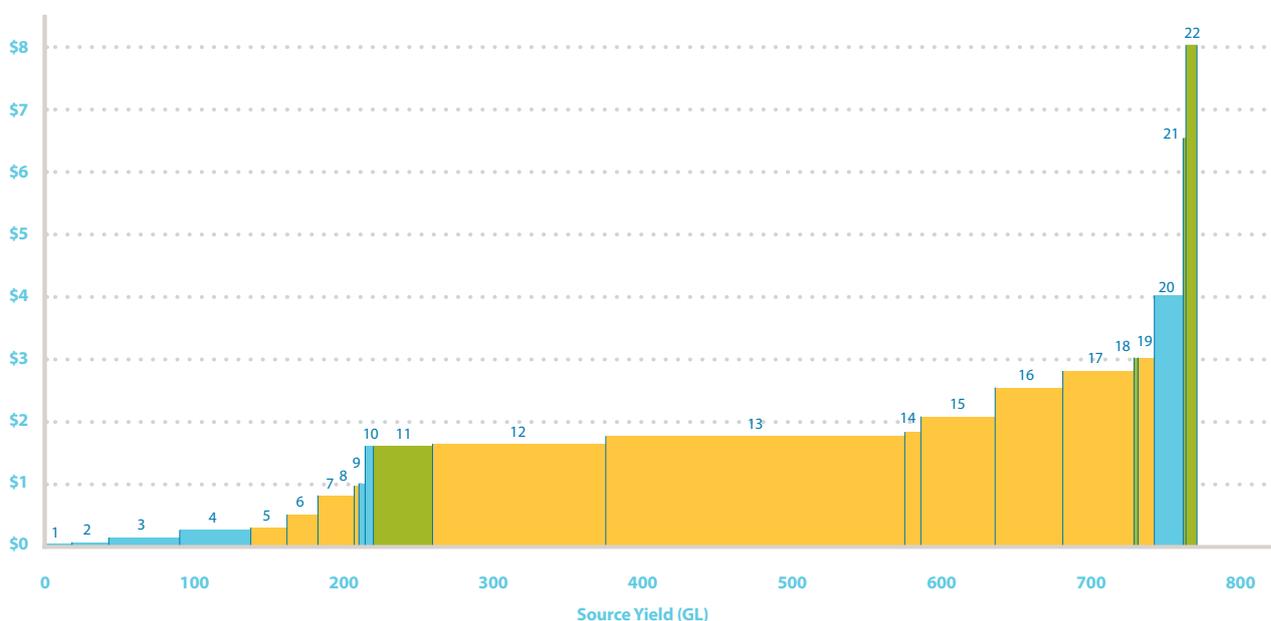
Of the larger source augmentation options, the Water Corporation is actively progressing North West Coastal groundwater, expansion of the Southern Seawater Desalination Plant, groundwater replenishment, catchment management and Gngangara water trading. A transparent and comprehensive engagement process will be undertaken to secure future sources for the IWSS.

FUTURE POSSIBILITIES NOT IN PORTFOLIO

It is recognised that as technology advances and innovative practices are developed, the options in the portfolio will evolve. To ensure that new options are considered, this plan highlights new technologies which may be added to the portfolio over time.

Portfolio of options cost and yield (figure 10)

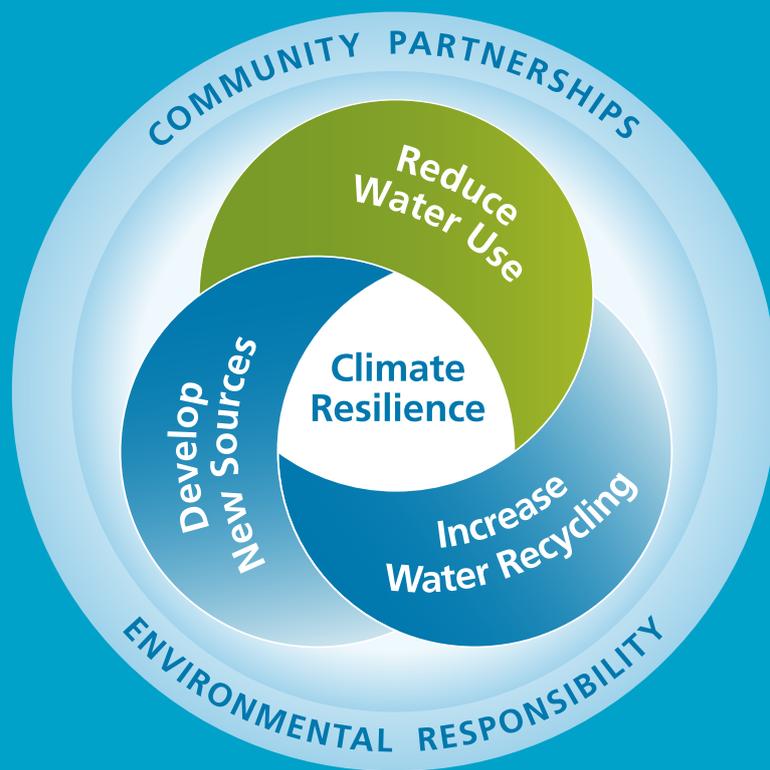
(Dollars per kilolitre)



- | | | | |
|-----------------------------|--|--|--|
| 1 Increased Urban Density | 7 North West Metro Coastal Groundwater | 13 New Desalination Sites | 19 Esperance - Kalgoorlie Desalination |
| 2 Urban Form | 8 Jandakot Groundwater Expansion | 14 Wellington Dewatering | 20 Rainwater Tanks |
| 3 Technological Advancement | 9 Garden Bores | 15 Southern Seawater Desalination Pt 2 | 21 Sewer Mining Systems |
| 4 Behavioural change | 10 Community Bores | 16 Wellington Dam Desalination | 22 Greywater Systems |
| 5 Catchment Management | 11 Industrial Recycling | 17 Gingin - Jurien Groundwater | |
| 6 Gngangara Water Trading | 12 Groundwater Replenishment | 18 Community Greywater | |



REDUCE WATER USE



REDUCE WATER USE

The Water Corporation believes that it can help business and households reduce their current water use by a further 25% over the next 50 years.

Since 2001, the average per person water use has decreased to 147 kilolitres a person, from 185 kilolitres. However, even at this lower level, Perth remains one of the highest water using cities in Australia.

Figure 11 summarises scheme water use per person in all major Australian capital cities over the past few years. During this period, Melbourne and Brisbane in particular were subject to severe restrictions due to low rainfall. Adelaide and Sydney also had water restrictions. All of these cities have set targets to further reduce water use, even after restrictions are lifted.

While the Water Corporation is not planning for restrictions of this nature, further reductions in water use in Perth and surrounding areas are achievable. This is further highlighted in a comparison of international urban water use (figure 12).

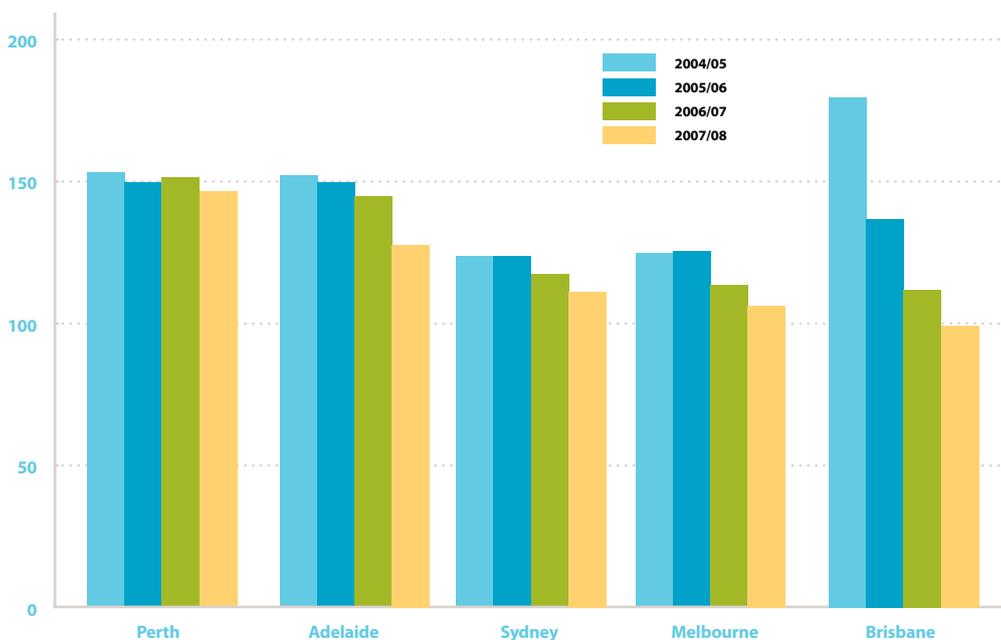
Community engagement has highlighted the desire for greater efforts in water efficiency, particularly in business, industry and in the use of water for public open spaces. The Water Corporation is committed to helping Perth and surrounding areas continue to reduce the amount of water used.

The *Water Forever* sustainability assessment noted there were numerous benefits to reducing water use, as it:

- is highly valued by the community;
- significantly reduces our environmental footprint as a community;
- reduces the amount of energy required to treat and transport water;
- reduces energy consumption in homes, particularly by reducing the amount of energy used to heat water;
- can save money for business and households;
- is cost effective for the Water Corporation – generally less than \$1 a kilolitre; and
- significantly reduces and defers the need for capital intensive new sources.

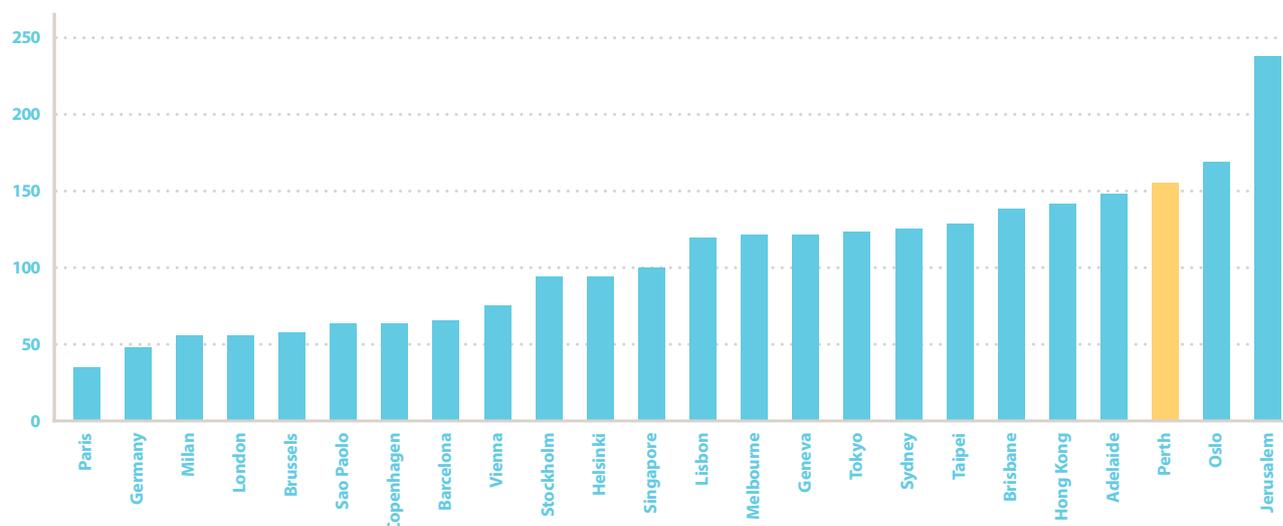
Per person water use across major Australian capital cities 2005-2008 (figure 11)

(Kilolitres per person per year)



International comparison of per person water use 2007 (figure 12)

(Kilolitres per person per year)



The Water Corporation believes that it can help business and households reduce their current water use by a further 25% over the next 50 years.

Figure 13 illustrates historical water use and how this use is projected to decline to 110 kilolitres to meet a 25% reduction in use by 2060. A significant, yet cost effective investment in water efficiency measures will be required to achieve this outcome.

By investing more in water efficiency programs, the Water Corporation will help households and businesses reduce per person water use to 125 kilolitres a year by 2030. This will result in 50 gigalitres being saved – about 40% of the supply-demand gap to 2030.

A long term objective to use a quarter less water would reduce per person water use to 110 kilolitres per person. This would save 130 gigalitres – about 35% of the supply-demand gap to 2060.

Table 8 outlines how different sectors are anticipated to contribute to these savings by 2030 and 2060.

Estimated water savings and per capita targets by 2030 and 2060 (table 8)

Sector	Estimated water savings by 2030 (GL/yr)	Per capita target by 2030 (KL/yr)	Options for water savings by 2060 (GL/yr)	Per capita target by 2060 (KL/yr)
Homes and gardens (new and existing)	30	85	70	75
Urban density	15		45	
Business, industry and services	5	40	15	35
Total	50	125	130	110

WHY NOT RELY SOLELY ON REDUCING WATER USE?

Experience around Australia has highlighted the problem of relying solely on reducing water use (water efficiency), particularly as a short term option.

Since 2003, Queensland, Victoria, South Australia, the ACT and New South Wales have undertaken urgent water planning to address water shortages. Early plans highlighted water efficiency as the dominant response in most cases.

Based on experience to date, it takes time to adjust to using less water. In all cases, programs designed to achieve significant reductions in water use over a short timeframe were unable to address acute water shortages without severe water restrictions.

Perth was the first city to commission a desalination plant to respond to the drying climate. This, together with a focus on water efficiency, helped us to manage significant reductions in water availability without the need for severe water restrictions.

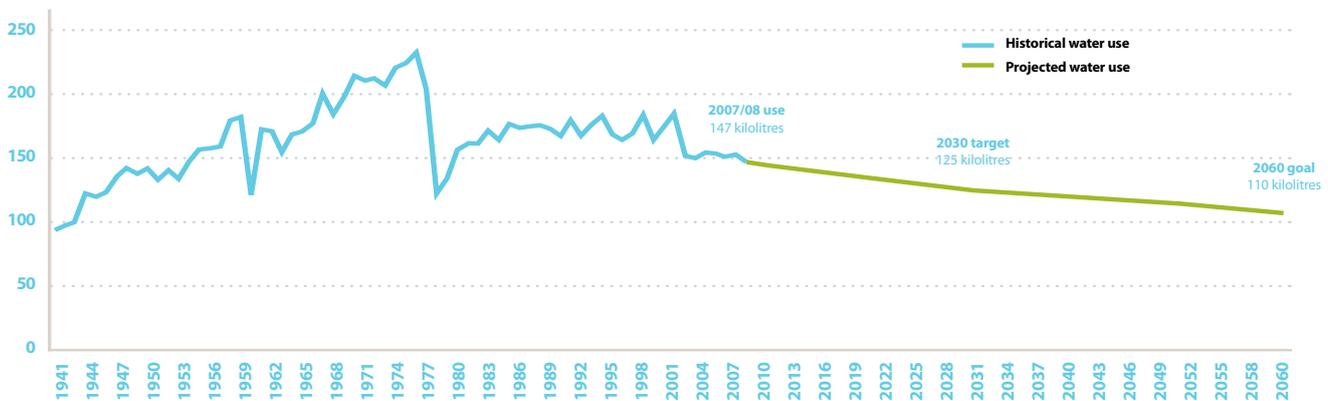
Sydney, Melbourne, Adelaide and Brisbane are now undertaking significant source development programs including desalination and large scale recycling schemes. Moving off severe water restrictions is the immediate priority, although Melbourne and Adelaide water supplies remain at very low levels and further water restrictions may be required in these cities.

Securing urban water supplies continues to be a national priority and most cities have set long term targets to reduce water use. This highlights that even after new water supplies are commissioned, reducing water use will continue to play a vital role in urban water management in Australia.

Water efficiency works best when coupled with source development as part of an integrated water plan.

Historical and projected water use 1941-2060 (figure 13)

(Kilolitres per person per year)



HOMES AND GARDENS

Collectively, households still have the greatest potential to make a significant contribution to reducing water use, as they are by far the highest users of water from the IWSS. Relatively small reductions in water use in individual households can add up to significant savings.

At the household level, the Water Corporation believes that the largest water savings can be made through:

- working one-on-one with residents in their homes to demonstrate how they can save water inside and outside;
- continuing to drive technological advancements in water efficient appliances;
- providing education and incentives to help households and land developers plant waterwise gardens more suited to a drier climate; and
- working with land planning agencies, land developers and builders to increase urban density and promote climate resilient developments within the metropolitan area.

Waterwise Homes program

Research shows that up to 45% of the Perth population think they cannot do any more to save water. At the same time, most households significantly underestimate their current water use.

To address this gap, the Water Corporation is planning to develop a new Waterwise Homes program.

Four trials of this type of program have been conducted nationwide since 2003, the most recent completed in Perth in 2008. Overall there was a 21% saving in water use for households participating in the program.

The program is expected to include:

- regular water meter readings;
- access to Waterwise specialists to advise on water saving activities at home;
- regular letters and phone calls to households to provide advice regarding ways to reduce water consumption; and
- ongoing information to encourage water savings.

Significant water savings can be achieved by helping households change the way gardens are landscaped. As the climate continues to dry, household gardens should be redesigned to require less water to sustain them.

These changes can involve:

- replacing non-native plants with native plants or other species suitable for a dry climate;
- minimising the amount of lawn in the garden by replacing it with waterwise plants, groundcover, paving or synthetic turf; and
- using larger shrubs and trees or cover to provide shaded areas and conserve soil moisture.

Water efficient appliances

In 2001, the introduction of Waterwise rebates in Western Australia for water saving appliances helped to stimulate market innovation in water saving technology. For example, as a result of the rebate program, over 200,000 water efficient washing machines are now in use in Western Australia.

This has contributed to the introduction of the Water Efficiency Labelling Scheme (WELS), a Federal Government initiative that requires certain products to be registered and labelled with a star rating to indicate their level of water efficiency.

Introduced in July 2006, the following products are now legally required to have a WELS rating:

- showerheads;
- tap equipment;
- toilet and urinal equipment;
- clothes washing machines; and
- dishwashers.

The Water Corporation will continue to work with State and Federal Governments to improve the water efficiency standards for a range of appliances.

URBAN DENSITY

Urban density refers to the number of houses developed in a land area. The likely future trend for urban density is for an increase in the number of multi-residential dwellings in Perth and Mandurah. Currently, the ratio of single residential to multi-residential dwellings in Perth is 71% to 29%.

Multi-residential dwellings tend to result in smaller living areas and in particular, smaller gardens. This in turn, reduces household water consumption.

WATERLESS TECHNOLOGY

In the future, water efficiency may well evolve to waterless technology for many domestic applications.

Water and energy efficiency, are now playing a major part in the evolution of the washing machine. Some of the more recent technology being developed includes replacing the majority of the water with tiny reusable plastic beads making washing more energy efficient (30% less energy).

It also reduces the amount of detergent required and eliminates the need to tumble dry, saving even more energy and time.

This innovative research provides one example of waterless technology and the opportunity for traditional water reliant appliances to become increasingly more water efficient.

A recent study by the CSIRO on *Water-energy futures for Melbourne: the effect of water strategies*, water use and urban form found that by 2045, an increase in urban density in Melbourne is estimated to save up to 100 gigalitres of water a year. These forecast savings were primarily attributed to reductions in outdoor water use.

Estimated water savings from an increase in higher density living in Perth and Mandurah are outlined below.

Estimated water savings through increased urban density (table 9)

Level of urban density	Estimated water savings by 2030 (GL/yr)
60% single residential / 40% multi-residential	15
50% single residential / 50% multi-residential	25
40% single residential / 60% multi-residential	40

The Water Corporation supports the transition to greater housing diversity, including higher density living in the metropolitan area.

BUSINESS, INDUSTRY AND SERVICES

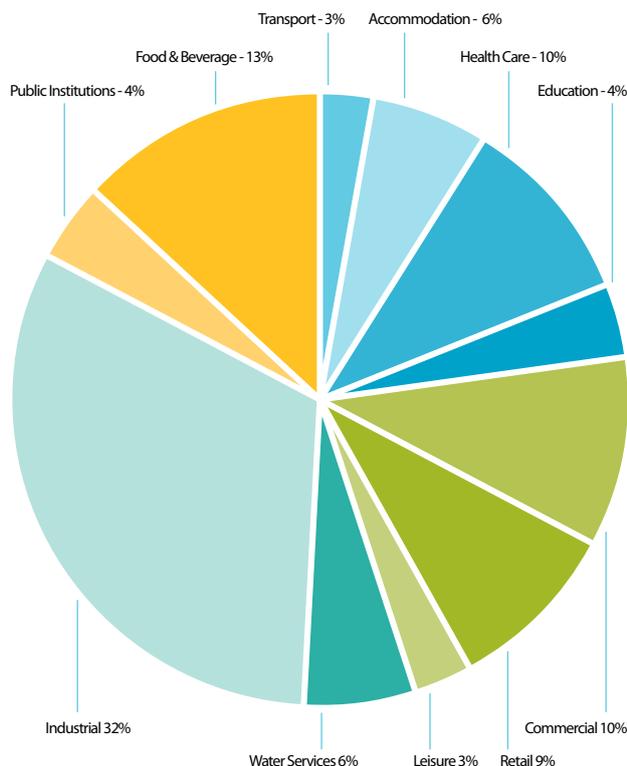
Collectively, business and industry customers use around 50 gigalitres of water supplied by the Water Corporation. The Water Corporation has been engaging with large business and industrial water users in recent years to help them identify opportunities to improve their water management processes.

As with households, further water savings can be achieved in this sector. In October 2007 the State Government announced a range of water efficiency measures that impacted on the whole community. As part of these measures, business and industry customers who use more than 20,000 kilolitres a year are now required to develop and maintain a Water Efficiency Management Plan.

In 2007/08, a total of 344 customers State-wide used more than 20,000 kilolitres a year with total scheme water use around 40 gigalitres a year. Of these customers, 302 have a Water Efficiency Management Plan in place.

Of the 344 customers, 216 are in the Perth metropolitan area and collectively use approximately 19 gigalitres of scheme water a year.

Scheme water use by metropolitan business and industry users over 20,000 kilolitres in 2007/08 (figure 14)



The Water Corporation assisted business and industry to prepare Water Efficiency Management Plans by conducting water assessments at their sites to identify opportunities to improve water efficiency.

Water Efficiency Management Plans:

- track on-site water use;
- establish a water use benchmark which correlates to business activity;
- identify short and long term water reduction targets;
- identify opportunities to enable businesses to achieve reduction targets; and
- help to develop an annual action plan over a five year timeframe.

Customers are required to provide annual reports to the Water Corporation, outlining their progress in achieving their targets and report on the status of improvement actions identified.

Water efficiency plans from these customers are expected to help achieve a 15% reduction in scheme water use by 2030.

Business and industry customers who use more than 20,000 kilolitres a year are also encouraged to adopt fit for purpose water solutions. This may include exploring alternative water supplies, where appropriate.



New building codes for commercial buildings

The Water Corporation supports the development and application of building codes to new commercial buildings similar to *5 Star Plus* for residential buildings. Revised standards would ensure that new commercial buildings would meet specified water and energy efficiency requirements. The Water Corporation will work collaboratively with the Building Commission to seek to introduce the changes.

Leakage and pressure management

In Perth water loss accounts for about 8% of the total water supplied into the distribution system. Some of this is water used for essential activities such as unmetered firefighting and mains flushing.

The majority of water losses however are due to leakage at pipe joints, through small cracks and through reported leak and burst events. Leakage occurs in all urban and rural water supply networks. It can be difficult to detect due to the buried nature of most water infrastructure and can be expensive to repair.

Traditionally, water losses in Perth have been low by international and national standards. Increasingly however, especially where water is scarce, cities are investing in programs to reduce these losses.

Water losses can be reduced by a range of initiatives - most commonly through pressure management and active leak detection.

Pressure management reduces excessive water pressure, while ensuring a minimum level to meet customer needs and operating standards. Reduced water pressure has the dual benefit of lowering background leakage and reducing the number of leak and burst incidents.

The Water Corporation recently completed pressure reduction trials in Perth. The trials indicated the potential to expand these programs to about 30% of the metropolitan area.

Active leak detection programs involve proactive surveys to locate leaks in the water network. The Water Corporation is currently undertaking trial active leak detection in four Perth suburbs to gain an understanding of the effectiveness of the latest technology in this field.

As part of reducing water use by 15% by 2030, the Water Corporation will develop leak detection and pressure management programs, where cost effective.

LAND DEVELOPMENT

The Waterwise Land Development program assists developers to design waterwise communities. The Water Corporation will continue to provide information and advice to the land development industry on how to achieve water savings, with an emphasis on establishing climate resilient gardens that can easily adapt to using much less water as rainfall continues to decline.

WATERWISE SCHOOLS

The Water Corporation's Waterwise Schools program aims to educate students, their families and the wider community about the need to value, protect and conserve our precious water resources.

Currently more than 420 primary and some secondary schools across the State are recognised through the program with over 60 additional schools working towards recognition. This represents over 130,000 students involved in the program on an annual basis.

In late 2008/09, the Water Corporation launched three new teacher resource files for students from pre-primary to year ten. Topic booklets included in these files cover a range of themes including water and the natural environment, stormwater and waterways, water and health, water supply, water conservation and wastewater. Further curriculum material is being developed for year 11 and 12 students.

The Water Corporation will expand the Waterwise Schools program with the aim of accrediting all primary schools by 2015.

Reducing water use in schools

The Schools Water Efficiency Project aims to reduce water use in schools across the State.

The project commenced in late 2007. In 2008, water assessments in over 210 schools were conducted. Based on the program findings, a number of recommendations were made for all participating schools. These included:

- a greater focus on irrigating school green spaces more efficiently through the use of bore metering, irrigation plans, precipitation rate tests and monthly irrigation schedules;
- replacement of single flush toilets, old showerheads and aerators with dual flush toilets, three star rated showerheads and flow control aerators;
- weekly water meter reading by schools to monitor water use; and
- participation in the Waterwise Schools Program.

The Water Corporation will continue to work with educational institutions and schools to implement these recommendations, provide training programs and raise awareness of funding and grant opportunities available to assist them in reducing water use.

WATERWISE SPECIALISTS

Waterwise Specialists are businesses from a range of industry groups that have the ability to directly influence the way households use water.

The Water Corporation has partnered with businesses and industry groups through the Waterwise endorsement program. This ensures that providers of water using products and services are trained and assessed on their ability to implement and promote high standards of water efficiency.

Waterwise Specialist programs include:

- Waterwise Display Villages
- Waterwise Garden Centres
- Waterwise Garden Assessors
- Waterwise Garden Irrigators
- Waterwise Garden Landscapers
- Waterwise Irrigation Design Shops
- Waterwise Land Developments
- Waterwise Lawnmowers
- Waterwise Plumbers
- Waterwise Schools
- Waterwise Water Auditors
- Waterwise Councils.

Over the next five years, the Water Corporation will continue to expand the Waterwise Specialist program by working with relevant industry groups to develop the highest possible standards for water efficiency and to promote best practice within the community.

Through this program, the Water Corporation aims to achieve measurable and sustained water savings in residences, businesses and across urban landscapes.

WATERWISE COUNCILS

The Water Corporation and the Department of Water, with support from ICLEI – Local Governments for Sustainability, have jointly developed a Waterwise Council program. The aim of this program is to build a co-operative working relationship with local governments to promote sound water management and improve water use efficiency in local governments and their communities.

The program will assist councils to improve water management for public open space and to reduce overall water use. It will also support behavioural changes in the community by encouraging participation in Waterwise programs and the use of products and services designed to maximise efficient water use.

Through partnerships with local government, this program will help to achieve water savings at both corporate and community levels in the longer term.

ALTERNATIVE WATER SUPPLIES

Alternative water supplies include sources of water usually managed at a community or household level. They can provide water for non-drinking uses such as garden watering, toilet flushing and clothes washing (often referred to as “fit for purpose”). In addition, they can provide increased autonomy to the community, particularly in times of restrictions.

Alternative water supply options considered in this section are:

- rainwater tanks;
- garden bores; and
- community bores.

The Water Corporation estimates that collectively these alternative water supplies could account for up to 19 gigitalres of supply by 2030. This is a best case scenario, where up to 13 gigitalres could be supplied by rainwater tanks if all new developments installed tanks and there was a significant uptake of tanks by existing properties.

Consideration also needs to be given to the rainfall dependence of these options. In Perth’s Mediterranean type climate, rainwater tanks tend to yield lower volumes of water than tanks in wetter areas of the State and across Australia. Similarly, groundwater use needs to be carefully managed in a drying climate.

Recycling greywater in households and the community is discussed in detail in the section on *Increase Water Recycling*.

Alternative water supplies can provide water for non-drinking uses such as garden watering, toilet flushing and clothes washing.



Rainwater tanks

The Water Corporation supports the use of rainwater tanks connected for inside use, for non-drinking purposes such as toilet flushing and clothes washing. While rainwater tanks often provide water for outdoor uses such as garden watering, greater savings can be made by plumbing the tank water for internal use.

Research undertaken by the ABS in March 2007 indicates that there are approximately 44,000 households using rainwater tanks as a source of water in Perth, accounting for just over 7% of all homes. Currently only about 10% of these rainwater tanks are connected internally, although the number is increasing.

The *Australian Drinking Water Guidelines* (2004) note that above-ground rainwater tanks generally provide a safe supply of water. However, the guidelines recommend that for household drinking water supply, emphasis should be on selecting the best quality source water available.

In Perth, the Water Corporation recommends that people connected to the public water supply system use this water for drinking and direct water from rainwater tanks to non-drinking water uses.

Based on a study of rainwater tanks in Perth in 2009, continued customer choice in the use of rainwater tanks is supported. However, due to the relative high unit costs, the mandating of rainwater tanks for new housing developments is not warranted at this time.

Rainwater tanks have been included in the portfolio of options for the future.

The opportunity to provide more information and training to consumers when purchasing a rainwater tank in regards to installation, maintenance and use is supported by the Waterwise programs.

Garden bores

Garden bores are used across Perth to irrigate household gardens. It is estimated that there are over 150,000 garden bores in the Perth metropolitan area.

The Department of Water manages the use of garden bores. Bores can provide an alternative water supply in areas where there is shallow groundwater of relatively good quality.

They are however not supported in areas where:

- there are acid sulphate soils;
- there is salt water intrusion;
- there are unacceptable impacts on groundwater dependent ecosystems; or
- groundwater may otherwise be contaminated.

The number of garden bores has increased steadily from the 1970's until 2006. In 2006 / 07, the number of garden bores installed was about 3,800.

In October 2007, the State Government introduced permanent water efficiency measures for garden bores. They are now operated on a three day a week sprinkler roster. This regulation, combined with smaller average block sizes resulting in less outdoor water use, has significantly reduced private investment in new bores. As a result, in 2007/08 the number of new bore installations halved to only 1,900.

In general, fewer new garden bores are expected to be added in the future. This area may require stronger regulation, in the event that short term water restrictions are needed to manage through a critical supply period.

Existing garden bores will continue to play an important role in meeting the needs of the community for residential gardens. Garden bore owners share the resource of the superficial aquifer with other users. The Water Corporation supports increased monitoring and reporting on this resource, to ensure its long-term sustainability.

Community bores

Community bores are being trialled in Perth to supply non-drinking water in some new housing developments. The bores are shared by the entire community and the supply to households is controlled at a central point, limiting over watering.

Currently these bores are only used for irrigating gardens and lawns. The Water Corporation is working with the Department of Health and land developers to see if the water can also be used for toilet flushing and clothes washing.

Currently, there is insufficient information to determine water savings from community bore systems.

Bores still rely on rainfall to recharge groundwater. If rainfall levels continue to decline as projected, Perth may not be able to rely on bores as a water source beyond 2030. This is why it is important to monitor bore water use, so this precious resource is used wisely.

THE COST AND ROLE OF RAINWATER TANKS IN PERTH

In April 2009, a study examining the cost effectiveness of rainwater tanks in Perth was undertaken for the Water Corporation and Department of Water.

The study found that the costs and yields from a rainwater tank can vary significantly. To optimise the yields it is important to maximise:

- roof size to capture the rain;
- connections to internal and external use; and
- tank size.

The study found that household location (north to south of Perth) and projected declines in rainfall are not expected to significantly impact on tank yields.

Under a best case scenario, rainwater tanks can provide up to 28% of a household's water supply, with costs ranging from \$4-\$13 a kilolitre. Tanks are most cost-effective when they are connected for use inside the home, as more water can be used all year round, thereby reducing the overall cost.

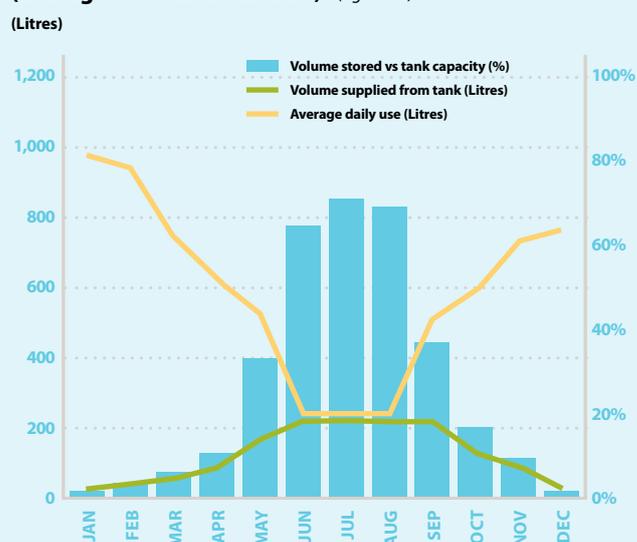
A summary of the costs and yields of different scenarios are shown below.

Figure 15 outlines the volume of water stored in a tank as compared to the volume of water used and supplied. The graph demonstrates that water demand is greatest when the supply of water from the tank is at its lowest (eg over summer months). Any potential storage over the level of rainwater supplied represents losses or overflows.

In terms of overall contribution to Perth's water supply, the study considered several scenarios based on current levels of rainwater tank uptake as well as increased levels of uptake for new and existing homes.

The study found that rainwater tanks could provide up to 13 gigalitres of water to households by 2030 if all new properties were mandated to install rainwater tanks and current levels of retrofitting were maintained.

Rainwater tank water supply modelling (average of 3 Perth suburbs)* (figure 15)



* data shown for 2,000 litre tank, 125m² roof, -8% climate scenario, maximum indoor use

	Outdoor use only		Outdoor and indoor use	
	2 KL	5 KL	2 KL	5 KL
Costs				
Tank & pump (approx)	\$800 - \$1,600	\$1,250 - \$2,050	\$1,800	\$2,250
Plumbing & installation (approx)	\$650	\$650	\$950 - \$1,450+	\$950 - \$1,650+
Operation & maintenance (approx)	\$20 pa	\$20 pa	\$20 pa	\$20 pa
Unit costs	\$7 - \$17 per KL	\$5 - \$15 per KL	\$5 - \$11 per KL	\$4 - \$13 per KL
Residential rainwater tank yields				
Annual yield	10 - 26 KL	14 - 42 KL	25 - 59 KL	27 - 76 KL
Proportion of average annual consumption	4 - 10 %	5 - 16 %	9 - 22 %	10 - 28 %
Savings to household water bill (estimated)	\$8 - \$22 pa	\$12 - \$35 pa	\$21 - \$49 pa	\$22 - \$63 pa

IRRIGATION OF PUBLIC OPEN SPACE

Access to public parks, gardens and ovals is important to maintaining an active and healthy community.

The majority of parks and ovals are the responsibility of local government and are watered using self supply groundwater, rather than public water supply. As rainfall continues to decrease, it is important that all water resources are used sustainably, including groundwater, to enable continued recreation on public parks and ovals.

The Department of Water, with assistance from the Department of Sport and Recreation, has been working with local governments to develop water conservation plans to ensure that groundwater is being used as efficiently as possible. This includes the concept of "hydrozoning"- only irrigating sporting ovals and public open space in the areas that require high quality grass and returning unused grassed areas to native vegetation which does not require irrigation.

The Water Corporation will continue to work with State and local governments to:

- support the Waterwise Councils program to encourage water efficiency in local government operations;
- support a reduction in the use of groundwater by providing recycled water to irrigate public parks and ovals; and
- provide Water Corporation owned land for use by sporting and community groups, where this land can be irrigated with recycled water from a nearby wastewater treatment plant.

REDUCING WATER USE IN AGRICULTURE

In the Perth and Mandurah areas, the Department of Water estimates that irrigated horticulture uses approximately 15% of total water use every year. Almost all of this water is self supplied from groundwater, rather than public water supply.

The Department of Water is responsible for managing the sustainable supply of groundwater for agricultural purposes.

While the Water Corporation has a limited role in supplying water to the agricultural sector, there may be future opportunities to supply recycled water to irrigate crops, including fruit and vegetables. This is discussed in more detail in *Increase Water Recycling*.

MINIMISING OUTDOOR WATER USE

Perth households use about half of all residential water outside the home, providing an opportunity to improve water efficiency.

The Cooperative Research Centre for Irrigation Futures has developed a new decision making tool, Water Saving Potential framework (WASP), that can help householders save water on their gardens.

WASP combines a:

- biophysical model (uses data on soil type, vegetation, climate and use to calculate the amount of water needed to maintain a landscape); and
- water demand model (uses water meter readings and aerial photographs to work out how much water was actually used).

Comparing results from the models reveals the water saving potential. It is intended that householders could access WASP online, allowing them to assess their own water savings. The model has been tested in two Sydney suburbs. The results indicated that the suburb with less rainfall and higher evaporation rates needed less water for gardens than the other because the soils absorbed more water.

This tool has the potential to be applied in Perth for residential use and public open space.

Access to public parks, gardens and ovals is important to maintaining an active and healthy community.



PRICING TO REDUCE WATER USE

The Water Corporation operates as a commercial business, and charges customers for water, sewerage and drainage services provided.

In the metropolitan area, most customers pay the full cost of services delivered. The State Government provides pricing concessions to some customer groups (such as pensioners and seniors) to maintain the affordability of these essential services.

Water prices are set by the Minister for Water in Cabinet. While the Water Corporation prepares an annual submission to the State Government on proposed water prices, the primary source of advice comes from the Economic Regulation Authority (ERA).

The ERA undertakes a major review every three years to support the provision of this advice. Advice is also received from the Department of Treasury and Finance and the Department of Water on the appropriate structure and quantum of customer tariffs for water services.

It is noted that there are many issues to be considered when setting prices.

There are two types of charges for a water service:

- annual service charge – billed annually with the option to pay in either one, two or four instalments; and
- water usage charge – billed twice yearly, based on water consumption.

For metropolitan customers, when combining the annual service charge and the water usage charge, the total charge reflects the full cost of providing the water.

Reforms are being implemented to shift the balance between the service and usage charges. These reforms will place a greater emphasis on the usage charge, with the increase in the usage charge matched by decreases in the service charge.

Usage charges are forecast to continue to rise to reflect the long term cost of meeting the supply-demand gap.

Billing to support reduced water use

Water bills help to inform people about how much water they are using. They can also encourage high water using households to reduce consumption.

The overwhelming majority of Perth users (90%) believe that they are either average or below average water users. To address this perception, the majority of water bills now include information on how much water a household uses in comparison with the average water use for their suburb.

The Water Corporation will consider opportunities to assist people to better understand their water use patterns. These measures may include:

- increasing the frequency of water bills, so households can understand how they use water across the seasons;
- providing online access to account information so people can track their water use in between billing periods;
- sub-metering multi residential developments to send accurate information to each dwelling on actual water use; and
- the use of smart meters to send more detailed and timely information about water use.

Scarcity pricing

Scarcity pricing is a concept associated with balancing short-term supply and demand through changing price rather than enforcing restrictions, and to create prices that would signal the need for source augmentation or to encourage water trading.

The concept is to allocate scarce water resources to customers on the basis of the price they are willing to pay rather than by set rules embodied in restrictions.

National interest in scarcity pricing has been sparked due to significant water restrictions in most cities. Few commodities are restricted in the way that water is. Generally, price is used to ration demand, or promote investment in additional supply. To date, scarcity pricing has not been implemented for water charges in Australia.

In theory, customers would reduce the activities of least value (minimising the cost of the water shortage), and pay more to encourage the provision of additional supply. Alternatively, some may just pay more, forcing the required reduction in consumption onto other members of the community.

Wealthy customers would be able to afford the significant increases required to reduce demand and are unlikely to reduce consumption significantly.

This means that in practice, customers with the least ability to pay would have to reduce their consumption while customers with greater financial capacity may increase their use.

Scarcity prices are only effective as a means of controlling water demand if customers are responsive to price signals. Typically, water demand is insensitive to price (price inelastic). It is estimated that a 10% increase in price would result in a 2% to 4% reduction in consumption. However, this relationship is very hard to measure and cannot be predicted with any certainty.

The practicality of this approach is further hampered as opportunities to augment water supplies are limited in the short-term. It typically takes many years to plan, gain approvals and construct new water sources. Customers would therefore need to pay high prices for new water sources for many years for this approach to be effective.

Scarcity pricing has the potential to undermine the current community focus on reducing water use. Currently people moderate their consumption for community objectives even though they would be willing to pay more for higher levels of use in normal times. If water use is not moderated voluntarily, scarcity price increases would have to be greater, again transferring the impact of reduction in consumption onto those who cannot afford the higher prices.

Under scarcity pricing, it is likely that water prices would become volatile in response to annual weather variations. Fluctuations in the price of water would lead to uncertainty about the long term cost of water. It is expected that this would hamper investment in long term water saving initiatives such as water efficient gardens and whitegoods.

SMART METERING

Smart meters allow service providers and consumers to manage energy and water use in new ways.

Smart metering includes two elements: a meter that is able to capture information over short time intervals (typically 30 minutes or less) and a communication system that can transmit this information to the service provider in real time.

The benefits of smart water meters include:

- providing timely feedback to customers on water use;
- assisting in the identification of leakages in the system; and
- facilitating the introduction of pricing mechanisms such as peak tariffs and drought pricing.

Wide Bay Water in Queensland is replacing 20,000 traditional water meters with smart meters which are expected to result in savings of 182,000 kilolitres a year in leak detection and 914,000 kilolitres a year from new off-peak pricing. Busselton Water has already installed some smart meters for its customers to provide real time information.

This will provide customers with accurate detailed usage patterns enabling them to reduce water consumption and to detect leaks early.

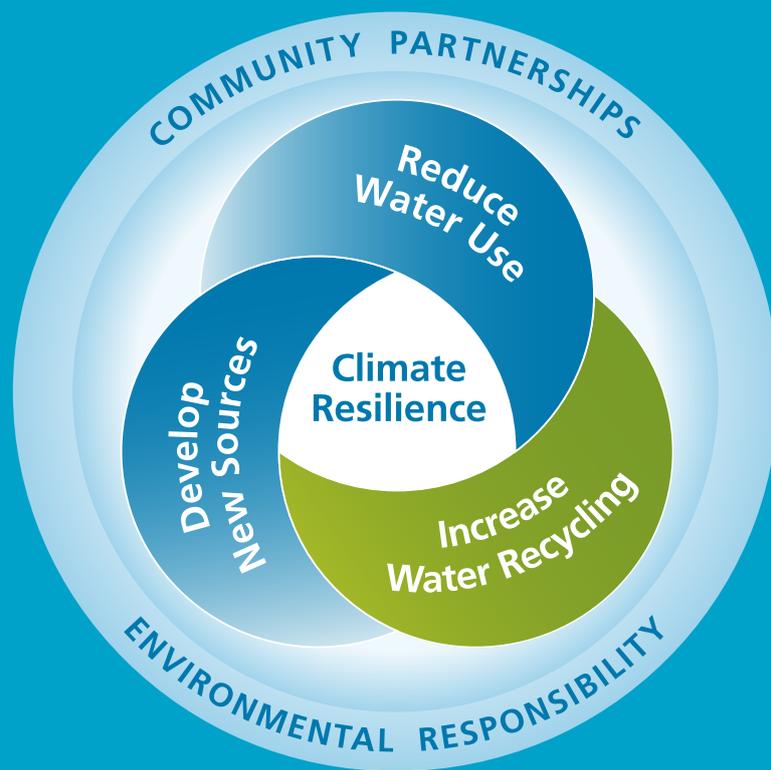
Energy Futures Australia, consultants on energy and environmental policy and programs, predict that a national rollout of smart meters could result in a reduction in total electricity use of 4 – 10% and a corresponding reduction in total national greenhouse gas emissions of 3.5%. The Federal Government has announced the intention to invest in an integrated system of renewable energy, smart grid and smart meter technology in a large scale demonstration project.

South East Water, Melbourne, is already piloting smart meters which integrate the metering of water, electricity and gas.

The installation of smart water meters in Perth and regional areas of Western Australia will be favourably influenced by the opportunity to partner with full scale implementation in the energy and telecommunications sectors.



INCREASE WATER RECYCLING



INCREASE WATER RECYCLING

By 2030 it is estimated that water recycling in Perth will exceed 30%.

WASTEWATER COLLECTION AND TREATMENT

The current and projected wastewater flows for Perth are shown in figure 16. How much wastewater is collected and treated into the future will depend on population growth and levels of water use in the home and by business and industry.

The base planning case is for constant wastewater flows of 155 litres per person per day over the 50 year period. This is shown in figure 16 as the higher forecast for wastewater inflows to treatment plants – with volumes growing from 124 gegalitres in 2008 to an estimated 268 gegalitres in 2060.

If additional water efficiency savings are achieved, wastewater flows are projected to be about 20% less than this base planning assumption by 2060. This would lead to significant land, energy, capital and operating savings in the overall wastewater system.

The benefits of water efficiency extend to the whole of the water cycle, including wastewater treatment and disposal. However, higher concentrations of contaminants in the wastewater stream as a result of water efficiency measures, may require adjustment to treatment processes.

There are five major catchment areas proposed for the collection and treatment of wastewater from households and businesses in the Perth metropolitan area. The three existing wastewater treatment plants (Beenyup, Subiaco and Woodman Point) will be augmented with two new systems at Alkimos (north) and East Rockingham (south). These five plants are planned to have the capacity to treat almost all wastewater in the study area over the next 50 years.

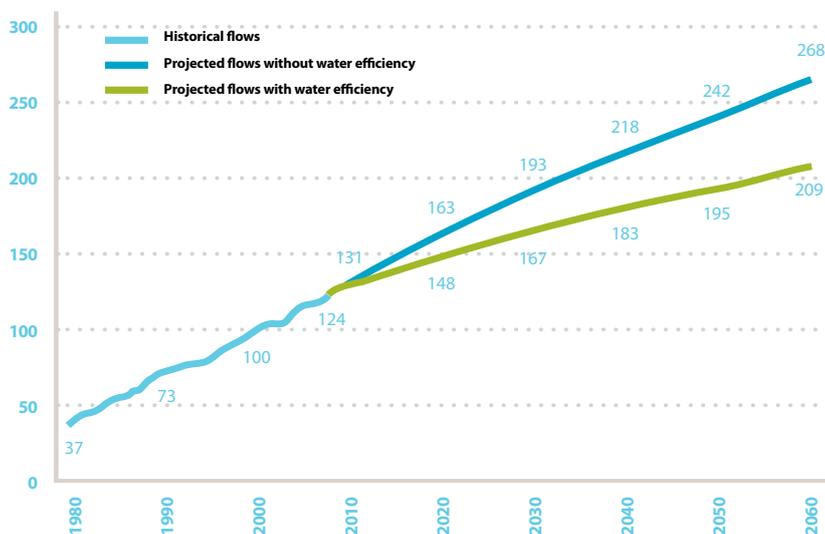
In Mandurah, there are four wastewater treatment plants at Halls Head, Gordon Road, Caddadup and Pinjarra.

Table 10 shows the current and estimated maximum wastewater flows for each system. For planning purposes, these flows reflect the higher range of estimates (without water efficiency).

Current and projected wastewater inflows to 2060 (table 10)

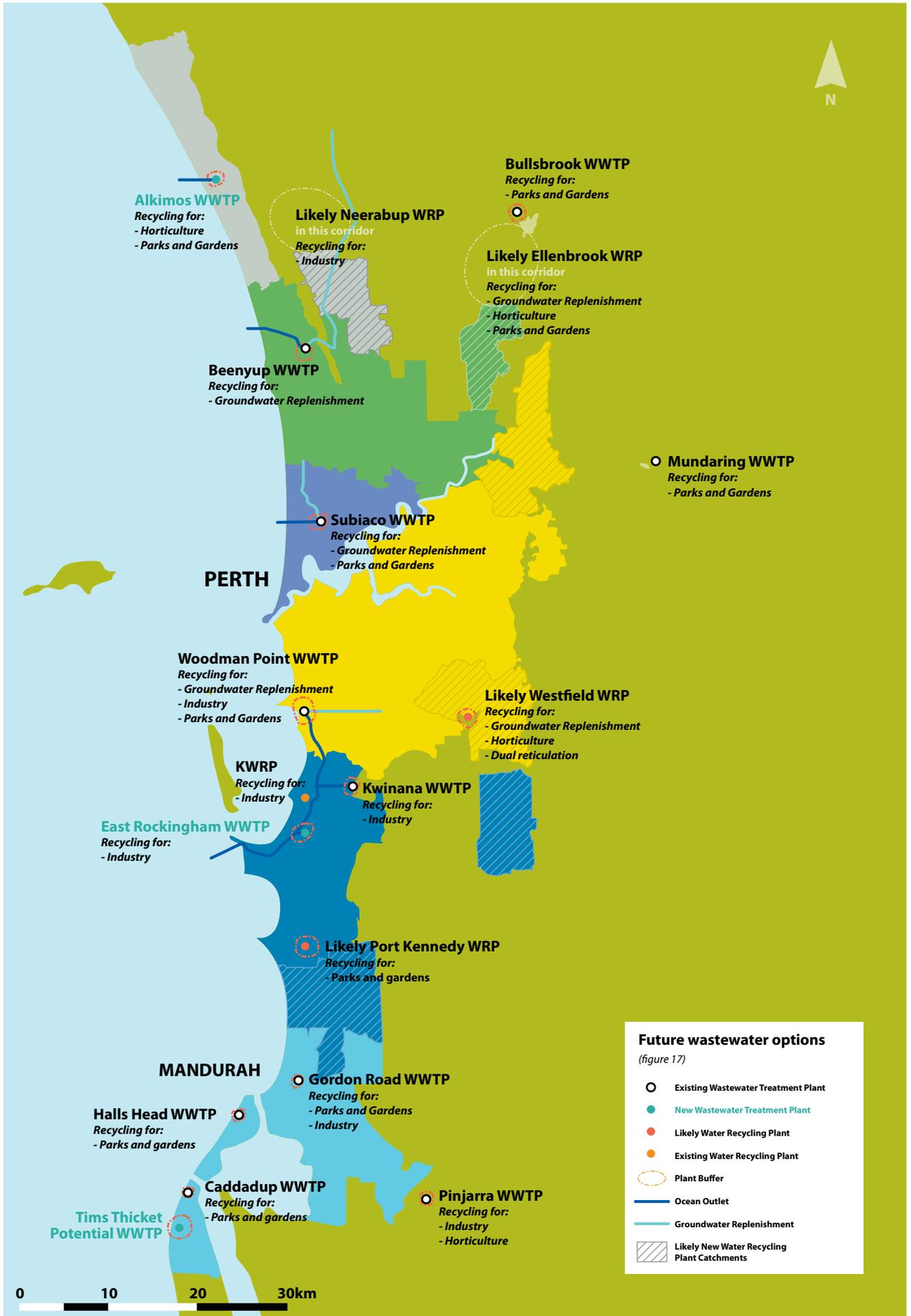
Wastewater systems (GL/yr)	Actual flows at 2008	Estimated flows at 2030	Estimated flows at 2060
Alkimos	0	11	23
Beenyup	45	50	61
Subiaco	22	35	45
Woodman Point	46	74	92
East Rockingham (Point Peron)*	5	8	21
Kwinana	2	3	5
Greater Mandurah	4	10	18
Mundaring, Bullsbrook	0.1	0.7	3
Total	124.1	191.7	268.0

* Point Peron Wastewater Treatment Plant will be decommissioned once the East Rockingham Wastewater Treatment Plant is operational in 2015.



Historical and projected wastewater flows for Perth and Mandurah (figure 16)
(Gegalitres per year)





In general, it is more economical to build and operate larger wastewater treatment plants than a series of smaller plants, although land constraints often limit the ultimate size of a plant. Generally, the larger the plant, the more cost-effective it is to treat, recycle and dispose wastewater.

The Water Corporation is investigating other future treatment plant sites in areas that may have, or may develop, significant demands for recycled water. For example, new sites are being considered in the north east corridor near Ellenbrook, the south-east corridor near Westfield and in new industrial areas such as Neerabup. Treatment plants may be located at one or more of these sites with recycled water used locally. This would reduce the ultimate size of the existing large treatment plants.

Conversely, the Water Corporation is considering options to consolidate two or more of the plants located in Mandurah into a larger plant with options to recycle and discharge the treated wastewater.

There will be a need to expand existing and new plants over the next 50 years to accommodate growth. This could entail a range of works including:

- expansion of conveyance systems;
- expansion of capacity of liquid and sludge treatment facilities;
- new odour management works; and
- duplication or expansion of some ocean outfalls.

Formal environmental approval is required for most of these works.

OPPORTUNITIES FOR WATER RECYCLING

The extent to which recycling occurs will be significantly influenced by numerous factors including availability of groundwater, land planning policies and conditions, pricing for recycled water and the demand for recycled water.

The estimated recycled water potential for each plant in Perth and Mandurah is outlined in table 11.

Estimate of future water recycling opportunities to 2060

(table 11)

Wastewater systems	Estimate of water recycling by 2030 (%)	Estimate of water recycling by 2060 (%)
Alkimos	40	60
Beenyup	70	60
Subiaco	10	65
Woodman Point	20	65
East Rockingham	20	65
Greater Mandurah	12	20
Overall	30%	60%



The Water Corporation can facilitate an increase in the use of recycled water in the metropolitan area, subject to trends in these areas.

Currently only 6% of all wastewater is recycled in the metropolitan area. This is primarily due to groundwater traditionally providing a cheaper, safer, fit for purpose alternative for most uses including industry and public open space.

In recognition that more groundwater areas are reaching the sustainable limit of their supply around the State, the State Water Plan 2007 set a target to recycle 30% of all wastewater by 2030.

The Water Corporation aims to facilitate recycling of 30% of all metropolitan wastewater by 2030 – a five-fold increase over current levels. Further, the Water Corporation is investigating feasible methods of harvesting other materials from these plants including energy and biosolids.

To promote this significant increase in recycling in Perth and Mandurah, the Water Corporation is exploring a range of options including:

- beneficial recycling of water to the environment;
- groundwater replenishment;
- recycling to new and existing industrial areas;
- greywater recycling;
- dual reticulation recycling schemes; and
- irrigation water for public open space and horticulture.

These opportunities are discussed in this section.

BENEFICIAL RECYCLING OF WATER TO THE ENVIRONMENT

Perth is in the unique situation of having predominantly sandy soils with underlying groundwater systems that:

- are replenished from rainwater that runs off land, roofs and streets;
- provide water for a range of uses including irrigation of agriculture, household gardens and public parks and ovals; and
- can store drainage or wastewater of an appropriate quality for use by the environment or other purposes.

As the climate continues to dry, it is likely that local wetlands and lake systems dependent on rainfall and groundwater will also dry. This has already been the case for a number of wetlands in the northern corridor of Perth.

Recycled water of an appropriate quantity and quality could be used to replenish groundwater supplies for retention in the environment or for use by industry, local government or private users. Additionally, recycled water could also be used to increase river or stream flows.

These options often require high levels of treatment which have traditionally made these options cost prohibitive.

Increasingly however, the Water Corporation believes that there are more cost-effective and environmentally sound methods to return recycled water to the environment.

The Water Corporation has partnered with the CSIRO and the Town of Cambridge to investigate the potential for recycled water to be returned to groundwater around Perry Lakes in Floreat, to help improve lake levels. The CSIRO has been testing what happens to treated wastewater filtered through sand into groundwater south of Perry Lakes for over 18 months. They have found that the quality of the water improves through natural soil and groundwater processes over time.

If this project is successful, recycled water could be made available by the Water Corporation for use in other areas to supplement water levels in a drying climate. New sources of funding and regulatory regimes would be required to make these projects viable.

The Water Corporation will continue to work with the CSIRO and local and State Government agencies to determine the feasibility of this approach.

GROUNDWATER REPLENISHMENT FOR DRINKING

The Water Corporation is investigating the potential for high quality recycled water to be returned to the environment through groundwater aquifers to be used as part of drinking water supplies.

Although groundwater replenishment is primarily considered a drinking water source, it is also potentially one of the most viable options for recycling large volumes of water in the future. This is because it provides an opportunity to use Perth's large groundwater supplies as a storage mechanism for high quality recycled water. The water can be abstracted as required. Existing water infrastructure can be used to remove and treat the water before supplying it to households and businesses. Groundwater replenishment has the added benefit of supplementing groundwater levels during dry periods.

The Water Corporation is undertaking a three year trial, commencing in 2010, to test the viability of this option and to ensure that neither the environment nor human health would be impacted.

If the trial is successful and with regulatory approvals and community support, the Water Corporation will develop a groundwater replenishment scheme, which will provide around 35 gigalitres of water for public water supply by 2030, enough to supply 145,000 households. In the longer term, groundwater replenishment could provide up to 115 gigalitres of water by 2060, enough to supply almost half a million people.

Future treated wastewater from the Beenyup Wastewater Treatment Plant has been reserved for groundwater replenishment, subject to the outcomes of the trial.

Recycled water from the Subiaco Wastewater Treatment Plant could replenish groundwater to prevent salt water from the ocean entering aquifers used as a drinking water source in the Gwelup area. Recycled water from Woodman Point could also be considered for groundwater replenishment in the longer term, potentially returning high quality recycled water into groundwater near Jandakot.

As groundwater replenishment is considered to be a drinking water source, this option is further explored in *Develop New Sources*.

RECYCLING TO INDUSTRY

It is forecast that by 2030, a further 20 gigalitres of recycled water could be provided to industry by:

- expanding the capacity of the existing Kwinana Water Recycling Plant; and
- providing recycled water to new industries at the proposed Neerabup and East Rockingham industrial areas.

Kwinana Water Recycling Plant

The Kwinana Water Recycling Plant has provided fit for purpose recycled water to industry since 2004. The plant supplies high quality desalinated water for process uses within industry in the Kwinana Industrial Area. The Water Corporation is proposing to expand this plant from six gigalitres a year to ten gigalitres a year, subject to sufficient demand from industry. This would deliver maximum capacity for this plant, on its existing site. Environmental approvals are already in place for this expansion.

There is no new groundwater available in Kwinana and the rising cost of scheme water is making recycled water cost competitive. Industry has shown great leadership in the uptake of recycled water to date.

Further use of recycled water in Kwinana would require customer demand and new infrastructure. Major uses need to be identified to allow planning to match water of an appropriate quality. It is recognised that many industries in Kwinana would like a lesser quality recycled water – reflecting the nature of its use and the need for new supplies to be commercially attractive. Careful planning is required to adequately address health guidelines.

The private sector could provide the infrastructure or contract to receive a volume of wastewater from the Water Corporation for treatment and use. This approach has been deployed in Sydney where the private sector has been contracted to deliver the first private scheme for recycled water to a network of multiple industrial users. The private sector will build, own and operate the plant.

Pinjarra Wastewater Treatment Plant

The Water Corporation pumps all of its treated wastewater from the Pinjarra Wastewater Treatment Plant through a pipeline to the nearby Pinjarra Alcoa refinery for use in the refining process.

There will be opportunities in the future to supply more recycled water to industry and to public open space in this area.

East Rockingham Industrial Park

A new wastewater treatment plant is proposed to be located in East Rockingham by 2015 as part of the East Rockingham industrial precinct.

The Water Corporation is working with local and State Government planning agencies to provide recycled water to industry in the area. Most importantly, this requires the provision of a third pipe for recycled water as part of the subdivision process.

The piping to enable this use in future is extremely important. The absence of a third pipe in Kwinana hampers the greater use of recycled water in that estate.

Neerabup Industrial Estate (Meridian Park)

The Neerabup Industrial Estate, now known as Meridian Park, is located north of Wanneroo and will be one of the largest industrial areas in the north west corridor. Development of the area has commenced.

The Water Corporation is working with the City of Wanneroo and State Government land planning and development agencies with a view to supplying recycled water to industry from one of the northern wastewater treatment plants.

The Water Corporation is working with land planning, development agencies and local government to identify opportunities to supply recycled water for public open space.



PUBLIC OPEN SPACE

Public open space is estimated to use just over 9% of all water in Perth. These public amenities are an important feature of our city and there are opportunities to reduce the amount of water used and find fit for purpose water sources, to irrigate these parks. These options are discussed further in the *Reduce Water Use* section.

Recycled water could provide a suitable source to irrigate metropolitan parks and ovals, where groundwater does not provide a viable alternative. This may be for several reasons:

- lower rainfalls;
- full or over allocation of the resource for other uses;
- contamination; and
- risk of salt water intrusion from continued abstraction.

At the Halls Head Wastewater Treatment Plant, treated wastewater is infiltrated into the aquifer and abstracted through bores for watering greenspaces in the local area.

Using recycled water for irrigating public spaces is most cost-effective when the wastewater treatment plant is located near the sites being watered. For example, McGillivray Oval in Floreat is watered with recycled water from the adjacent Subiaco Wastewater Treatment Plant.

There is significant potential for the irrigation of public open space from the Subiaco Wastewater Treatment Plant and from new wastewater treatment plants at Alkimos and East Rockingham, where public open space is located or planned in their vicinity. Appropriate training needs to be provided to operators and management controls put in place to ensure that recycled water schemes are operated to protect public health.

The Water Corporation is working with land planning, development agencies and local government to identify opportunities to supply recycled water for public open space.

GREYWATER RECYCLING AT HOME

The most common way to recycle water at home is to directly bucket or transfer greywater onto lawns and gardens. Greywater is the water from the kitchen, laundry and bath/shower which can be reused for non-drinking purposes.

The Australian Bureau of Statistics estimate that around 42% of Perth residents used greywater as a source of water in 2007.

The Department of Health advises that greywater may be used via manual bucketing or an approved greywater system. There is an established Greywater Code of Conduct issued by the Department of Health which provides a sound regulatory framework for how and when greywater should be used.

The majority of greywater use is through simple diversion systems (such as from laundry taps) or bucketing (such as from cold water from showers), rather than installing a greywater treatment system, which can cost around \$1,500.

At this time there is insufficient data to reliably estimate any savings made through the installation of greywater systems. Since the commencement of the Waterwise Rebate program in 2003, about 250 government rebates have been provided for these systems. With the conclusion of the Waterwise Rebate program in June 2009, the Water Corporation is currently evaluating the effectiveness of the program and the savings achieved.

In other states, there are reports that some people leave internal taps running in times of restrictions to fill the systems for use outdoors. There are therefore doubts about the role of greywater systems in reducing water consumption.

Greywater systems can contain high levels of nutrients and salts (from laundry soaps etc) which may make them unsuitable for irrigating native vegetation. Greywater is not a safe source of water for vegetable crops. Using biodegradable detergents and cleaning products can help reduce the required level of treatment, minimise the environmental impacts and make it easier to use the recycled water in gardens.

The Water Corporation supports the use of household recycling solutions that make the safest and best use of greywater, where they do not cause harm to the environment or human or animal health.

The Water Corporation can assist households and business to make the safest and best use of greywater recycling by:

- educating households about simple, safe opportunities for greywater recycling at home; and
- providing training and information to Waterwise specialists such as plumbers, to ensure correct installation and maintenance of greywater systems.

DUAL RETICULATION SYSTEMS

Dual reticulation systems require two separate pipes to provide two types of water supply to residential or commercial buildings - one for drinking water supply and one for non-drinking uses such as toilet flushing and garden watering.

The source of the water for non-drinking uses can be treated wastewater (wastewater from the kitchen, laundry, bathroom and toilet), greywater (wastewater from kitchen, laundry and bathroom, but not the toilet), stormwater, rainwater or groundwater.

This section specifically addresses the use of wastewater and greywater in community-scale dual reticulation systems.

Use of groundwater and rainwater is discussed in more detail in the section on *Reduce Water Use*. Use of stormwater is also discussed in the section on *Environmental Responsibility*.

Wastewater used in dual reticulation systems is generally treated to a higher level than wastewater required to be discharged to the environment. It is normally treated to a level suitable for uses such as garden watering, toilet flushing and clothes washing, but not for drinking.

While it is possible to retrofit dual reticulation systems to existing residential or commercial areas, these schemes are typically very expensive due to the need to retrofit additional infrastructure to treat and transport relatively small quantities of water. Further, dual reticulation systems that supply water for outdoor use generally cannot be used where groundwater is used for drinking, due to the risk of groundwater contamination.

The Water Corporation estimates that dual reticulation systems could supply up to ten gigalitres of water by 2030 in the study area. Dual reticulation systems are most viable in new developments where there is limited groundwater available. Accordingly, dual reticulation systems are more likely to play a role in new greenfield developments in peri-urban areas, such as the Perth hills.

Dual reticulation systems have been included in the portfolio of options for the future.

Currently, there are no dual reticulation systems in operation in Western Australia using treated wastewater, although there are new developments in the outer areas of Perth and Mandurah that have installed village-scale recycling systems, where greywater from a group of homes is collected and reused to irrigate gardens and grassed areas.

ONSITE WASTEWATER TREATMENT

Onsite wastewater treatment plants provide an opportunity to increase the use of recycled water.

Membrane Bioreactors (MBRs) are water treatment units mainly used for treating household and municipal wastewater. These units employ a biological treatment process that uses microorganisms (similar to most wastewater treatment plants) to breakdown waste materials and pathogens present in wastewater. A membrane separates the solid particles from the treated wastewater.

Due to the use of membranes, MBRs can be made more compact than other forms of treatment and are also more robust to variations in the volumes and strength of the wastewater. As such, MBRs can be designed to treat a variety of wastewater types (i.e. municipal wastewater, greywater, industrial wastes). MBRs are commonly designed and manufactured in modules to suit the scale of operation required.

The MBR produces consistent performance in terms of treated water quality and operations when compared to other biological processes.

The main drawback of such a system (as with any membrane based technology) is the energy required to pump the water through the membranes and the cost of the membranes themselves. With extensive research and investment in technology there is an opportunity to reduce the energy used, as well as recognising that MBRs can save energy by reducing the distance over which pumping is required.

This technology can be installed in the basement of a building, or to service a local community. The flexible and modular properties of MBRs may increasingly make them a favoured option when considering wastewater treatment for smaller scale operations.

MBRs are one example of a fit for purpose, decentralised technological solution likely to feature increasingly in our water future.

The Water Corporation believes there is also significant opportunity for the private sector to be involved in developing, operating and maintaining dual reticulation systems.

The Water Corporation will continue to work with government agencies, land developers and the private sector to identify opportunities to trial dual reticulation systems, where appropriate. In particular, the Water Corporation will work with these organisations to address a range of issues including:

- treatment technologies and design standards;
- risks to public health;
- regulatory and development approvals;
- responsibilities inside lot boundaries; and
- education and training requirements.

WATER RECYCLING TO AGRICULTURE

As discussed in *Reduce Water Use* there may be future opportunities to supply recycled water to irrigate crops, including fruit and vegetables. These opportunities tend to require large volumes of recycled water.

Recycled water can be an expensive water source for crops. The development of recycled water schemes in South Australia, Victoria and Queensland have been enabled by the establishment of agricultural precincts near wastewater treatment plants, generally with significant government subsidy.

Any future opportunity to recycle water for irrigated agriculture is expected to require State or Federal Government leadership and funding.

The State Government has explored the opportunity of creating a horticultural precinct north of Wanneroo, which could be supplied with recycled water from the Alkimos Wastewater Treatment Plant currently under construction and due for completion in September 2010.

The Water Corporation will continue to work with State Government agencies to determine the feasibility of this option and more broadly finding fit for purpose water solutions to support food production.

PRICING FOR RECYCLED WATER

The price of providing recycled water should reflect the costs of additional treatment and infrastructure required to supply the recycled water, less any cost savings from not having to dispose of the wastewater.

Recycled water projects are viable where demand for recycled water can support this minimum level of cost recovery.

In some circumstances, the availability of water for recycling is limited, and consideration has to be given to allocating it to its highest value use, both in the short-term and the long-term. For example, some potential high value future uses such as groundwater replenishment for drinking will need large volumes to achieve economies of scale. It would be short sighted to allocate these resources now and forego a higher value use in the long-term.

The ERA finalised an inquiry into pricing for recycled water in February 2009.

TREATING AND RECYCLING WASTEWATER SUSTAINABLY

Treating, disposing and recycling wastewater requires both energy and water. The Water Corporation is committed to reducing our impact on the environment by reducing energy and water use in our own operations, including wastewater treatment.

GENERATING ENERGY FROM WASTEWATER

Wastewater treatment products and by-products can be recovered for other uses, such as energy generation.

Norway is trialing a biofuel which is methane generated by fermenting wastewater treatment plant sludge, to run their buses. The biofuel emits fewer pollutants than traditional fuels and the buses are 92% quieter. The price per litre of biofuel is competitive with petrol and diesel, although this is offset by higher maintenance costs.

If the trial is extended to a second wastewater treatment plant, it is possible that all of Oslo's buses (about 400) could run on biofuel. This would reduce carbon dioxide emissions by 30,000 tonnes per year. Two other European cities (Lille, France and Stockholm, Sweden) have also been trialing the biofuel.

There is an opportunity to provide energy and water efficiency solutions through new technologies and innovative practices.

WATER RECYCLING FOR COMMUNITY BENEFIT

The Water Corporation has developed a water recycling policy to assist in the increase of water recycling in Western Australia. This policy recognises the role of the Water Corporation in facilitating water recycling projects by making commitments to:

- provide recycled water free for community uses;
- streamline the agreement process; and
- create a water recycling centre of expertise.

Wastewater will be made available from wastewater treatment plants free on an “as-is-where-is” basis where it is used for community benefit. Users of recycled water will need to meet health and environmental guidelines set by the relevant government departments before the water can be supplied.

For example, if a local government wants to irrigate an oval for everyone to enjoy at no cost, wastewater will be made available from the treatment plant without charge. The local government will need to pay for any additional treatment and piping to transport and reticulate their oval.

It is expected that these changes will reduce costs and timeframes to implement community based recycling schemes.

The Water Corporation will ensure wastewater treatment plants can be operated in the most sustainable way. This will be achieved by:

- reducing the amount of wastewater entering the system by investing in water efficiency programs and using regulations to manage the quality and quantity of wastewater;
- reducing the amount of drinking quality water that is used in the treatment process from 25% to 10%;
- recovering energy sources, such as biogas, from the treatment process and using these to power operations;
- recovering biosolids from the wastewater treatment plant process for use as fertiliser in accordance with the *Western Australian Guidelines for Direct Land Application of Biosolids and Biosolids Products* released by an across government working group; and
- only disposing of wastewater to the ocean when it is not recycled or when it is a by-product of the recycling process.

Ocean discharge

Well managed ocean discharge is a sustainable way of disposing of treated wastewater. Even with an increase in recycling, ocean discharge will still be required:

- for surplus water, particularly during winter months when less recycled water is required for uses such as irrigation;
- to safely dispose of wastewater concentrate, a by-product of the treatment process to make recycled water suitable for use; and
- as a safe alternative when recycling schemes need to be shut down for maintenance or other purposes.

Currently there are three ocean outlets at Ocean Reef, Swanbourne and Cape Peron. These outlets are more than one kilometre long and do not affect beaches or swimming areas.

The Water Corporation has been monitoring these outlets for many years through the Perth Long Term Ocean Outfall Monitoring (PLOOM) program to ensure that the wastewater has no major impacts on public health or the ocean environment.

Two new ocean outlets will be constructed at Alkimos and Cape Peron to service the new Alkimos and East Rockingham Wastewater Treatment Plants.

The Department of Environment and Conservation regulates ocean discharge.

Managing odours

Odours from treatment plants can impact on nearby residences and businesses. The Water Corporation has invested in odour reducing technologies at all of the major wastewater treatment plants. The complete elimination of odours is difficult to achieve, however it is important that a number of measures are taken to limit odour impacts. These include:

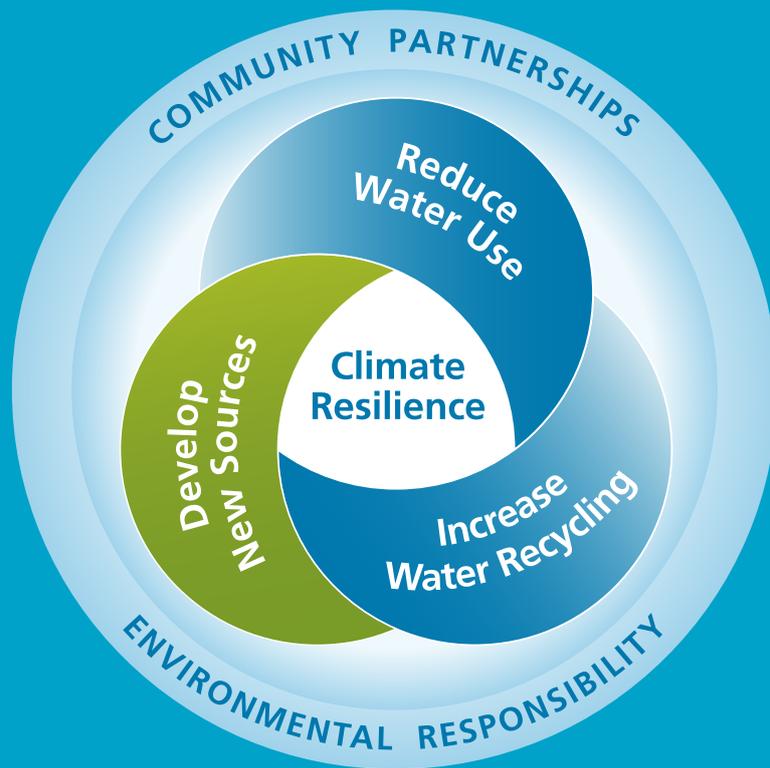
- ensuring the treatment process is designed to minimise odours;
- containing odours within a confined area; and
- ensuring there are adequate buffers around treatment plants.

The Water Corporation acts to retain buffers around treatment plants through the land planning process.



FILTOMAT
Self-Cleaning

DEVELOP NEW SOURCES



DEVELOP NEW SOURCES

As the climate dries, the focus of new source development will continue to favour rainfall independent sources such as recycling and desalination.

As part of *Water Forever*, the Water Corporation undertook a sustainability assessment of 35 different water efficiency, recycling and source options to assist in determining which options should be developed into the future.

The *Water Forever Sustainability Assessment* report was published in December 2008. Options were assessed against a range of criteria including:

- environmental considerations;
- energy intensity;
- estimated yield;
- cost;
- social impacts, including public health considerations;
- community preference;
- ability to adapt over time to changing circumstances; and
- degree of rainfall independence.

Table 12 summarises the water sources assessed. It highlights those sources included in the portfolio of water options at this time. Note that this does not imply that they will be developed now, or at any time in the future. Inclusion in the portfolio indicates that work to investigate these options will occur progressively and they will be considered more fully when the need for source augmentation arises.

Sources not currently under consideration are also highlighted. At this time, these sources are not expected to be subject to future feasibility studies or investigation by the Water Corporation.

To include these options in the portfolio may provide an inflated view of what are considered to be viable water options for the future. If and when future circumstances change, some of these options could be re-assessed and further investigated.

Water source options (table 12)

Water sources included in portfolio		
<p>Desalination:</p> <ul style="list-style-type: none"> • Southern Seawater Desalination Plant expansion • Esperance – Kalgoorlie desalination • Other seawater desalination plants • Wellington dam desalination 	<p>Groundwater:</p> <ul style="list-style-type: none"> • Gingin-Jurien groundwater • North West metropolitan coastal groundwater • Jandakot groundwater expansion • Wellington dewatering 	<p>Source optimisation:</p> <ul style="list-style-type: none"> • Catchment management • Gnamagara water trading <p>Water recycling:</p> <ul style="list-style-type: none"> • Recycled water to dams • Groundwater replenishment
Water sources not included in portfolio		
<p>Surface water:</p> <ul style="list-style-type: none"> • Brunswick dam • Water from the Kimberley 	<p>Groundwater:</p> <ul style="list-style-type: none"> • South West Yarragadee • Mining Gnamagara confined aquifer • Karnup – Dandalup groundwater 	<p>Source optimisation:</p> <ul style="list-style-type: none"> • Reducing evaporation from dams • Harvey – Waroona Irrigation District water trading • Cloud seeding <p>Water recycling:</p> <ul style="list-style-type: none"> • Direct drinking water recycling





Ultimately, the Water Corporation will continue to diversify its range of water sources to ensure that we can adapt to the changing climate over time. With the addition of the second desalination plant at Binningup by 2011, and with continued focus on reducing water use, it is anticipated that no major new source of water will be required until about 2020.

At this time, the most prospective sources include:

- groundwater replenishment - using recycled water for drinking;
- optimising the use of existing dams through catchment management;
- expanding the Southern Seawater Desalination Plant by a further 50 gigalitres;
- Gnangara water trading; and
- developing the North West metropolitan coastal groundwater source.

Further work needs to be done to determine which sources will be developed and by when.

This section discusses all future water sources considered for further investigation.

DESALINATION

There are four desalination options under consideration:

- Southern Seawater Desalination Plant Phase 2;
- Esperance – Kalgoorlie desalination and pipeline;
- New seawater desalination sites; and
- Wellington Dam desalination.

These options have high supply security because, in common with water recycling, desalination does not rely on rainfall and is not dependent on water allocation policy (although environmental approvals are required). Desalination is highly attractive in a drying climate.

Desalination also scores highly on public health criteria, due to the high levels of treatment (membrane filtration rather than chemical) and controls to safeguard drinking water quality. Seawater has a lower source risk than treated wastewater or dams with degraded catchments.

The downside of desalination options is the relatively high physical footprint (especially when distant from demand due to the pipeline and reservoirs) and high energy intensity. Managing land use including biodiversity impacts and energy requirements (including sourcing energy from renewable generators or offsetting greenhouse emissions), are important mitigants where these options are adopted.

Southern Seawater Desalination Plant

The Southern Seawater Desalination Plant at Binningup in the south west of the State is scheduled to be operational in late 2011. Once online, the plant will produce an additional 50 gigalitres to supply the Perth-Mandurah area. As a result of this additional supply, the Water Corporation will be able to reduce the amount of groundwater taken from the Gnangara Mound, which is currently under stress due to climate change impacts.

The Water Corporation has also committed to purchasing the energy requirements for the second desalination plant from renewable energy generators, or purchase accredited offsets if suitable energy cannot be obtained.

The Southern Seawater Desalination Plant is being planned so that it may be doubled in size to produce another 50 gigalitres, most likely after 2020. The expansion, included in the range of water sources under consideration, could be owned, operated and maintained by the private sector.

The Southern Seawater Desalination Plant was given environmental approval by the Federal Government in June 2009 and site construction has now commenced.

Desalination at Esperance

In 2005, United Utilities Australia proposed an alternative drinking water source for the Goldfields and Agricultural regions and the Perth metropolitan area. They proposed that water be sourced from a seawater desalination plant at Esperance and piped 385 kilometres to Kalgoorlie. The water would mainly be used for mining operations in the area and for domestic water supply in Kalgoorlie.

Esperance has some of the hardest water in the State indicating high levels of calcium and magnesium salts. This negatively impacts the lathering of soap and creates salt deposits on water pipes, kettles and hot water systems. A seawater desalination plant in Esperance could therefore also supplement this town water supply, to address these issues.

A seawater desalination pipeline to Kalgoorlie could result in the existing Goldfields and Agricultural water supply pipeline terminating at Southern Cross.

At the time it was proposed, this option was not cost competitive with other large scale source options. Further, it is difficult to forecast demand from mining companies. This uncertainty and risk of stranded assets increased the cost of the plant as a substitute drinking water source.

The proposed Esperance desalination plant (and pipeline to Kalgoorlie) remains a potential water source. As a result, it is included in the portfolio of source options as a potential future water source for public water supply.

Desalination is not our only option for the future, however it is an important one. It provides a benchmark for safe drinking water, cost and reliability in a drying climate.



New seawater desalination sites

The extent to which additional seawater desalination plants may be required will be dependent on how much water can be saved through water efficiency programs and how much can be recycled, as well as how quickly rainfall declines.

Desalination is not our only option for the future, however it is an important one. It provides a benchmark for safe drinking water, cost and reliability in a drying climate.

Future desalination plants could be situated along the coast, both north and south of Perth.

Due to high growth projected for the northern corridor, a new desalination plant north of Yanchep would support future growth. A desalination plant in this area would be close to new demand and existing storage and treatment facilities. Over time it could replace the loss of some of the historical capacity of the Gnangara groundwater system, previously expected to service urban expansion in this area.

A study undertaken by the Water Corporation in 2008 identified a range of possible sites for future plants. The criteria specified was that potential sites should:

- be close to the ocean;
- allow easy integration into the existing public water supply system;
- have easy access to a suitable power source;
- be environmentally compatible, with minimal impact on environmentally sensitive areas;
- be at least 20 hectares in size to accommodate plant components;
- have adequate and available buffers for chlorination facilities; and
- have compatible surrounding land uses (industrial, rural, park or recreation).

The number of sites identified from this survey was limited due to a number of factors including an appropriate marine environment, matched with compatible land uses and not excluded due to policies such as Bush Forever. Further evaluation is being undertaken on these sites.

Environmental and social impact assessments, together with full economic costs, are required to identify optimal sites. It is important however, that options are not ruled out too early and without due process. To do so, risks the security of our water future.

Wellington Dam desalination

The opportunity to desalinate some of the water in Wellington Dam has been considered by both the private and public sectors.

From a public water supply perspective, the long term sustainable water yield of the dam is a major risk. It is expected that the available water in the dam will reduce to possibly less than half the current amount due to future climate change impacts. Building an expensive desalination plant for a declining source adversely impacts on the commercial feasibility of this option if the risk remains with the State Government.

The option considered in *Water Forever* is based on the assumption that the Water Corporation has gained access to the majority of the water through commercial trades. This option may have value in the short to medium term, and for this reason it has been included in the portfolio of future source options.

All desalination options outlined have been included in the portfolio of future water options.

PORTABLE DESALINATION

Flexibility in the delivery of water supply is an important feature in considering new sources.

A relatively new concept involves locating a standard seawater desalination plant aboard a sea vessel. The seawater is desalinated aboard the vessel and the drinking water transferred to shore via a pipeline, tankers or large water bags.

Some advantages of this approach are the proximity of the ocean for seawater extraction and subsequent brine disposal. In addition, renewable energy sources such as wind, wave and solar could be used to drive the plant. The vessel could be moved from location to location along the coast to obtain the best conditions for energy generation.

A facility such as this could be used as a drought relief measure and moved to different parts of the coastline (not just for Perth). Environmental approvals to connect to land based distribution systems would be required.

This concept is yet to be utilised in Australia. However, a number of new plants are being planned and commissioned in various parts of the world including India, Cyprus, USA and Saudi Arabia.

This technology could be utilised in the future as a climate independent water source to meet relatively small, critical demand shortfalls.

WHY NOT RELY SOLELY ON DESALINATION?

The question as to whether desalination could be completely relied on to secure Perth's water future, rather than considering it a part of the solution with water efficiency and recycling, has also been considered.

Desalination will continue to play an essential role in providing water to Perth in the future, but it is unlikely to be able to supply Perth with unlimited volumes of water.

The main difficulties faced if Perth was to rely solely on desalination plants as the source of water for the future include:

- with no additional investment in reducing water use, ten new 50 gegalitre desalination plants are estimated to be required to supply Perth with enough water by 2060;
- a third desalination plant would be required before 2020 and another every five years after that;
- there would be a six-fold increase in energy use over current levels;
- significant private or public capital would be required (an estimated \$10 billion); and
- customer water bills would essentially double in real terms.

Securing sites, infrastructure corridors, capital and enough renewable energy for an additional ten desalination plants by 2060, would be a formidable challenge.

To be cost competitive, desalination plants need to be located close to the coast, with the ability to be integrated into the current water supply network.

Future sites could take up coastal land that could otherwise be used for residential, industrial or recreational development, or preserved for environmental benefit. The corresponding marine environment needs to be sufficiently deep and energetic to accommodate intake of seawater and discharge of the salty concentrate.

Current investigations for future desalination sites have indicated that suitable land and marine conditions are available but somewhat limited along the coastline.

In a drying climate and with a growing population, new sources of water will be required periodically, even with reductions in water use. Future desalination plants will be considered alongside other options, as part of the portfolio of future water options.

GROUNDWATER SOURCES

Although groundwater is dependent on rainfall, it can insulate the environment from reductions in rainfall. In Perth, the large groundwater aquifers have a significant storage capacity which helps to buffer the impact of short term droughts or drier years.

For example, the volume of water in the Gnangara groundwater system in the Perth region exceeds 500,000 gegalitres. It contains 7,000 times the volume of water in Mundaring Dam.

Groundwater systems therefore provide significant flexibility to respond to short term variations in rainfall and the forecast longer term drying climate.

This could include harvesting superficial groundwater or stormwater in wet years which would otherwise flow to the ocean to store or "bank" in the deeper aquifers, for use in drier years. Water may be banked for long periods of time, perhaps for up to a decade. Superficial bores could also be used only during winter periods when groundwater levels are higher and environmental requirements are being met.

Increasingly, satellite and airborne imagery can be used to monitor for potential impacts of changes in groundwater levels and modify abstraction as appropriate. The Water Corporation is committed to investigating these options to ensure that Perth's largest water source is managed sustainably and efficiently as climate dries and population increases.

Future impacts of a drying climate on groundwater levels will be considered in managing existing groundwater sources and the development of new sources.

There are several potential groundwater schemes that could be developed in the future. These schemes need to be carefully planned to ensure they do not adversely impact the environment or local groundwater users and have sufficient reliability to warrant the investment.

All future groundwater schemes require extensive investigation to determine likely yields, impacts and costs. Work undertaken to date has been high level only and a few preferred sources need to be progressed to a further level of detail.

Formal water resource and environmental approvals would be required for any new source, including groundwater. The Water Corporation will not develop a groundwater source if the yield or impacts of developing the source are unsustainable.

In the case of groundwater, seven options were assessed in this group:

- Gingin-Jurien groundwater;
- North West metropolitan coastal groundwater;
- Jandakot Groundwater expansion;
- Wellington dewatering;
- Karnup and Dandalup groundwater;
- South West Yarragadee groundwater; and
- mining Gngangara groundwater.

In the sustainability assessment these options scored well on source risk (particularly where the water is sourced from a confined aquifer). They also scored well on energy efficiency and flexibility (reflecting the ability to turn bores off if required and possibly reuse the infrastructure if the bores are shut down permanently).

Groundwater sources are typically highly cost effective (often less than \$1 per kilolitre) where they are developed close to the point of use.

In common with all large scale scheme options, they score poorly on empowering customers and represent the development of a new water source (rather than an investment in water efficiency or fit for purpose water).

The option to mine the confined aquifer reflects the abstraction of water without regard to environmental consequences. This is not current practice and is not supported by existing water policy in Western Australia, as determined by the Department of Water.

Where there is adequate water resource management, the sustainable use of groundwater provides a good option for Perth, given its proximity to large high quality groundwater reserves at low cost.

Gingin – Jurien groundwater scheme

This scheme is located to the north of Perth, near Moore River. There is potentially a large amount of water in this scheme, around 48 gigalitres a year. This option has been included in the portfolio, although further resource investigation is required.

The Gingin area also provides large amounts of groundwater for agricultural and horticultural purposes and there are many private users of groundwater in this area. The Water Corporation would need to ensure that local users were not unduly impacted by the development of this source for public water supply.

North West metropolitan coastal groundwater scheme

This scheme is located near the coast, just north of the existing Neerabup groundwater scheme near Wanneroo. Although there are currently no competing uses for this resource it is recognised that there may be competition for the resource in the future.

It is potentially the best future groundwater option and could supply around 25 gigalitres of water a year which would otherwise drain to the ocean. This source would best be developed as the north west coastal area urbanises, which provides road access and power and could potentially increase groundwater recharge.

This source could be of a high quality for drinking and relatively inexpensive to develop and has therefore been included in the portfolio of future options.

Jandakot groundwater expansion

This is a proposed expansion of the Jandakot scheme located south of Perth. There are only about three gigalitres a year likely to be available from this source, which would again require investigation.

Like Gingin - Jurien, there are private users of groundwater in this area. The Water Corporation would need to ensure that local users were not impacted by the development of this source for public water supply.

This groundwater option is included in the portfolio of future water options.

Wellington dewatering

The Water Corporation is considering the possibility of developing a small dewatering scheme in Wellington that could yield ten gigalitres a year. Currently, a portion of this water is used by local power stations. Any proposal to transfer water to the IWSS would only be considered after the power station's water demand was satisfied. This may be achieved by commercial trades.

Groundwater sources not under consideration

The South West Yarragadee groundwater scheme has been reserved for development for local south west water supply needs rather than Perth metropolitan water supply. This is in accordance with the Department of Water's South West Groundwater Areas Water Management Plan.

Mining large volumes of groundwater from the confined aquifers on the Gnangara Mound was also assessed. This has been excluded from the portfolio due to unacceptable negative environmental and social impacts. The long-term mining of aquifers is generally not compatible with current abstraction policies set by the Department of Water (the exception being for mine dewatering).

The Karnup - Dandalup groundwater scheme has been removed from the portfolio as there is no public drinking water source protection in this area.

SOURCE OPTIMISATION

Source optimisation is a selection of opportunities to maximise the amount of water that can be obtained from existing water sources. The assessment considered the following options:

- catchment management;
- Gnangara water trading;
- Harvey – Waroona Irrigation District water trading;
- reducing evaporation from dams; and
- cloud seeding.

In the sustainability assessment, these options generally all performed well on energy intensity and economic cost, reflecting the low need for significant additional infrastructure.

One exception is reducing dam evaporation, which scores very poorly on economic cost. Despite the lack of new infrastructure there is a significant cost in the application of new, untested technology to implement this option.



Catchment management and Gngangara water trading options are considered suitable for inclusion in the portfolio. Harvey – Waroona water trading, dam evaporation and cloud seeding are not included due to very low levels of reliability and significant technical, social, commercial and regulatory hurdles.

The rationale for this proposed approach to these options is outlined further in this section.

Catchment management

Catchment management includes various techniques to improve the state of the forest and conserve the environment. Catchment thinning is one such technique that has been used in the past to increase streamflows into dams by thinning forest regrowth.

Thinning regrowth tends to move the forest back towards its previous natural state, had it not been logged. Catchment thinning is best applied to regrowth forests where the tree density is much greater than pre-European or mature old growth forests. Without catchment management, regrowth forests result in less water being available to the environment and reduced flows into streams and drinking water dams.

The portfolio of options includes a thinning trial being undertaken in the Wungong Dam catchment. Current estimates suggest the trial could yield an additional four gigalitres of water a year in the Wungong Dam by 2015. If the trial is successful and a thinning program was implemented across the IWSS catchments, it is estimated a further 25 gigalitres of water a year could flow into the dams, after the completion of a widespread thinning program.

The estimates of improved yield take into consideration the impacts of a drying climate.

Gngangara water trading

Water trading on Gngangara Mound could involve purchasing licensed water allocations from private users within the Gngangara Groundwater Area. In principle, water could be purchased from users such as irrigated horticulture, local government and industry. Trades can be temporary or permanent.

The legislative framework to allow water trading exists in Western Australia although the security of the underlying water allocation entitlement is poor.

The Department of Water is currently undertaking extensive work to improve the water management regime in this area. Work includes leading the Gngangara Sustainability Strategy across government and developing a management plan and new allocation approaches that consider the impact of climate change. Legislative changes are required to improve the security of water entitlements to facilitate trading, particularly on a permanent basis.

An important issue in a drying climate is food security. The Water Corporation has a preference to trade water saved through water efficiency measures, rather than trading water allocations from existing food production. Other users may also achieve efficiencies in their use or no longer require their allocations in the short or long-term.

Water trading from users on the Gngangara Mound is a viable option and has been included in the portfolio for future consideration.

Harvey – Waroona Irrigation District water trading

This option involves obtaining additional surface water as a result of water being saved from on-farm efficiencies in the Harvey - Waroona Irrigation District. The additional water would flow into the Logue Brook Dam.

The recent decision to reopen the Logue Brook Dam for recreational use means that the Water Corporation will no longer consider this as a public drinking water source. The trade-off to allow recreational activities in preference to public water supply, effectively precludes further trading of efficiencies for water quality reasons. There may be opportunities however to improve the management of shared resources with Harvey Water.

Other options to trade irrigation water with Harvey Water have not been included in the portfolio as these catchments are not significantly protected for public water supply purposes.

Reducing evaporation from dams

There are a number of dams around Perth that contribute to the water supply of the city and its surrounding areas. It is estimated that five to ten gigalitres of water loss could be saved if suitable dam evaporation technology was available for drinking water reservoirs.

Methods to reduce these losses include physical methods such as floating covers, floating objects or chemical retardants which prevent evaporation when applied to the water surface, and other methods such as deepening reservoirs, windbreaks and cellular storage.

Due to the nature of Perth's reservoirs, only chemical retardants have been considered for further evaluation. Trials are being conducted on this technology in Queensland by the CSIRO. This is a high risk option because in a drying climate the potential extra yields achieved may be minimal. In addition, this is an unproven technology in drinking water dams.

Currently, this option is not considered feasible due to the lack of precedent of using chemical barriers in public water supply dams in Australia and the reduction in expected future flows, rendering a return on further investment highly uncertain. It has not been included in the portfolio to avoid the overstating of future water source options.

The Water Corporation will continue to monitor the outcomes of this research nationally. If the situation changes in the future and this option proves successful, it could be re-instated as a possible source option.

Cloud seeding

Cloud seeding aims to artificially generate rain by implanting clouds with particles such as silver iodide crystals. Prevailing clouds could be seeded as they approached Perth. Rain in the catchment areas would create runoff into the dams.

A feasibility study undertaken for the Water Corporation by the Bureau of Meteorology has indicated that it is questionable whether cloud seeding would be successful in Perth due to a general lack of cloud cover for most of the year. The matter is further complicated by the drying climate and the risk of adverse impacts on local agriculture and communities. There are significant social, technical, regulatory and funding barriers to this option.

This option is not considered prospective and is not included in the portfolio of water options.



WATER RECYCLING

There are a number of ways recycled water can be treated to drinking water standard and used as part of drinking water supplies. Not all options however, are under consideration by the Water Corporation.

The main ways recycled water can be used in drinking water supplies are by treating it to a specified standard and then either piping it directly into the drinking water supply system or by storing the recycled water either in a dam or groundwater aquifer.

In the sustainability assessment, large scale recycling options achieved very high scores for supply security, reliability and flexibility. These options are not as dependent on rainfall, making them attractive in a drying climate.

However, they scored poorly on empowering customers as these options are scheme based where the customer has no control over the source and supply of the water.

Recycling water for drinking is highly technical and complex from a regulatory perspective, given that this has only recently been considered a new potential source of drinking water in Australia.

Direct drinking water recycling

Direct drinking water recycling involves the treatment of wastewater to a standard suitable for drinking, and connecting this directly to pipelines for delivery to customers for drinking. Only one such scheme currently exists in the world in Windhoek, Namibia.

The major problem with this option is reliance on a single mechanical process to treat the water. The *Australian Drinking Water Guidelines* recognise that mechanical treatment processes alone are not a safe or practical substitute for good source protection practices. While treatment technologies are capable of removing harmful contaminants in recycled water, they should not be the sole process relied upon to maintain drinking water quality standards.

The Water Services Association of Australia, in the position paper *Refilling the Glass 2006*, does not support direct drinking water recycling due to the lack of an environmental buffer (such as a dam or groundwater).

For these reasons, the Water Corporation has not considered this a viable future water source at this time.

Recycled water into dams

As outlined, water can be treated to a standard suitable for drinking and then stored in dams. Retention times in a dam improve water quality and provide further opportunities to monitor, treat and control supply.

In Perth, wastewater treatment plants are generally located along the coast near the population that they service. In contrast, dams are arrayed to the south east of the city in catchments. Transporting highly treated water for drinking to these dams would require long pipelines and significant energy to pump large volumes of recycled water into the dams.

In cases where treatment plants are closer to surface water reservoirs than suitable groundwater systems, storing recycled water in dams is a water source option that has been included in the portfolio of future options.

Groundwater replenishment

Perth is fortunate to have large groundwater stores on the Swan Coastal Plain. This water currently supplies around 50% of Perth's drinking water as well as large proportions of water for horticulture, agriculture and garden watering. This makes replenishing groundwater stores with high quality recycled water a viable option, particularly in a drying climate.

Groundwater replenishment involves storing high quality recycled water in groundwater for use in Perth's drinking water supplies. As discussed in the section *Increase Water Recycling*, while it is foremost a drinking water source, groundwater replenishment can also provide a way to recycle large volumes of water and supplement groundwater levels as the climate dries. Essentially, groundwater replenishment is a rainfall independent source of water.

Storing high quality recycled water in groundwater is highly prospective. Groundwater systems are often located near major wastewater treatment plants (the source of the recycled water), retention times are far longer than dam storage, water can be stored for many years without evaporation and groundwater acts as an environmental buffer, providing further filtration of the water.

While highly feasible, groundwater replenishment will require health and environmental approvals and significant community support before it can be progressed.

A groundwater replenishment trial will commence in 2010 at the Beenup Wastewater Treatment Plant in Craigie. Recycled water will be treated to drinking water standard using a three step treatment process involving ultrafiltration, reverse osmosis and ultraviolet disinfection. It will then be injected into groundwater at a depth of approximately 200 metres underground.

The trial will monitor:

- water quality, before and after the water is injected into the groundwater;
- any changes to the groundwater and water movement once the water is injected; and
- the performance of the treatment processes and associated equipment.

The water from the trial will not be used for drinking or for other purposes, but will be closely monitored and tested as part of the trial and research program. It will not affect private bores in the area.

Research and monitoring results from the trial will be made publicly available and the community will have access to a range of information about the trial's progress. Community support for and feedback on groundwater replenishment will ultimately play a large part in determining whether this option is developed as a water source.

Subject to the success of the trial, groundwater replenishment has the potential to provide around 35 gigalitres of water into the public water supply system by 2030.

By 2060, it is possible that groundwater replenishment could contribute up to 115 gigalitres each year by recycling water from Perth's major wastewater treatment plants. This could account for over 20% of annual demand for public water supply.

SURFACE WATER

For surface water only two main options were assessed in this group:

- Brunswick Dam; and
- Kimberley canal and pipeline options.

The sustainability assessment highlighted a number of limitations with respect to the development of surface water resources to supply Perth and surrounding areas. No new surface water sources have been included in the portfolio of future options as a result.

Firstly, the drying climate renders surface water for public water supply highly unreliable. Secondly, most viable sites near Perth have already been developed and all proposed dam sites are therefore distant to Perth. This means that land clearing, pipeline costs and energy use are high. Increasingly, there is a community expectation of developing water sources for local use, evidenced in falling community acceptance of transporting water to distant communities.

Brunswick Dam

The Brunswick River Dam in the south west of the State has been under consideration for many years. However, due to the considerable social, environmental and financial impacts, the Water Corporation is not considering it as a future water source at this point in time.

The most significant concerns are:

- the yield of the source would most likely halve over the next 50 years due to climate change impacts. This could lead to stranded or over-sized assets;
- the water quality is poor due to farming and recreational activities in the catchment;
- there are significant Aboriginal and European heritage and cultural impacts; and
- there would be significant forest clearing required for the dam's inundation area.

Water from the Brunswick River supports the ecology of the Leschenault catchment, provides social amenity to the local community and is accessed for riparian and agricultural purposes. The Water Corporation supports the retention of the river for these values. For these reasons, it has not been included in the portfolio of future water source options for the IWSS.

Water from the Kimberley

Options to transport water from the north west of Western Australia (the Kimberley region) were considered as part of the *Water Forever* sustainability assessment.

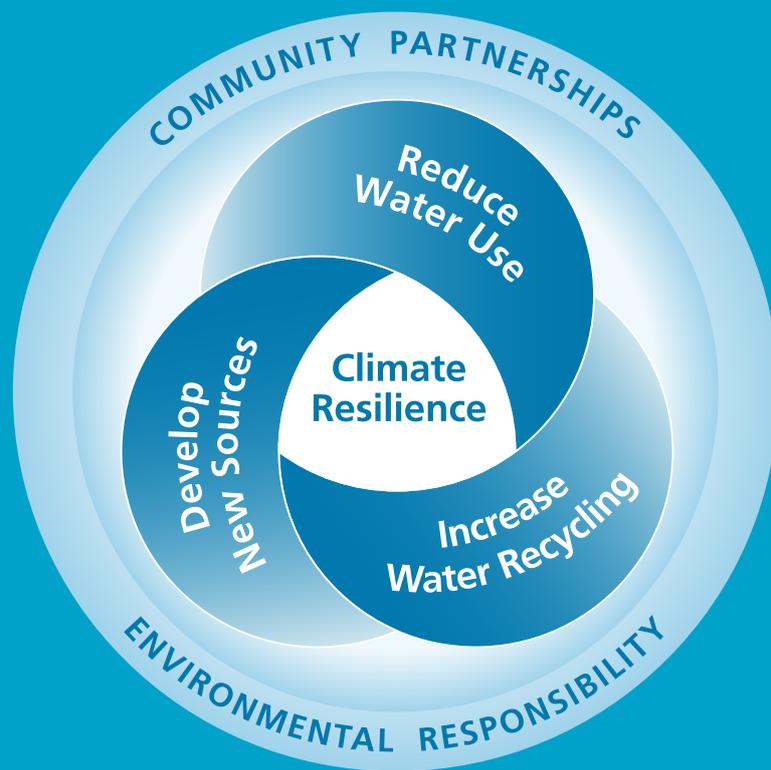
The State Government commissioned an independent assessment of a range of options for transporting water from the north, evaluated in the 2006 report *Options for Bringing Water to Perth from the Kimberley - An Independent Review*. The report found that the supertanker and water bag options were the most energy intensive of any of the Kimberley options and had lower supply security, being sourced entirely from surface water sources.

This report also identified that the Kimberley canal and pipeline options both utilise surface water from a tributary of the Fitzroy River. Rainfalls in the north of Western Australia are expected to continue to be highly variable. There is a preference for the retention of this water for local use, particularly to support an expansion of the Ord Irrigation Area in order to encourage more agricultural production in the north of Australia.

As a result, transporting water from the Kimberley is not currently being considered as a source option for Perth.



MANAGING RISK AND UNCERTAINTY



MANAGING RISK AND UNCERTAINTY

Managing a reduction in per person water use is the most important aspect to securing our water future. It surpasses climate and population as the major risk to be managed.

Water Forever has sought to identify, evaluate and plan for major risks to this 50 year plan to secure water services.

The predominant risks relate to under-estimating demand or over-estimating supply, resulting in a shortfall of water services to the community. The Water Corporation has evaluated sensitivities pertaining to assumptions for:

- climate and rainfall patterns;
- population growth; and
- water demand.

Other risks to meeting water demand include changes in water policy and the risk of a water quality incident.

The supply-demand balance needs to be considered across different time horizons. The first is to 2011, prior to the construction of the second seawater desalination plant for the IWSS water grid.

Secondly, managing the supply and demand balance in the longer term will require that we adapt to changes over time. For example, experiencing drier years than forecast, as well as some wetter ones.

These uncertainties are considered in this section. Also highlighted is the risk of energy supply failure and possible rising sea levels.

An ongoing commitment to research and development is required to build a knowledge base. This will be essential to manage in the changing and challenging times ahead.

Regulations enacted under the *Federal Water Act 2007* require the Water Corporation to provide available information to the Bureau of Meteorology on a range of parameters including:

- surface water;
- groundwater;
- major and minor storages;
- meteorological conditions including rainfall, humidity, evaporation and pressure;
- urban water management;
- water restrictions; and
- water quality.

This information assists in the ongoing monitoring of existing and observed conditions and responses and is part of our adaptive management response.

In the final section of the report, the Water Corporation commits to ongoing monitoring and adaptation over time. This will be needed to accommodate inevitable, although at times unforeseen, changes in operating conditions, community preference and opportunities for source augmentation.

CHANGING ASSUMPTIONS – LONG TERM CLIMATE

Climate change has been the most influential factor related to Perth's water supplies over the last 25 years. The drying climate has had a dramatic impact on streamflows into dams and groundwater availability. As a result, the Water Corporation has built a range of new sources and increased our efforts in water efficiency.

Most CSIRO climate models project a reduction of rainfall in the south west of Western Australia from the 1990 baseline. The Water Corporation's climate assumption is no different, reflecting a possible 20% reduction by 2030 and 40% reduction by 2060.

Current rainfall patterns evidence a 12% decline in rainfall since the 1990 baseline. A further reduction of 8% from the baseline over the next 20 years is therefore plausible. Small reductions in rainfall are expected to be amplified by much larger reductions in streamflows.

Analysis of an even drier climate (30% rainfall reduction by 2030 and 60% by 2060) indicates that the Water Corporation would be required to bring forward new water sources by about five years on average. If this change happens over the next few years, this would most likely accelerate the next major source augmentation closer to 2015, which would be about five years earlier than currently planned.

The robust portfolio of options proposed will support the acceleration of source development, if required.

If the climate dries even further than currently projected, there will most likely be a strong preference for rainfall independent sources, such as groundwater replenishment and desalination. Securing sites for desalination plants and progressing the groundwater replenishment trial are therefore integral to mitigating this risk.

Alternatively, if rainfall reductions are less severe, (say a 15% rainfall reduction by 2030), new major sources of water could be deferred until after 2030 if targeted reductions in water use are achieved.

CHANGING ASSUMPTIONS – POPULATION FORECASTS

A key planning parameter is population growth. *Water Forever* has adopted a planning assumption for Perth's population to be 3.1 million by 2060. Population is significantly influenced by underlying economic conditions, fertility rates and migration policy.

Western Australia has experienced a boom period over the last decade and recent growth rates have been substantial, mainly due to high migration rates. Whether these rates will be sustained over a longer period is unknown.

At the same time, other cities in Australia have experienced higher than forecast growth in population.

Applying a 15% variation to projected growth rates to create a high and low forecast, results in changed assumptions as outlined in Table 13.

CHANGING ASSUMPTIONS – WATER DEMAND

Table 14 outlines three possible scenarios for IWSS scheme water demand:

- *Water Forever* recommended scenario (including water efficiency initiatives); and
- a best case scenario (higher rainfall, lower population growth, lower per person water demand);
- a worse case scenario (lower rainfall, higher population growth, higher per person water demand).

Without a continued focus on existing and new water efficiency programs, demand is expected to increase as a result of several factors including a loss of community awareness and focus, smaller household size (number of people in a home), increased industrial demand due to limited recycling, an expected increase in very hot days (>35 degrees Celsius) and a potential decrease in the availability of local groundwater supplies.

Under the worse case scenario, increased water demand, population growth and lower rainfall result in the need for more new sources than forecast under *Water Forever*. The worse case scenario would increase overall demand by 95 gegalitres by 2030 and 315 gegalitres in 2060. This gap would require investment in additional new water sources.

In comparison, the best case scenario outlines what may be possible if more targeted water efficiency initiatives were implemented, together with higher rainfall and lower population growth.

Achieving more than a 15% saving in water efficiency (as in the *Water Forever* scenario) by 2030, would require significant regulatory intervention such as mandating:

- plumbed in alternative water supplies (such as rainwater tanks) in new homes;
- the retrofit of existing homes to be more waterwise on resale;
- specific business water use measures; and
- the restriction of lawn and / or garden areas.

At this time the Water Corporation does not believe that these significant regulatory interventions are required or supported by most members of the community (although they would likely be welcomed by some). Water savings of this magnitude would impose significant costs on the community and are not supported by the Water Corporation at this time.

Population growth sensitivities (table 13)

Year	2010	2020	2030	2040	2050	2060
Low population forecast	1,711,000	1,961,000	2,211,000	2,431,000	2,651,000	2,871,000
Water Forever population forecast	1,720,000	2,015,000	2,310,000	2,575,000	2,840,000	3,105,000
High population forecast	1,727,000	2,067,000	2,407,000	2,747,000	3,087,000	3,427,000

Water demand sensitivities (table 14)

Water demands	2010	2020	2030	2040	2050	2060
Water Forever scenario						
Per person annual consumption (KL)	145	135	125	120	115	110
Total annual demand (GL)	285	305	330	350	370	385
Best case scenario						
Per person annual consumption (KL)	145	135	125	110	100	90
Total annual demand (GL)	285	300	310	310	310	310
(Decrease) over planned demand	0	(5)	(20)	(40)	(60)	(75)
Worse case scenario						
Per person annual consumption (KL)	145	153	163	172	181	190
Total annual demand (GL)	285	350	425	510	600	700
Increase over planned demand	0	45	95	160	230	315

CUMULATIVE IMPACT OF CHANGING ASSUMPTIONS

Water supply security is dependent upon the three main factors of climate, population growth and the extent to which water efficiency is supported by policy makers and the community.

The best case scenario assumes the climate to 2030 to be similar to the period 1975 - 2008. This is wetter than we have seen over the last 7 years, hence the higher surface water contribution and groundwater abstraction levels. In this case, the IWSS source capacity would exceed the system demands, so no new sources would be required prior to 2030.

The *Water Forever* recommended scenario plans for a supply - demand gap of 70 gigalitres per year at 2030. It assumes water efficiency savings in the order of 50 gigalitres per year.

The worse case scenario considers the risk of the climate drying faster than anticipated - a 30% reduction by 2030. The surface water contribution would drop to around 45 gigalitres per year and groundwater abstraction to drop to 60 gigalitres per year.

With the higher population growth and with no water efficiency initiatives, total demand sharply increases well beyond IWSS source capacity. The gap between supply and demand would be in the order of 225 gigalitres by 2030. Significant source development would be required to meet this gap.

Table 15 summarises the cumulative impact of the worse case scenario assumptions on the base *Water Forever* planning case, by 2030.

Sensitivities to planning assumptions (table 15)

High water demand scenario	Supply – demand gap at 2030 (GL/yr)
Water Forever scenario	70
Higher water demand	79
Lower rainfall	58
Higher population growth	18
Worse case supply-demand gap	225

Figure 19 shows the cumulative impact of the three factors on the supply-demand gap at 2030.

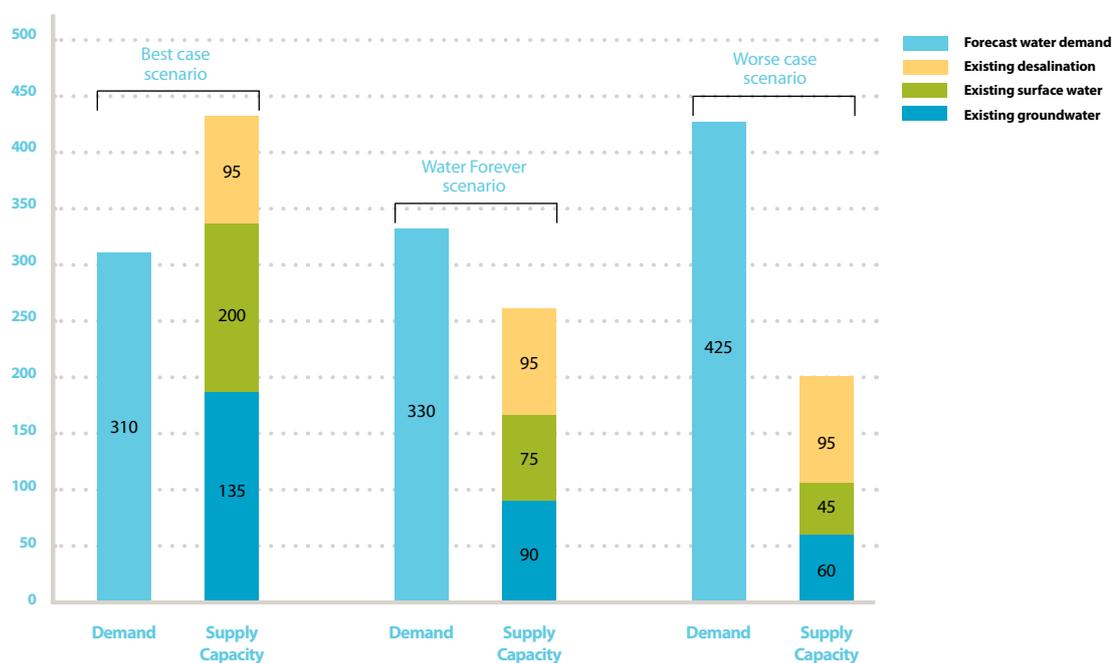
The most significant variable is the degree to which additional water efficiency initiatives are implemented. Small changes in the uptake of water efficiency measures can have a significant impact on the deferral, or acceleration, of the need for new sources.

Water supply security is dependent upon the three main factors of climate, population growth and the extent to which water efficiency is supported by policy makers and the community.



Need for new sources by 2030 under different scenarios (figure 19)

(Gigalitres)



Climate is still a major factor, but is expected to become less important as the community progressively adapts through investment in rainfall independent sources of desalination and recycling.

Population change is the least sensitive planning assumption in the short to medium term. While it may have a significant impact on the long term need for new water sources, it does not imminently threaten supply security. Population should be progressively monitored and updated in periodic forecasts, to adapt to long term growth trends.

While it is unlikely that all assumptions will trend favourably or unfavourably, understanding the cumulative impact of changes to planning assumptions assists in determining the importance of specific responses.

In all responses, a planned 'buffer' is included so that the impact of unforeseen events or changes in planning assumptions can be accommodated without significant stress on the system. Creating system buffers (or spare capacity) however can be costly. This is why the portfolio approach is also employed, to reduce lead times from planning to commissioning.

Managing a reduction in per person water use will be the most important aspect to securing our water future. It surpasses climate and population as the major risk to be managed.

POTENTIAL LOSS OF SOURCE CAPACITY

There are a number of reasons, other than climate, as to why planned system yields may not eventuate. These include:

- policy decisions such as further environmental water provision from surface or groundwater resources; or
- water quality incidents caused by events such as bushfires or gross pollution.

Environmental water provisions retain water in the environment to maintain ecological processes and support the biodiversity of water dependent ecosystems. These provisions may have other public benefits such as public health, cultural, recreation, fisheries, tourism and others.

The introduction of further environmental water provisions from surface water sources would reduce the water available from existing dams. It is estimated by the Department of Water that further allocations to the environment of between five and ten gigalitres a year from dams are possible. The issue is currently under review.

Future groundwater allocations from the Gngangara Mound are also dependent on climate change. If the climate continues to dry, then future reductions in groundwater allocations may be greater than expected.

The management framework (both legislation and policy) for the Gngangara Mound is unclear. The Gngangara Sustainability Strategy is coordinating a review of a number of land and water resource management issues to provide policy direction and clarity. This review is being undertaken for the State Government as a matter of urgency.

In a drying climate, future groundwater replenishment projects become even more prospective to help support groundwater supplies on the Gngangara Mound.

A major water quality incident, such as a bushfire in a water catchment, or gross pollution of a source, may result in the temporary loss of a water source. Ensuring that diverse sources are developed over time, reduces the impact that such a loss will have on overall water supply.

The Water Corporation has invested significantly in water quality monitoring and incident management, to establish robust processes to protect public health as a priority. The Water Corporation is committed to preserving the quality of existing sources through active source protection measures.

MANAGING THE SUPPLY AND DEMAND BALANCE – TO 2011

At the end of the 2009 winter, metropolitan dam storage levels were about 50% full – the highest for a number of years.

A key milestone will be the commissioning of the Southern Seawater Desalination Plant. When this source comes on line, the IWSS will be in supply surplus allowing groundwater abstraction to reduce and aquifers to recover.

Measures have already been taken to ensure management of the supply and demand balance to 2011, including utilisation of the Harris Dam pumpback to Stirling Dam and exploring the possibility of temporary trades with other users on the Gngangara Mound.

The State Government announced a trial winter sprinkler ban (stage six restrictions) from 1 July to 31 August 2009 to address poor winter rainfalls to June of this year and high levels of water use in the southern part of the State.



The trial resulted in at least 2.2 GL of water saving this year and enjoyed strong community support.

A trial winter sprinkler ban summit was jointly convened with the Department of Water to explore application of the bans to future years.

Following the summit, the Minister for Water, The Hon. Graham Jacobs MLA, announced in principle support for the bans to become a permanent feature of a sensible water regime. Consideration is being given to the ban area and possible exemptions to address any implementation issues.

There is also the possibility that rainfall may significantly increase over the next two years, as a result of natural variation in climate patterns. In this event, the most likely response would incorporate the following:

- dams would continue to fill to increase supply security;
- groundwater abstractions from the Gnarup Mound would be reduced to allow the aquifer to recover;
- the Perth Seawater Desalination Plant would be expected to remain operating at its normal output; and
- the Southern Seawater Desalination Plant would continue to be scheduled for commissioning in 2011.

In summary, this plan is to harness wetter years to improve surface water storage in dams, without overflowing, to offset drier years expected to follow.

MANAGING THE SUPPLY AND DEMAND BALANCE – IN THE LONGER TERM

If rainfall declines further than projected, surface water and groundwater sources will most likely continue to decline.

The caution here is that the rainfall pattern (seasonal timing of falls, intensity of precipitation events, intermittent drying of the catchments, rate of evaporation) is perhaps as important as the annual rainfall quantum. For example, surface water catchments maximise inflows to dams when they are saturated in late autumn to early winter, followed by consistent rainfall events. Summer rainfall or rainfall followed by prolonged dry periods, produce very little run off to public water supply dams.

Prolonged rainfall declines would most likely accelerate the need for new sources. Care is taken to avoid the need to restrict demand, particularly in summer periods or for commercial use.

The development and continued optimisation of a range of water sources outlined in *Develop New Sources* improves the Water Corporation's ability to respond to changing conditions, relatively quickly.

Recent experience suggests that it takes five to six years to commission a major new water source. Source options and initiatives must therefore be well advanced in planning, investigation and approval to allow for "fast tracking" if required.

There is always the possibility that Perth and surrounding areas may experience a sequence of very wet (over 150 gegalitres of inflow per year) years. The Water Corporation needs to be ready for this possibility, to optimise operations under this changed, but welcome, scenario.

In general, the Water Corporation's approach is to minimise water losses. Water can be lost through dam overflows or forgone production in the case of groundwater and seawater desalination.

Seawater desalination is being developed as a base load source. Desalination plants operate continuously and are not suited to peaking supply or intermittent operation. The current strategy for the Perth Seawater Desalination Plant includes an annual shut down period of around four weeks for completion of all maintenance activities. There is little opportunity to produce additional water in any year and water not produced is considered to be lost or forgone.

Output from seawater desalination plants would only be reduced if there was a high chance of water spilling from the surface water dams.

The probability of spill is constantly assessed through the winter filling period.

With groundwater, high annual rainfalls provide the opportunity to abstract less than the target average for the resource. This allows the aquifer to replenish.

If the wetter sequence continues for an extended period and dam levels are very high, desalination and groundwater may be further curtailed as they are both more expensive than surface water.

A commitment to water efficiency is expected to be maintained as this is a long term strategy, aimed at reducing the impact on the environment and preparing for, on average, continued and significant reductions in rainfall over the longer term.

ENERGY SECURITY

Our water future is increasingly an energy dependent one.

The Independent Market Operator (IMO) is a body corporate responsible for the administration and operation of the Western Australian wholesale electricity market in Western Australia. The IMO's aim is to provide and maintain effective infrastructure for the efficient operation of this market.

The IMO's role is:

- to administer the market rules;
- to operate the Wholesale Electricity Market; and
- to facilitate the provision of sufficient generation capacity and demand side management, to meet expected demand.

The Water Corporation relies on the IMO to ensure that sufficient generating capacity is always available to meet its energy demands. The Water Corporation has contingency plans in place for managing short term power outages such as portable generators.

RISING SEA LEVELS

It is predicted that one of the major impacts of ongoing climate change is a risk of increasing sea levels, increased storm surges and extreme weather events.

This poses a major risk to coastal settlements and infrastructure.

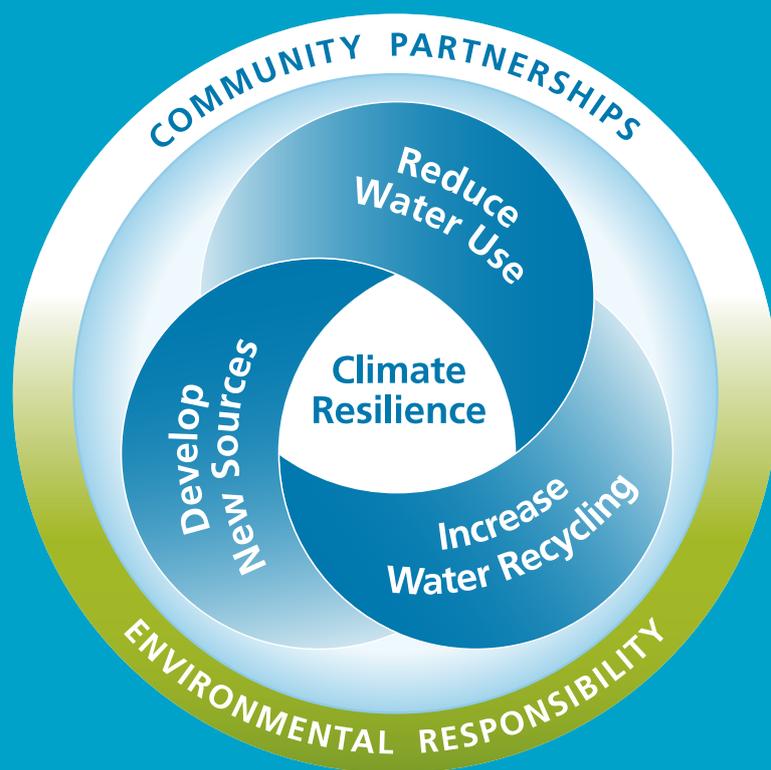
At present there is a great deal of uncertainty regarding the severity and timing of impacts related to this problem. Much existing water infrastructure for Perth and Mandurah is located on or near the coast.

The Water Corporation is working with the Swan River Trust to investigate the impacts of rising sea levels on assets in coastal areas through sharing of information and development of common models.





ENVIRONMENTAL RESPONSIBILITY



ENVIRONMENTAL RESPONSIBILITY

In delivering water services to the majority of Western Australians, the Water Corporation considers how these services ultimately impact on the environment and how to work collaboratively with the community to minimise these impacts.

The Water Corporation will work in partnership with business, communities and individuals to reduce water use and our environmental footprint. In so doing, the Water Corporation can help to preserve natural features including wetlands, healthy rivers and streams and biodiversity.

Other major environmental considerations for Water Corporation operations include:

- taking water from the environment for supply to customers;
- consuming energy and producing greenhouse gas emissions;
- clearing native vegetation;
- discharging water into the ocean, rivers, streams and groundwater; and
- managing contaminated sites.

The Water Corporation's approach to working to reduce our environmental footprint, mindful of these impacts, is discussed in this section.

REDUCING WATER USE

Using less water is the most cost effective and environmentally beneficial way to reduce our shared impact on the environment.

The Water Corporation will assist households, businesses and industry to further reduce water use, by investing more in Waterwise programs. By saving more water, it is anticipated that a new source of drinking water will not be required until closer to 2020. More information about this approach to water efficiency is outlined in the *Reduce Water Use* section.

WATER FOR THE ENVIRONMENT

Taking less water from the environment and ensuring there is enough water to maintain the health of waterways is essential for the sustainable management of water supplies.

The Water Corporation has a number of actions in place to both reduce the amount of water taken from the environment, and return water to the environment for a range of uses.

Reducing groundwater taken from the Gngangara Mound

The development of rainfall independent water supplies such as desalination has meant that reliance on groundwater supplies can be eased.

Once the Southern Seawater Desalination Plant is commissioned in 2011, the Water Corporation will reduce the amount of groundwater taken from the Gngangara Mound as outlined in the draft Gngangara Sustainability Strategy, released by the Department of Water (2009) for public comment.

The Gngangara Mound needs to be protected for the environment and public and private water supply. The environment is inevitably changing as the climate dries. Nonetheless, use compounds these impacts.

A focus for all users on improved water efficiency, resulting in reduced abstractions, is expected to be reflected in the allocation plans and licensed allocations managed by the Department of Water.

The water future for Perth for private and public water supply is interconnected. We all need to contribute to making Perth a climate resilient city.

Releasing water from dams

Historically, the Water Corporation has released water from dams to provide water for:

- use in the downstream environment;
- stock and domestic uses; and
- recreational activities.

The Department of Water is currently reviewing environmental water releases from dams. The Water Corporation will work with the Department of Water to determine the appropriate amounts of water that could be released for this purpose while recognising and mitigating where possible, the impacts on downstream users.

Releasing wastewater to the ocean

An increase in the use of recycled water for industry, public open space and potentially to supplement drinking water supplies, is expected to result in less treated wastewater being discharged into the ocean.

Ocean outfalls are required to discharge excess treated wastewater, due to surplus or variations in seasonal use. Additionally, ocean outfalls dispose of the concentrate that is removed from wastewater to make it suitable for recycling.

The Water Corporation has been monitoring the impacts of discharging wastewater to the ocean for many years. Ten years of monitoring has so far demonstrated no adverse environmental impacts. The Water Corporation's Perth Long-term Ocean Outfall Monitoring program will continue to monitor the coastal environments at existing outfall sites.

Making local use of drainage and stormwater

Unlike other cities in Australia, most drainage water in Perth is used to recharge groundwater. From here, it is used for garden watering and the irrigation of public open space. A much smaller amount drains to rivers and wetlands where it supports these ecosystems. Perth is fortunate that most drainage water is already beneficially recharged, recycled and used in the urban environment.

The Water Corporation is responsible for managing most main drains in the Perth metropolitan area. There are over 335,000 homes and businesses connected to this drainage network. Local government is responsible for maintaining local drains.

The Water Corporation will continue to provide existing drainage services and encourage water efficiency and water sensitive urban design as a part of drainage management. The primary contribution to drainage water quality is achieved by facilitating recharge and reuse in local areas to increase flows to receiving water bodies.

A certain amount of water drains into the ocean through stormwater outfalls. This drainage water can be harvested for use, including recharging groundwater to prevent saltwater intrusion.

A recent report released by the Department of Water, *Report for Potential Use of Stormwater in the Perth Region: Quantity and Storage Assessment* estimates that around 120 gigalitres of water is discharged from three major catchment areas in the Perth - Mandurah area, the Swan Canning catchment, coastal main drains at Carine, Herdsman and Subiaco and the Peel main drains. This estimate is based on rainfall data from 1965 - 2000, a wetter period than has been experienced from 2001 onwards.

Most of the water drains into the Swan and Canning Rivers. These environmental flows may support river health, subject to the quality of this water. Only a small proportion, estimated to be around 20 gigalitres a year, flows out to the ocean.

The Water Corporation will explore opportunities to work with local governments and other lead agencies on specific projects to improve drainage water quality.

Water sensitive urban design

One of the best ways to manage the water not required for environmental flows, is to return it to local aquifers, where it can be used to maintain groundwater levels or to irrigate public open space or gardens. This concept is the essence of water sensitive urban design.

Water sensitive urban design maximises the use of drainage and stormwater to recharge groundwater, replenish lakes and wetlands and to help naturally irrigate streetscapes, parks and gardens.

The Water Corporation will work with State and local governments and the land development industry, to provide advice and training to help build expertise in water sensitive urban design in the private sector and in government agencies.

MINI-HYDRO

Mini-hydro is a small scale hydroelectricity scheme. Hydroelectricity is generated when the energy of flowing water is converted into electrical energy.

The key benefits of mini-hydro are that it provides a cost-effective and reliable clean energy supply.

There are a number of mini-hydro schemes in operation including one owned by SA Water who, in partnership with Hydro Tasmania, have developed a mini-hydro plant capable of producing electricity from the flow of water in large water mains. The plant is designed to produce up to 7,000 megawatt hours per year which is enough electricity to power 1,000 homes for a year.

Energy and greenhouse gas emissions

Water service provision often requires significant amounts of energy to treat and move water and wastewater around the system.

In 2008/09 the Water Corporation used 2.2 million gigajoules of energy in the following areas:

- 90% from electricity;
- 8% for transport; and
- 2% for heating using natural gas and biogas.

Most electricity used by the Water Corporation is purchased. Approximately 1.2% is generated at the Woodman Point Wastewater Treatment Plant from biogas.

The Water Corporation's energy consumption is directly related to three major factors:

- number of customers;
- level of water or wastewater treatment required – the higher the quality of water and wastewater required, the more energy used to treat it; and
- the distance over which water and wastewater is transported.

Almost 74% of all energy use is attributed to water services with a further 20% due to wastewater services. Support activities such as energy use in buildings and transport account for the balance.

New rainfall independent sources tend to use more energy as they often require higher levels of treatment. The energy needed to treat 1 kilolitre of drinking water varies by source:

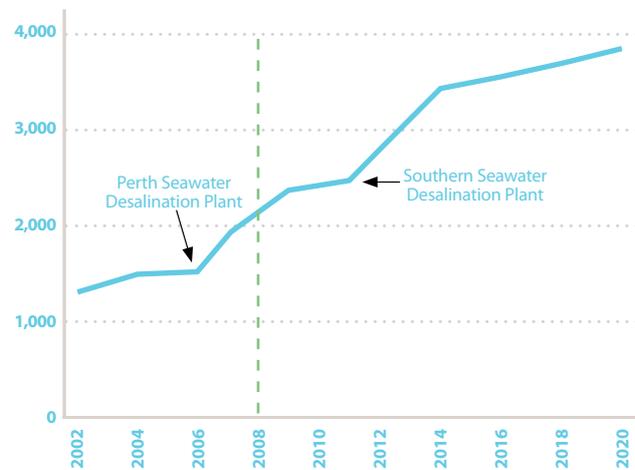
- 0.4 to 0.6kWh for water treatment of surface and groundwater sources;
- 0.8 to 1.0kWh for recycled water; and
- 3 to 5kWh for reverse osmosis desalination of seawater.

Currently, the Water Corporation reports over 550,000 tonnes of direct and indirect greenhouse gas emissions each year. Eighty percent of these emissions result from electricity used to remove and treat wastewater, manage drainage networks and irrigation, and supply drinking water to communities spread across 2.5 million square kilometres of one of the driest continents on earth.

Figure 20 estimates the amount of energy likely to be required for water services up to 2020.

Historical and projected energy use by Water Corporation water services 2002 - 2020 (figure 20)

(Terajoules)



Carbon Pollution Reduction Scheme

A national Carbon Pollution Reduction Scheme may be introduced in 2011. The scheme is expected to require organisations to take the cost of carbon pollution into account when making business decisions. Carbon pollution permits will be required for direct emissions covered by the scheme.

Under the scheme, businesses will need to account for facilities that directly emit more than 25,000 tonnes of carbon dioxide equivalent. The Water Corporation's participation and carbon liability under the scheme is not yet clear, pending finalisation of the legislation. Steps are being taken to reduce energy consumption where appropriate.

In relation to the area of wastewater treatment and disposal, the water industry is undertaking more work to determine the role of its processes in the generation of greenhouse gas emissions. The Water Corporation will work with the State and Federal Governments and the Water Services Association of Australia to monitor and plan for the proposed introduction of the scheme in 2011.

Linking energy and water efficiency

When considering energy use in the water service sector, it is important to understand this use in the context of overall energy use within the urban environment.

A recent CSIRO study has found that when compared to energy use in a total urban system, the total energy use by water utilities in major capital cities across Australia is only 0.2% of the total energy demand of the city.

Taking less water from the environment and ensuring there is enough water to maintain the health of waterways is essential for the sustainable management of water supplies.



The report, *Energy Use in the Provision and Consumption of Urban Water in Australia and New Zealand* highlights that total energy use by water utilities in major capital cities in Australia was approximately only 15% of the energy used for residential water heating.

For Perth, total energy use by the Water Corporation accounted for 19% of residential hot water energy consumption. That is, five times more energy is used heating residential water than the energy used for the delivery of all the water and wastewater services to metropolitan Perth.

The report notes that a 15% reduction in the use of residential hot water systems across Australia could completely offset the total energy used by utilities providing water to those households in 2006/07.

Encouraging consumers to use less water not only reduces the amount of energy used by the utility to provide water services, it also reduces the amount of water heated for residential water use.

The Water Corporation's 2030 target to reduce water use by 15% will not only assist in conserving water, but will go some way to reducing household and utility energy use.

Energy efficiency and renewable energy

Together with gains that can be made in energy efficiency by reducing water use, the Water Corporation is committed to reducing energy use, or using renewable energy, where appropriate.

The Water Corporation has already taken major steps to achieve this objective. Various energy efficiency measures, including biogas capture for sludge heating and power generation, have all contributed to reducing greenhouse gas emissions.

In remote areas, solar power has been used to power small pump stations.

In addition, the energy requirements of the Perth Seawater Desalination Plant are purchased from the Emu Downs Wind Farm.

The Water Corporation intends to purchase the electricity needs of the Southern Seawater Desalination Plant from renewable energy generators. Most of the renewable energy purchased will be from sources such as wind and the remaining energy from more alternative sources such as wave or biomass, if viable.

The Water Corporation is also committed to reducing the amount of energy used to move water and wastewater around the system. This will be achieved through:

- implementing water efficiency programs to reduce the amount of water used and therefore the amount of wastewater entering the treatment system;
- assessing major Water Corporation plants and sites and implementing energy efficiency measures;
- making improvements to pumping systems used to move water and wastewater around so less energy is required;
- investigating opportunities for co-generation and creating biofuel from wastewater treatment plants; and
- conducting in-line hydroelectricity trials to determine how this renewable energy source could be used in the future.

The Water Corporation has registered to take part in the Federal Government Energy Efficiency Opportunities Program. This program aims to improve the identification and evaluation of energy efficiency opportunities for large energy consuming businesses.

Participating businesses identify, evaluate and report publicly on cost effective energy savings opportunities. As part of the program the Water Corporation is undertaking energy assessments of sites, covering 80% of our energy use, by June 2011.

GEOTHERMAL DESALINATION

Identifying new technologies that provide renewable energy is an important aspect of water supply.

Geothermal desalination accesses hot water deep below the earth's surface as an energy source, which can be applied to a distillation style desalination process.

The technology is still in development but may become feasible in future years. It is very attractive because it could fully utilise renewable energy (naturally occurring hot water). Perth has large reserves of hot groundwater that may be suitable for this technology.

Biodiversity and native vegetation

Native vegetation surrounding water sources such as estuaries, reservoirs, watercourses and wetlands form an important buffer to shield these sensitive sources from contaminants, erosion, weed species and unwanted access from humans and animals.

Protecting this biodiversity and native vegetation is therefore a priority. The Water Corporation manages over 700,000 hectares of freehold and reserve land across the state. Almost 60% of this land is within the south west eco-region, which has a high biodiversity conservation value. In addition, over 90 Water Corporation owned assets are included within Bush Forever which protects regionally significant native vegetation and wetlands on the Swan Coastal Plain.

The Water Corporation will strive to avoid the clearing of vegetation for new infrastructure. If clearing is unavoidable and significant ecological value is impacted, this clearing will be offset to ensure ecological values are preserved.

The Water Corporation currently refers to the Environmental Protection Authority's *Position Statement No. 9 on Environmental Offsets* to determine when and what type of offsets might be required.

CONTAMINATED SITES

Historically, processes involved in the provision of water and wastewater services have had unintended consequences on the natural environment. The Water Corporation has sometimes acquired land, already contaminated, for water infrastructure.

Site contamination generally arises where soils or groundwater have been affected by infiltration of nutrients associated with treated wastewater or leaching of chemicals or heavy metals from onsite or adjacent activities.

These sites are known as contaminated sites and are required to be reported to the Department of Environment and Conservation (DEC).

The Water Corporation has developed an extensive contaminated sites assessment process based on the guidelines provided by the DEC. This includes site investigation and remediation, validation and ongoing monitoring as required.

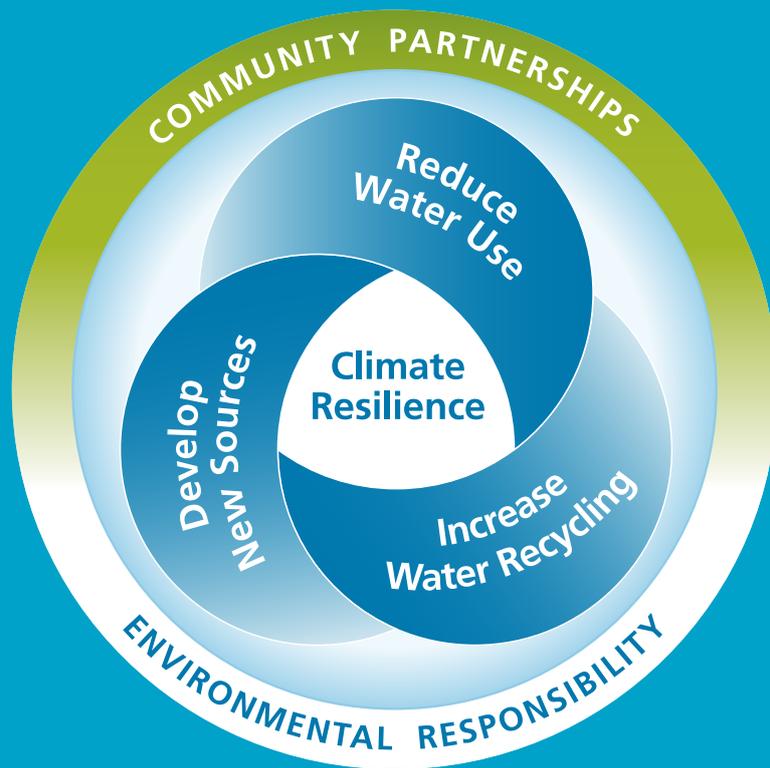
The Water Corporation has conducted a comprehensive site audit and has reported around 60 known or suspected contaminated sites. 80% of these sites are located within the south west of Western Australia. Ten of these sites will require remediation and a further 20 require immediate investigation.

The Water Corporation works to prevent any additional contamination of sites from current and future activities.





COMMUNITY PARTNERSHIPS



COMMUNITY PARTNERSHIPS

Perth can only become resilient to the drying climate if everyone is involved in changing the way we use water.

The commitments made by the Water Corporation in this document will be achieved by working with all sectors of the community, including residents, business and industry, schools, indigenous people, academic and research institutions, State and local governments, environmental groups and many others.

The Water Corporation is committed to continuously engaging with Western Australians on water issues that affect them. This includes ensuring the public can have input into plans like *Water Forever*, educating everyone on how to reduce water use and engaging with local communities that may be impacted by, or benefit from, new water or wastewater infrastructure.

REGULATORY APPROVALS

The Water Corporation will continue to work with agencies to identify opportunities and solutions to meeting the supply-demand gap. A number of actions in the Action Plan recognise the partnerships required to deliver on the commitments in this document.

In addition, some actions require policy consideration or approval by the relevant regulatory agencies. These agencies and their responsibilities are outlined in table 16 opposite.

INDIGENOUS INVOLVEMENT

The Water Corporation recognises it is one of Australia's largest water service providers and has developed a Reconciliation Action Plan that commits to:

- providing and promoting opportunities for Indigenous participation and employment;
- progressing genuine Indigenous partnerships through engagement, consultation and communication;
- working with Aboriginal groups and land owners to consider their perspective on delivering water services; and
- developing ways for our diverse workforce to gain knowledge of and respect for Indigenous cultures in our areas of operations.



Agency roles and responsibilities (table 16)

Consideration from Water Forever	Agency	Responsibility
Identify water quality and quantity parameters for returning water to the environment.	Department of Water	Water recycling, water allocation and water quality
	Department of Environment and Conservation	Discharges to the environment
Continue to support the safe use of alternative water supplies for non-drinking water purposes.	Department of Health	Public health Drinking and recycled water quality
Legislate, regulate and promote the use of less water across all sectors.	Department of Water	Water efficiency and recycling Water allocation Water resource and industry policy
Develop guidelines and policies that continue to support the safe use of recycled water.	Department of Water	Water recycling, water allocation and water quality
	Department of Health	Public health, drinking and recycled water quality
Encourage the efficient uptake of recycled water, set price of scheme water to reflect the full cost of supply.	Economic Regulation Authority	Inquiries into water pricing and performance
Integrate strategic land and water planning and support water efficiency and recycling initiatives within urban planning and design.	Department of Planning	Strategic land use planning and development assessment
Legislate, regulate and promote the use of less water, the use of recycled water and alternative water in buildings.	Building Commission	Water efficiency and recycling in buildings
Provide strategic direction on the environmental aspects of the plan.	Environmental Protection Authority	Environmental aspects of the plan

Changes will be required at all levels of land planning to encourage water efficient buildings, gardens and public open spaces for new developments, as well as making improvements to existing suburbs and communities.



INTEGRATING WITH LAND PLANNING AND DEVELOPMENT

To help Perth and surrounding communities become climate resilient, the Water Corporation will work with State and local governments to better integrate water and land planning.

Changes will be required at all levels of land planning to encourage water efficient buildings, gardens and public open spaces for new developments, as well as making improvements to existing suburbs and communities.

The Water Corporation needs to be more actively involved in strategic land planning to ensure the most efficient use of water where possible.

To achieve this, the Water Corporation will work with governments at all levels to:

- secure future water and wastewater infrastructure sites, infrastructure corridors and buffers in structure plans, local planning strategies, zoning and land development decisions;
- plan for the supply of recycled water to emerging industrial areas (such as Neerabup and East Rockingham);
- increase the application of water sensitive urban design principles in new land developments; and
- support building codes and appliances that reduce water

PRIVATE SECTOR PARTICIPATION

Since establishment in 1996, the Water Corporation has progressively increased the involvement of the private sector in its service delivery. Private sector proponents have been given greater levels of control over design, scope and output. They have also been allocated greater levels of risk in relation to asset creation, operations and maintenance.

The Corporation is currently investigating a portfolio of public private partnership (PPP) options including the delivery of the Mundaring Water Treatment Plant. This proposed PPP model would provide the greatest allocation of control to the private sector to date.

The Mundaring Water Treatment Plant (WTP) will be part of the Helena Water Supply System. This system provides the only source of bulk water supply to the Goldfields & Agricultural Water Supply System.

The Mundaring WTP is to be developed in stages with an initial 65 gegalitres per annum due for completion in 2013. Ultimate capacity for the plant is to be 82 gegalitres per annum which would be completed by 2030 based on current demand growth projections.

Under a PPP model, the plant will be designed, constructed, operated, maintained and owned by the private sector. The Water Corporation will deliver water to the treatment plant and procure a water treatment service from the plant owner. The WTP lends itself to a PPP delivery model given it is a greenfield site currently at the planning stage.

Other potential PPP projects include a new major wastewater treatment plant at Rockingham and a new water source in the West Pilbara.

The wastewater treatment plant will be required by mid 2015 and will service growth to the south of Perth. At ultimate capacity this plant would process 160 million litres per day which equates to a population of up to 800,000.

Growth in mining and towns in the West Pilbara will require a new water source by 2013 to augment the current sources - Harding dam and Millstream groundwater aquifer. The Water Corporation is currently considering options including a new desalination plant and the development of a new groundwater aquifer.



ACTION PLAN

ACTION PLAN

The Water Corporation will monitor future performance against the targets and goals set in this plan.

The goals, targets and actions outlined have been developed further to extensive community engagement, a review of national and international approaches, consultation with industry experts, including the *Water Forever Science Panel* and extensive analysis of a range of options, scenarios and sensitivities.

Actions that are or will be undertaken directly by the Water Corporation are listed under the "Continue" or "Commit" headings. Actions that involve further investigation or require action, regulation and / or approvals outside the Water Corporation (but with Water Corporation involvement) are listed under the "Explore" heading.

MONITOR, REVIEW AND REPORT

The Water Corporation will monitor performance against the targets and goals set in this plan. Public reports on progress against the targets and actions will be provided periodically, with the first report in 2012.

Additionally, *Water Forever: Towards Climate Resilience* will be reviewed by 2015 to ensure that information is kept current and remains publicly available.



REDUCE WATER USE



▶ 2060 GOAL

25% reduction in per person scheme water use, from 2008 levels of water use

▶ 2030 TARGET

15% reduction in per person scheme water use, from 2008 levels of water use

Actions to 2015

Continue to	<ul style="list-style-type: none"> • Work with the nursery and garden, turf and irrigation industries to reduce water use • Reduce water use in high water using businesses, industries and services through Waterwise programs and Water Efficiency Management Plans • Work with the WA Planning Commission and the Department of Planning to promote water sensitive urban design and fit for purpose water use at regional, district, local and subdivision scales of development
Commit to	<ul style="list-style-type: none"> • Implementation of a large-scale Waterwise Homes program to work one-on-one with households to reduce water use inside and outside the home • Education programs to increase the uptake of climate resilient gardens at city, development, street and lot scales • Working with the WA Planning Commission and the Department of Planning to better integrate strategic land and water planning • Working with the Department of Sport and Recreation and sport/leisure associations to reduce water use • Expanding the Waterwise Schools program to all metropolitan primary schools • Facilitating water sensitive urban design recharge and reuse in local areas to improve water quality of receiving water bodies • Reviewing metering, pricing and billing practices to support reduced water use • Supporting the Waterwise Council program in partnership with the Department of Water and local governments • Implementing leak detection and pressure management programs, where cost effective
Explore	<ul style="list-style-type: none"> • Liaising with the Department of Water to increase metering, monitoring and reporting of private water use, with a view to improving its productivity by 20% • Working with land planning agencies to increase urban density • Working with the Building Commission and the housing industry to mandate minimum water efficient approaches and appliances for new residential and commercial developments • Working with national bodies to regulate for minimum WELS ratings for water efficient products • Collaborating with local governments and lead agencies on specific projects to improve drainage water quality

INCREASE WATER RECYCLING



► 2060 GOAL

60% recycling of all metropolitan wastewater

► 2030 TARGET

30% recycling of all metropolitan wastewater

Actions to 2015

Continue to	<ul style="list-style-type: none"> • Work with the private sector and industry to use biosolids for beneficial uses, including agriculture • Optimise operations of Kwinana Water Recycling Plant to supply recycled water to industry • Monitor ocean discharges to ensure appropriate water quality to protect the environment
Commit to	<ul style="list-style-type: none"> • Expanding the existing Kwinana Water Recycling Plant output by a further 3.6 gigalitres a year • Working with land planning and development agencies to ensure that the Neerabup and East Rockingham Industrial Estates are reticulated to support the use of recycled water • Reducing the use of potable scheme water in wastewater treatment plants to less than 10% of all in-plant water use • Investing in co-generation to harvest more energy from wastewater treatment plant processes • Identifying existing or proposed Water Corporation land that could be irrigated with recycled water and used for community, sporting and recreational activities • Working with local government to irrigate more public parks and ovals with recycled water
Explore	<ul style="list-style-type: none"> • Water quality and quantity parameters for returning recycled water to the environment • Working with the WA Planning Commission and the Department of Planning to incorporate future wastewater infrastructure, recycling plants and pipeline corridors into strategic planning proposals and schemes • Working with the WA Planning Commission, the Department of Planning and the Department of Water to develop streamlined approval processes for alternative water supplies and recycled water • Working with the Armadale Redevelopment Authority to identify the most appropriate non drinking water to supply the Wungong Urban Waters community (including design standards).



DEVELOP NEW SOURCES



▶ 2060 GOAL

New source options are identified, investigated and secured to support development by the Water Corporation and the private sector

▶ 2030 TARGET

Develop an estimated 70 to 100 GL of new sources from the portfolio of source options

Actions to 2015

Continue to	<ul style="list-style-type: none"> • Complete the 50 gigalitre Southern Seawater Desalination Plant at Binningup • Complete the Groundwater Replenishment Trial • Mitigate the impacts of energy intensive sources such as desalination by contracting for energy from sources including biomass, wind, sun and waves or purchasing offsets
Commit to	<ul style="list-style-type: none"> • Ensuring a range of water source options can be developed when required • Securing sites for possible desalination plants in the northern corridor • Developing a full scale groundwater replenishment scheme, if the trial is successful and supported by the community • Securing approvals for the next major water source, or partner with the private sector for delivery • Reducing the amount of water taken from the Gnangara Mound to an average 120 gigalitres per year (once the Southern Seawater Desalination Plant is operational) • Reviewing the Wungong Catchment Management Trial to determine the viability of thinning catchments to increase run-off into dams • Working with the State and Federal Governments and the Water Services Association of Australia to monitor and plan for the introduction of the Carbon Pollution Reduction Scheme
Explore	<ul style="list-style-type: none"> • Research into the viability of new technologies to reduce evaporation from drinking water dams • Resource investigation on groundwater in the North West metropolitan coastal groundwater area • Conducting a detailed economic, social and environmental impact assessment on the most prospective future water sources • Working with the WA Planning Commission and the Department of Planning to ensure that future buffers and infrastructure corridors are secured and reflected in structure plans and local planning strategies

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Information Sheets

Alkimos Wastewater Treatment Plant

Alternative Water Supplies

Brunswick Dam

Catchment Management

Cloud Seeding

East Rockingham Wastewater Treatment Plant

Garden Bores

Gingin Groundwater

Gnangara Groundwater

Greywater Reuse and Recycling

Groundwater Salinity in Rural Towns

Groundwater Sources – An Overview

Integrated Resource Planning

Jandakot Groundwater

Karnup & Dandalup Groundwater

Maintaining Biodiversity

Mandurah Wastewater Treatment Plants

North West Coastal Groundwater

Ocean Discharge of Treated Wastewater

Permanent Water Efficiency Measures

Rainwater Tanks

Recycling – Agriculture

Recycling - Groundwater Replenishment

Recycling – Industry

Recycling – Public Open Space

Reducing Dam Evaporation Losses

Seawater Desalination

Sludge and Biosolids

The Water Grid

Wastewater Odours

Water Efficiency

Water from the North

Water Restrictions

Water Sensitive Urban Design

Water Trading

Waterwise Businesses

Waterwise Homes, Gardens and Communities

Waterwise Schools

Wellington Dam

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TOWARDS CLIMATE RESILIENCE

