



Department of Water
Government of Western Australia

South West Water Resources – Regional Overview

Department of Water
April 2007

Level 4, 168 St Georges Terrace
Perth Western Australia 6000

<www.water.wa.gov.au>

Telephone +61-8-6364 7600

Facsimile +61-8-6364 7601

For more information about this report, contact the Strategic Water Planning branch on +61- 8-6364 7600.

April 2007

Contents

Purpose of this paper	5
About the South West Region	7
Population.....	7
Living in the region	9
Land use.....	9
Economic base	11
Natural resources	13
Natural resource management	14
Water and the South West Region	16
Climate	16
Major regional water systems	17
An overview of groundwater systems	19
An overview of surface water systems.....	21
High value waterways and wetlands.....	32
An overview of water availability and use	33
An overview of water allocation and use by major sector	35
Governance	36
Service provision	37
Regulatory environment.....	38
Community values for water use	38

Purpose of this paper

This draft paper outlines the state of water resource management and service delivery in the South West of Western Australia as of June 2006. It is intended to inform individuals and communities about our management framework for water resources, as it applies to the communities in the region.

Most importantly, it has been an important tool to seek feedback from members of the South West Water Forum as to whether the current state of water issues in the region has been outlined adequately and accurately. The South West Water Forum is a stakeholder body comprising representatives from key water sector groups in the region including:

- Agriculture
- Water service provision
- Local government
- Environment and Natural resource management
- Industry and development
- Fishing and recreation; and
- Indigenous affairs.

It should be read in conjunction with:

- *The South West Water Plan – an invitation to participate*
- *South West Water Resources: Water Policy Overview*; and
- *South West Water Resources: A Review of Future Trends*.

There will be a number of opportunities for public and stakeholder input into the South West Water Plan at all stages of the development process. The *Invitation to Participate* paper provides details on how community members can register their interest in community workshops that will occur as a part of the development of the South West Water Plan

In early 2007, the Department of Water will work with forum members to develop an action plan and define the accountability of government, the community, and industry in moving South West water planning forward to a sustainable future. A draft South West Water Plan will be released for public review in mid 2007.

The plan will be based on the vision for water resources management in Western Australia and supporting objectives being developed as part of the

State Water Plan. The South West Water Plan is the first strategic regional water plan to be developed under the new draft Water Policy Framework in recognition of increasing competition for water resources, the impacts of climate change, the importance of the environment, and increasing demand for water services because of population growth in the region.

The Draft State Water Policy Framework has been released for public comment and community workshops were held in key regional centres to gain feedback on the draft vision, objectives and outcomes to guide water management in Western Australia. One of these community meetings was in Bunbury. All members of the South West Water Forum were sent a copy of this framework.

Because the framework was still in a draft stage as this paper was being developed, the objectives in the State Water Plan have changed following public consultation. The South West Water Plan will reflect the final objectives as provided in the State Water Plan. Consequently, the objectives described in this paper may differ from those outlined in future papers.

In late 2006, a discussion paper was released by Government concerning proposed Water Reforms for Western Australia. This paper discussed options to address the broad directions of the Irrigation Review completed in May 2005. The paper also referenced relevant sections of the National Water Initiative.

*This paper on the current state of water resource management in the South West does not pre-empt the Water Reform discussion paper. Relevant discussion on the current state of these matters in the South West is included in the **South West Water Resources – Water Policy Overview** under the objective: “Enhance the Security and Certainty of Water Resources” (page 53). Other relevant sections include Community Involvement (page 10), Integration of Land and Water Planning (page 24), Metering (page 33), Water Use Efficiency (Page 68) and Cost Recovery for Resource Management (page 66).*

About the South West Region

This section outlines the major influences on the South West, including population and people, land use, economic development and the environment.

Population

The population of the South West is approximately 140,000. This represents seven per cent of Western Australia's total population of just over 2,000,000 in 2005. The South West is the most populous and economically diverse regional area. Table 1 shows the population spread by local government and average annual growth rates from 2001-05.

Table 1: Population by local government area

Local Government Area	Population	Average annual growth rate (%)
Bunbury	31,865	1.5
Busselton	27,546	4.4
Harvey	19,669	1.6
Augusta-Margaret River	11,689	3.4
Dardanup	10,424	3.7
Manjimup	9,736	-1.2
Capel	9,568	7.4
Collie	8,829	-0.7
Donnybrook-Balingup	4,782	0.6
Bridgetown-Greenbushes	4,001	-0.7
Boyup Brook	1,501	-1.9
Nannup	1,236	0.4
Total	140,486	

Source: ABS (2005) 3218.0 Regional Population Growth, Australia and New Zealand

Over the same period, six of the local government areas exceeded Western Australia's average growth rate of 1.4 per cent. These were Capel, Busselton, Dardanup, Augusta-Margaret River, Harvey and Bunbury. Capel was the second fastest growing local government area with an average growth rate of over 7.4 per cent. Much of this growth is centred on the beachside development of Dalyellup.

Figure 1 outlines the area covered by the South West Water Plan, including major town centres, local government areas and major rivers. The boundary is based on the South West Regional Development Commission boundary with a northern deviation to include the Harvey-Waroona irrigation districts. This boundary was chosen because it reflects a community of interest in the South West and closely aligns with Department of Water regional boundaries.

It is recognised that there are catchment-wide influences beyond the boundary of this plan (eg the upper Collie and Blackwood catchments) that

can have a significant effect on water issues. Where boundary issues are relevant, they will be discussed. The final South West Water Plan will develop strategies for boundary issues where necessary and ensure compatibility between future water plans in adjacent regions.

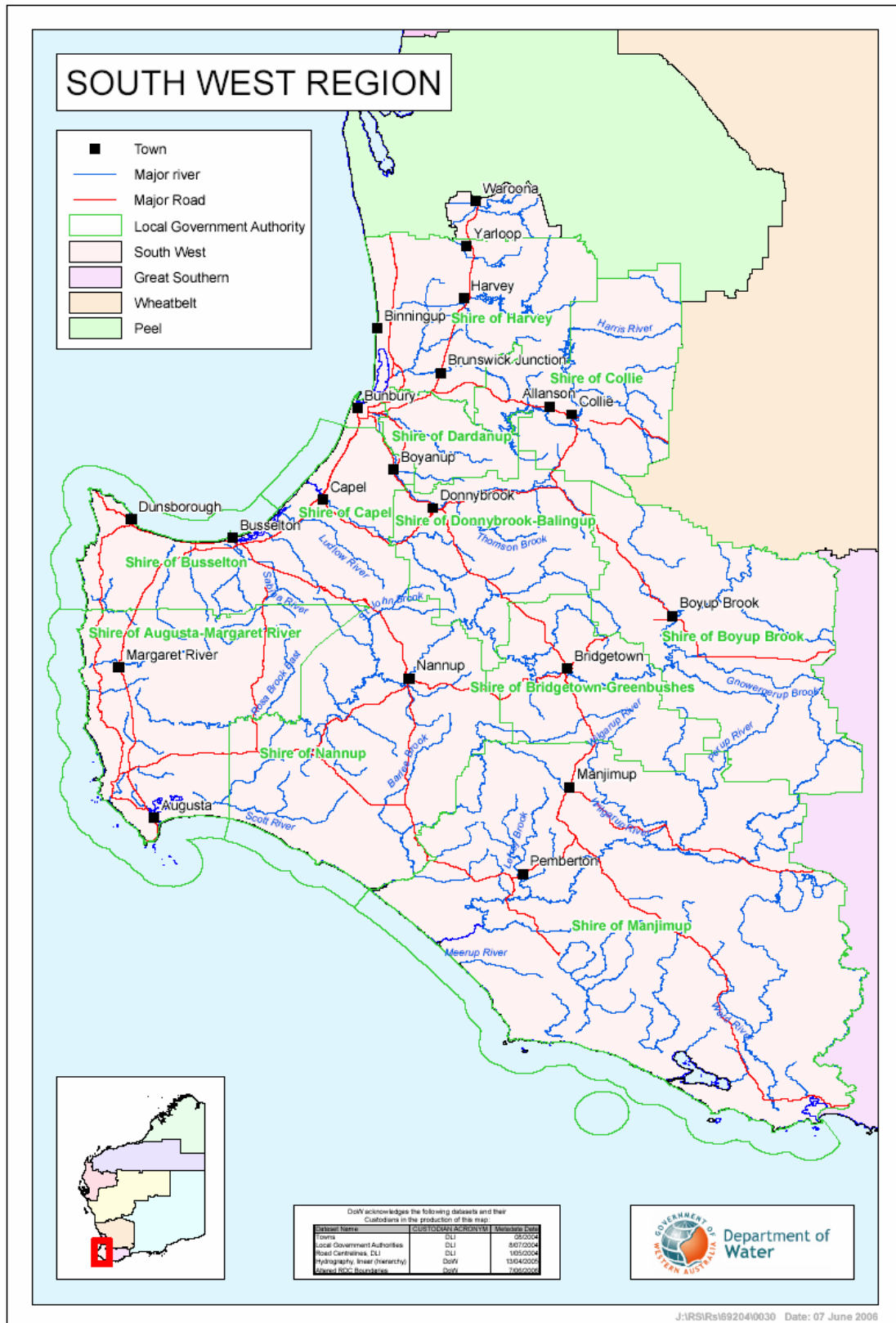


Figure 1: Boundaries of the South West Water Plan

Living in the region

Like most regional areas in Western Australia, the majority of residents live in towns. The *Living in the Regions – The views of western Australians South West Report* completed in 1999 estimated that 79 per cent of residents live in towns and a further 11 per cent live on farms.

This survey also noted that ‘lifestyle’ was stated by 75 per cent of residents as one of the major reasons for moving to the region, compared with 67 per cent state-wide. Respondents to the survey from the South West scored highly (compared to all regions) on issues of their perception of community spirit, satisfaction with community facilities, regard for the environment, the standard of health services and their intention to stay in the region.

Table 2 summarises other demographic information on the residents of the region:

Table 2: Demographic information

	South West	State Average
Australian citizens	910 per 1,000 people	865 per 1,000
Indigenous persons	22 per 1,000 people	35 per 1,000
Median age	36	35
Households with families	46.5%	46.9%
Unemployment rate	5.8%	5.9%

Source: ABS (Census) Basic Community Profile 2001

Land use

The land area of the region is about 24,000 square kilometres. Figure 2 summarises the region’s major land uses.

Almost half of the State’s forests are in the South West. State Forests and National Parks are concentrated on the Blackwood Plateau, together with almost half of the land use in the Augusta-Margaret River Shire. The Department of Environment and Conservation (formerly CALM) is responsible for the management of the forest and other natural resources on public land in this area.

The total freehold land area in the South West is 1,490,000 hectares. The dominant agricultural activities of the Swan coastal plain are dairy, beef, and sheep production, together with horticulture, orchards, and viticulture. On the Scott Coastal plain, drained land is used for large-scale horticulture. Private tree plantations are also found on the coastal plains.

In addition, a narrow zone of clearing that supports horticulture occurs along the Darling Scarp on the eastern edge of the Blackwood Plateau. Narrow fingers of clearing extend from this zone along major river valleys including the Blackwood River.

Land use on the Leeuwin-Naturaliste Ridge consists predominantly of intensive agriculture, particularly viticulture and horticulture. Commercial use centres on tourism and recreational facilities, retail, services, cottage industry, building and construction.

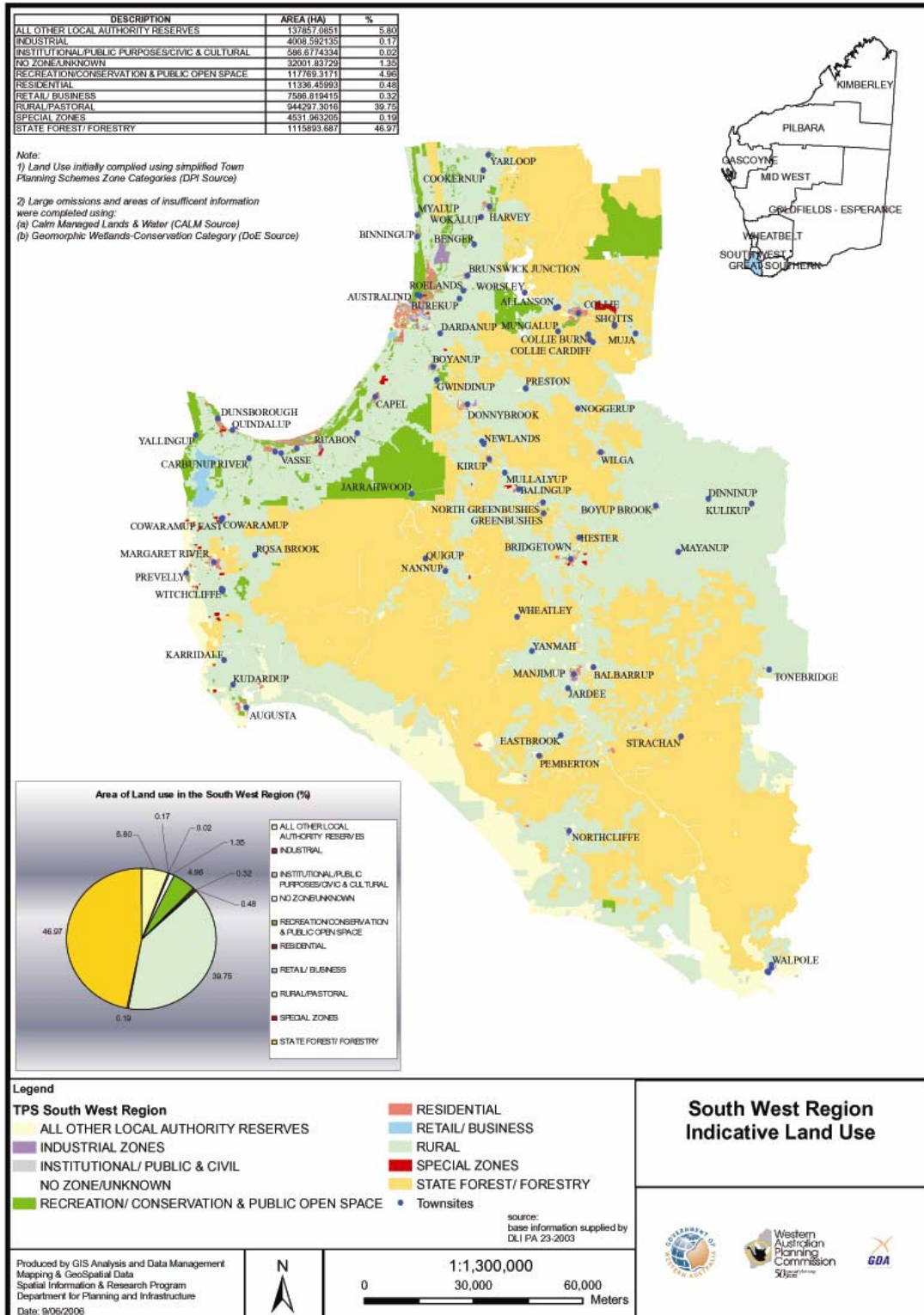


Figure 2: Land Use in the South West Region

Mining also occurs across the region, predominantly of mineral sands in the coastal areas, with bauxite and coal mined inland.

Table 1 shows that over half of the region’s population is resident in coastal areas (including Bunbury, Busselton, Margaret River and Augusta) that are predominantly urban land holdings of less than one hectare.

Economic base

The South West’s regional gross product is estimated at over \$6 billion dollars per year. Unemployment figures for the region generally compare favourably with the State average of 4.1 per cent.

Table 3: Regional Annual Value and Employment

Industries	Annual Value ¹ (\$)	Employment ² (%)
Mineral extraction and processing	\$1,509 million	3.8
Wholesale and retail	\$1,008 million	32.6
Manufacturing	\$851 million	12.4
Agriculture, forestry and fishing	\$627 million	10.8
Tourism	\$588 million	(included in retail)
Construction	\$433 million	8.9
Health and community services		7.9
Education		6.5
Other	Over 1,000 million	17.1
Total	Over \$6,000 million	100%

¹ Source: South West Development Commission, Profile – South West Region (2004)

² Source: South West Economic Perspective (2001 data)

Mineral extraction and processing is the largest industry in the South West in terms of gross regional product. Major mining activities include the extraction of coal in Collie, mineral sands on the coastal plains, silica in the Bunbury area, tantalum, lithium and tin extracted in the Greenbushes area.

Mineral processing is focused on the production of alumina from bauxite, and is the predominant export of the Bunbury Port. Most bauxite mined in the region is from the Shire of Boddington and is processed in Collie. Other processing activities include the manufacture of rutile from ilmenite and titanium dioxide pigment and silicon.

The region’s broad economic base has contributed to the development of a significant manufacturing capacity. Major manufacturing activities include wood and paper products, minerals processing, food and beverage industries, machinery and other light industrial manufacturing.

Over 1.5 million tourists are estimated to visit the region each year. The South West supports a variety of tourism activities based on its natural assets, combined with a high standard of accommodation and hospitality industries.

Tourism continues to be a strong growth industry for the region. Food, wine, fishing, forests, beaches, surfing, whale watching, trekking and cultural heritage are all popular tourist attractions. The majority of tourists are from WA, although international visitor numbers are increasing.

Recreational fishing is regionally important for both residents and visitors. Approximately one-third of all West Australians fish recreationally. While there are no commercial fisheries in the southern inland region (commercial fisheries in the South West are based on marine resources), the freshwater rivers and man-made lakes of the region provide significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced self-perpetuating stock. Black bream are also taken, as are small numbers of freshwater cobbler. Fishing also occurs in estuaries, off coastal beaches and many streams and rivers. Popular species for recreational fishing are salmon, herring, dhufish, whiting, bream, marron, trout, crab and rock lobster.

In the southern inland region, recreational fishing licences are required to fish for marron, as well as native and introduced freshwater finfish species. In 2004-05, around 22,000 licences were issued for these two activities. However, this figure includes a large number of 'umbrella' licences covering all licensed recreational fisheries.

A survey of freshwater fishing for finfish in the South West conducted over the 2002-03 season found that 74.4 per cent of fishing was carried out in rivers and 26.6 per cent in dams. Most river angling occurred in the Collie (31%), Murray (20%), Warren (15%), Donnelly (10%) or Blackwood (10%) river catchments. Most dam fishing was in Big Brook (28%), Logue Brook (19%), Waroona (7%), Harvey and Wellington Dams. The Blackwood River is also particularly popular for marroning.

Fertile soils, relatively high rainfall, and proximity to the markets of Perth support a diverse range of agricultural industries. These include meat (sheep, beef, poultry, deer and goat), dairy (cow and goat), wool, cereals, vegetables, grapes and fruit. The South West is Western Australia's major producer of important agricultural produce including apples, potatoes and onions and supports the majority of the State's dairy cattle.

Viticulture in the region is predominantly wine grapes with some table grapes. The South West produces the majority of all wine grapes in Western Australia and has an international reputation for the production of premium wines. Wineries are mainly in the Margaret River, Pemberton, Blackwood Valley, Geographe and Manjimup districts. This industry also has positive impacts on tourism.

There is a significant level of construction activity, mostly fuelled by population growth and increasing investment in holiday homes. Supporting this diverse economic base is a vibrant financial and personal services sector based in major town centres.

Harvesting of native hardwoods was one of the first major industries in the South West. With the introduction of new forest management policies in 2001 including the reservation of all native old growth forests, hardwood production has declined. In 2001-02, hardwood production in the region was valued at \$45.2 million and represented almost 80 per cent of the State's hardwood production.

Natural resources

Scientifically, the South West region is part of the internationally recognised South West Botanical Province that extends from Shark Bay in the north to Israelite Bay on the south coast. This are in one of only 25 internationally listed biodiversity 'hotspots' in recognition of the region's rich floral diversity.

The region has four bio-regions – that is, areas with similar geology, soils, and vegetation. These are the jarrah forest, mallee, Swan Coastal Plain and the Warren region.

These bio-regions support an immense variety of plant species with approximately 3,500 species having been recorded. An estimated 50 per cent of these are found only in this region. Of these 3,500 species, 71 are Declared Rare Flora and 303 are on the priority list of the Department of Environment and Conservation (formerly CALM), indicating high value flora for protection.

The rich flora supports an equally rich fauna with high diversity. There are approximately 49 species of mammals, 135 species of reptiles and amphibians, and over 330 species of birds in the South West. Land clearing and other threats, such as feral animals, have resulted in the listing of 57 species as threatened and another 71 as priority listing for conservation by the Department of Environment and Conservation.

The conservation of the 13 species of freshwater native fish, including nine species found only in the south-west, is an issue of growing importance. Changes in land use, water quality in catchments and climate change have put further pressure on the naturally restricted fish fauna of the region. The marron catch in particular is heavily influenced by rainfall and there has been a steady decline in catches and catch rates. The Department of Fisheries is working with other agencies and institutions to undertake research on the distribution and life history of native fish species to obtain the information required to protect them.

Importantly, the South West is renowned for its natural beauty and aesthetic values.

The beauty and diversity of natural waterways and estuaries, including the Blackwood and Leschenault estuaries, are essential to the preservation of the appeal of the South West to residents and visitors. These waterscapes are an integral part of people's lifestyles. In particular, the Indigenous people of the South West have an intense and personal connection to the natural environment.

Natural resource management

While there are a number of agencies that undertake natural resource management-based activities in the region, including the Department of Water and the Department of Environment and Conservation, there are also important non-government organisations that contribute significantly to natural resource management (NRM) regionally. The South West Catchments Council (SWCC) is the peak regional organisation that identifies and coordinates strategic opportunities to achieve sustainable NRM in the South West.

SWCC members include community and public agency representatives. Community members are nominated by natural resource management groups in the six South West subregions. These groups are:

- Blackwood Basin Group;
- Cape to Cape Catchments Group;
- Geographe Catchment Council (GeoCatch);
- Leschenault Catchment Council;
- Peel-Harvey Catchment Council;
- Warren Catchments NRM Group; and
- CoastSWaP.

Public agencies represented include the Departments of Environment and Conservation, Water, Agriculture and Food, Planning and Infrastructure; the South West and Peel Development Commissions; and the WA Local Government Association.

The role of the SWCC is

- to provide leadership on NRM matters within the region; and
- to coordinate partnerships between the community and all levels of government to share responsibility for NRM.

The role is carried out by:

- supporting communication and information sharing within the region;
- advocating and brokering support for improved NRM;

- coordinating implementation of State and Commonwealth NRM policies and programs relevant to the SW region; and
- coordinating the development of a targeted, strategic approach to NRM.

The SWCC has a formal Partnership Agreement with the State Government to deliver maximum public benefits from the NRM framework. The agreement with SWCC was the first of its kind in WA (Statement of Agreement and Cooperation SWCC 2000). The SWCC is supported by the Commonwealth Government through the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality to develop and implement regional NRM strategies.

The regional boundaries of the SWCC extend beyond the boundaries of this plan and include the upper catchments of the Collie, Blackwood and Donnelly rivers. This extends their area of work into the Wheatbelt regions of the State. These upper catchments, though beyond the boundaries of this plan, influence water quality, resource availability and ecosystem health within the area.

This plan will consider and highlight any boundary issues that arise from catchment areas that sit outside the plan area.

Water and the South West Region

Some of the overriding influences and factors for consideration in developing a plan for water management in the South West region are climate, governance, natural resource management, economic development and community values.

Climate

The climate of the South West region is temperate with cool, wet winters and hot, dry summers. Rainfall is dominated by the supply of moist air from the Indian and southern oceans and the topography of the region. The highest rainfalls occur in the western Darling Range (annual average about 1,200 mm/yr) and in southern parts about 10 to 20km from the south coast (annual average about 1400 mm/yr). Rainfall declines rapidly further inland, especially in the north of the region, where annual average rainfall becomes less than 700 mm/yr within 70km of the coast.

The region's streamflow and groundwaters are generated from the excess of rainfall over evaporation (and transpiration¹) during the cooler, wetter months of May to October. However, the excess is generally a small component of the water balance, with over 90 per cent of rainfall being lost to evapotranspiration across most of the region.

As a function of the (usually small) difference between rainfall and evapotranspiration, streamflows and groundwater recharge rates are sensitive to minor variations in either rainfall or evapotranspiration. As a consequence, streamflows and groundwater recharge rates are highly variable within and between years and are particularly sensitive to permanent changes in rainfall or evapotranspiration likely under a modified climate. Climate change affects how much rain falls, when it occurs, and where it falls. Temperature and evaporation rates can also change. When overall temperatures rise, or the number of hot days in a season increases, this can result in greater water needs for crops and an increase in evaporation from waterways. These all contribute to changes in groundwater recharge, surface water runoff, and water needs for crops, animals, humans, and vegetation. These factors will affect how much water is available from different sources and the changing needs of society and the environment.

The climate of the South West of Western Australia has experienced significant rainfall and temperature changes over the past 30 years. Winter rainfall has decreased substantially since the mid-1970s with a sharp 15-20 per cent decline overall. In 2004, the Indian Ocean Climate Initiative (IOCI)

¹ Transpiration is the movement of water within a plant and the loss of water as vapour through its leaves. Transpiration usually occurs at rates less than evaporation rates from open surface water. Exceptions are dense forests that have high leaf areas and an abundant source of soil moisture.

noted that the annual rainfall decline is primarily evident through the decrease in autumn and early winter (May-July) rain. Both night-time and day-time temperatures have increased over the past 50 years with the largest increases in winter and autumn temperatures.

The decreased rainfall has led to an approximate 50 per cent reduction of streamflow into the Darling Scarp reservoirs supplying the Integrated Water Supply Scheme (IWSS) Predictions for streamflow decline in other South West catchments vary. The large decrease in runoff, compared to the smaller decrease in rainfall decline, occurs because of a lack of very wet years. Such years normally ‘top up’ moisture banks in the soil and create more run off into surface water systems and recharge into groundwater systems. As a result, rivers and groundwater aquifers can both experience decreases in the volume of water flowing into them.

IOCI has expressed a view that decreased rainfall has occurred because of changes to global atmospheric circulation. Temperature changes are likely to be because of the greenhouse effect and overall global warming trends.

The future climate of the South West will continue to show a natural climate variability of wet and dry periods. In 2002, IOCI noted that the current warming trend, coupled with decreased winter rainfall, would be likely to continue.

Major regional water systems

Table 4 summarises the major ground and surface water systems in the region.

Table 4: Major water systems in the South West

	Management Areas	Includes	Land area	Local Government Areas
Bunbury	Groundwater	Not applicable to groundwater systems		Bunbury
Busselton – Capel	Groundwater			Busselton, Capel
Collie	Groundwater			Collie
Blackwood	Groundwater			Augusta-Margaret River. Nannup
Harvey River Basin	Surface water	Logue Brook Samson Brook Drakes Brook Bancell’s Brook Macknoes Brook Clarke Brook Wellesley Creek	1088km ²	Harvey

Collie River Basin	Surface water	Brunswick River Harris River Bingham River Batalling Creek Camballin Creek Henty Brook Flaherty Brook	3,745km ²	Collie
Preston River Basin	Surface water	Ferguson River Thomson Brook Crooked Brook Lyll Mills Crk Charley Creek Joshua Creek	1,134km ²	Bunbury Donnybrook- Blaingup
Busselton Coast Basin	Surface water	Capel River Ludlow River Abba River Sabina River Margaret River Vasse River	2,650km ²	Capel Busselton Augusta- Margaret River
Donnelly River Basin	Surface water	Barlee Brook Carey Brook Fly Brook	1,725km ²	Manjimup
Blackwood River Basin	Surface water	Rosa Brook Chapman Brook St Johns Brook Balgarpur River Nth Arthur River Arthur River Beaufort River Cobline River Scott River Hardy Inlet Millstream Dumpling Gully Moultons Gully Balingup Brook Tanjannerup Bk	22,520km ²	Bridgetown- Greenbushes Augusta- Margaret River
Warren River Basin	Surface water	Perup River Lefroy Brook Tone River Wilgarup River Dombakup Brook	4,410km ²	Manjimup
Shannon River Basin	Surface Water	Wold River Deep River Shannon River Gardner River Canterbury River Walpole River Buldanina Creek Collier Creek Boorara Creek	3,368km ²	Manjimup

The following section provides more detailed information on these ground and surface water systems.

An overview of groundwater systems

The South West has four declared groundwater management areas. These are the Bunbury, Busselton-Capel, Blackwood, and Collie areas.

Bunbury, Busselton-Capel, and Blackwood Groundwater Management areas

The South West overlies the southern portion of the Perth Basin, which extends from Geraldton to Augusta. Fresh water can be abstracted from the sedimentary formations in the basin from depths of up to two kilometres and these formations represent a major resource for the region. There are limits to abstraction due to the requirements of groundwater-dependent ecosystems and the risk of salt-water intrusion into the freshwater aquifers along the coastal plains. The three proclaimed groundwater management areas in this basin are the Bunbury, Busselton-Capel, and Blackwood.

The Perth Basin is bounded in the east by the Darling Fault and in the west by the Dunsborough Fault. It is subdivided into the Bunbury Trough (that lies between the Darling and Busselton Faults) and the Vasse Shelf (between the Busselton and Dunsborough Faults). The basin contains a number of major regional aquifers with fresh groundwater extending down to a maximum of about 2,000 metres. The Leeuwin Complex lies to the west of the Dunsborough Fault. It is an area of granite rocks between Cape Naturaliste and Cape Leeuwin, in which groundwater resources are limited to the shallow weathered profile and thin overlying sands and limestone.

Systematic groundwater investigation drilling by the Geological Survey (1966 to 1995), and the Water and Rivers Commission (1996) has provided substantial knowledge about the extent of the Southern Perth Basin groundwater resources. In 2003-04, Water Corporation also carried out additional groundwater investigation drilling.

The main aquifers in these areas are the:

- Yarragadee – restricted to the Bunbury Trough;
- Leederville – (the major aquifer for the area) across the Trough and Vasse Shelf; and
- Superficial aquifer (restricted to the Swan and Scott Coastal Plains).

The quality and quantity of water able to be accessed from the superficial aquifer varies between locations. The Leederville and Yarragadee aquifers are the preferred sources for public water supply providers, large-scale irrigators, and industries requiring good quality water. Both the Leederville and Yarragadee are predominantly confined aquifers with limited outcropping. Minor aquifers are also found on the Vasse Shelf adjacent to the Leeuwin Complex and include the:

- Lesueur aquifer;

- Sue Coal Measures; and
- Various isolated fractured rock aquifers.

Collie Groundwater Management Area

The Collie Groundwater Management Area essentially comprises the Collie sedimentary basin, also known as the Collie Basin or the Collie Coal Basin. The Collie Basin contains substantial resources of groundwater that are important for both coal mining and power generation. Groundwater in the basin discharges into the Collie River and its tributaries, maintaining the pools and the associated environment.

Hydrogeological investigations comprising drilling and monitoring of bores in early 1990s by GSWA and later by the Water and Rivers Commission has provided a better understanding of the hydrogeology and groundwater resources of the basin for management of these resources and the associated environment. The Collie Basin, which forms a north-westerly trending valley in the Darling Plateau, has a maximum length of 27km and a maximum width of about 13km. It is surrounded by Archaean granitic rocks of the Yilgarn Craton. The surface area of the basin is about 230km². The basin is bilobate in shape and is filled with Permian and Cretaceous sediments having a maximum thickness of 1,400m.

Groundwater in abstractable quantities in the Collie Basin is mainly contained within the sandstone of the Muja Coal Measures, Premier Coal Measures, Allanson Sandstone, Ewington Coal Measures and Westralia Sandstone of the Collie Group; within the sand and sandstone of the Nakina Formation; and in the surficial sediments. Some groundwater may also occur in the sandstone of the Shotts Formation; however, this is yet to be proven. The net groundwater recharge to the basin from direct infiltration of rainfall is estimated as 19,000 ML/year. In addition, there is 1,000 ML/year of recharge from streams flowing into the basin. The volume of groundwater stored within the basin is about 7,100 GL; however, economics and management policies preclude abstraction at this level.

Groundwater abstraction in the basin has generally exceeded the recharge to the groundwater system. This is due mainly to large quantities of groundwater use for mining and power generation that is covered under the relevant State Agreement Act.

Almost all of the groundwater that is removed (dewatered) for facilitating mining below the watertable, is used by the power stations. The power station use is further supplemented by dedicated groundwater borefields in the Collie Group. More recently, the licensed allocation in the Collie Basin has increased to approximately 67,000 ML/yr due to planned expansion of coal mining activities.

Groundwater in the Collie Basin is generally acidic with pH ranging from 2.6 near the underground and open-cut mines to 6.3 near the southern and south-eastern boundaries of the basin. The acidity of the groundwater is attributed to its contact with sulphide bearing sediments. The groundwater outside the basin has neutral pH. Groundwater salinity is generally less than 500 mg/L total dissolved solids (TDS).

In areas closer to the South Branch in the southern part of Cardiff Sub-basin, where the river level is higher than the watertable, groundwater salinity is between 1,000 mg/L and 2,000 mg/L TDS. Outside the basin, the crystalline rocks and the overlying lateritic weathered profile mainly contain groundwater having salinity of 1,000 mg/L to 17,300 mg/L.

An overview of surface water systems

There are a number of river systems in the South West, as part of the South West Drainage Division. The South West Drainage Division extends from Geraldton to Esperance.

There are several drainage basins within the South West Region. They include the Harvey, Collie, Preston, Busselton Coast, Donnelly, Blackwood, Warren and Shannon River basins. For management purposes, these basins are divided into surface water management areas and sub-areas.

Harvey River Basin

The Harvey River Basin has a total catchment area of 1,088km², the majority of which lies to the north of the plan area. Average rainfall is greater than 1,200 mm/yr over much of the hills portion of the basin, with the upper reaches of the basin having an average rainfall of a high 1,100 mm/yr. Streamflow yields are high, exceeding 250 mm/year in many parts of the basin, especially where forest density is low.

The Harvey River is the main water resource of the basin. The smaller watercourses of Clarke, Logue, Bancell's and Drakes Brooks flow from the Darling Range to the north of the Harvey River, while Wellesley Creek flows from the hills to the south.

Land tenure in the Darling Range is predominantly State Forest or conservation reserve, although some private land extends into the hills in the catchments of Wellesley Creek and the lower parts of the Harvey River catchment. All streamflow is fresh; a reflection of the high rainfall in the basin.

Most of the Harvey Irrigation District (supplied by Harvey Water) is located within the Harvey Basin.

The sustainable yield of the basin has contributions from the main Harvey River (62%), the northern watercourses (~30%) and the watercourses to the

south of the Harvey River (8%). The estimated sustainable yield of 149 GL/yr total is a high 70 per cent of the basin's estimated mean annual flow and reflects the high level of development in the basin. While it is possible to harness more water from the northern streams of the basin, such as Bancell's and Clarke Brooks, these streams are identified as providing important environmental flows to the lower Harvey River and Estuary.

Current use and commitments

The resources are effectively fully developed by storage dams on Drakes, Samson and Logue Brooks and two (Stirling and the new Harvey Dam) on Harvey River; smaller or pipe-head dams on Bancell's, Yalup and Black Tom's and Wokalup Brooks; and additional diversions for other small self-supply use.

Of the licensed diversions, 30 per cent are for public water supply, 63 per cent are to enable the supply of irrigation water to the Waroona and Harvey Irrigation Districts, six per cent is for mineral processing of bauxite at Alcoa's Wagerup Refinery and one per cent is for self-supply use.

Collie River Basin

The Collie River Basin drains 3,745km² of forested, cleared and partly reforested land from the Darling Range just west of Darkan to the coastal plain adjacent to Leschenault Estuary, north of Bunbury.

The sedimentary formations of the Collie Coal fields are located in the centre of the river basin. These have been mined extensively since the 1890s and have provided the main energy source to fire the base-load power stations of the State's South West electricity grid.

The Collie River East Branch rises in cleared farmland with average annual rainfall of ~600 mm/yr, and flows westward through forested parts of the Darling Range, passing the edge of the Collie Coal Basin and the town of Collie (1,000 mm/yr). From the townsite, the river has cut a deep valley through the highest rainfall parts of the basin (1,200 mm/yr) to flow from the Darling Range near Roelands and discharge to the Leschenault Estuary, north of Bunbury. The river is saline in its upper reaches and is progressively diluted by fresher tributaries that drain the higher rainfall and more forested parts of the basin.

The most significant fresh tributary is the Harris River. This drains State Forest and National Park with annual rainfall of 750-1,100 mm/yr and enters from the north, upstream of the Collie townsite. It is regulated by the Harris River Dam (see below), seven kilometres upstream of the confluence with the Collie River. The Collie River is also diluted by the brackish South Branch, which rises in cleared private land (700 mm/yr) to the south, near Boyup Brook. This tributary flows to the north-west through State Forest and the

western edge of the Coal Basin's Cardiff Sub-basin, to join the main river just south of the Collie townsite.

Wellington Dam (catchment area 2,830km²) located about 35km downstream of Collie townsite, can store 185 GL of water and regulates the downstream flow of the Collie River. Built originally in the 1930s to supply the Collie River Irrigation District, the dam was raised to its current height in 1960 to improve the reliability of the irrigation supply and provide a new source of water to supply towns in the Great Southern region in the Great Southern Town Water Supply Scheme (GSTWS).

Concerns were first raised during the 1950s, about the likely increases in salinity of inflow to Wellington Dam, if private land in the catchment were fully cleared. While the Government restricted the release of additional private land in the Wellington catchment (and other potential water supply catchments) in 1961, action to control clearing on land already released in the Wellington Dam catchment was delayed until the mid-1970s. In November 1976, clearing controls were introduced that limited large-scale clearing in salt sensitive parts of the catchment. At the time, 660km² or 23 per cent of the catchment had been cleared and predictions indicated that the salinities of inflow could increase to over 1,700 mg/L TDS if the full 35 per cent of private land were allowed to be cleared. Active reforestation of farmland commenced in the late 1970s and by 1997 a total of 132km² or five per cent of the catchment had been planted to trees, leaving only 510km² or 18 per cent of the catchment as cleared agricultural land.

Analysis of salinity trends in 2000 indicated that the combination of the tree planting program and clearing controls had effectively stabilised the inflow salinities of a median inflow year at levels of about 950 mg/L by 1990.

In recent years of below average inflow, supply salinities from Wellington Reservoir has been about 1,000 to 1,100 mg/L TDS. These levels remain unacceptably high for drinking water purposes and are marginal for irrigation. Additional salinity recovery actions are being investigated, with the potential to allow the Wellington reservoir, the single largest developed water resource in the region, to be used for drinking water purposes.

The fresh Brunswick River drains mainly forested private land in the western high rainfall parts of the Darling Range (1,100 to 1,200 mm/yr), emerging from the hills in cleared farmland to flow across the coastal plain and join the Collie River from the north, six kilometres before the Leschenault Estuary. The fresh Henty Brook drains predominantly undulating cleared land near the Darling Scarp (1,000 to 1,100 mm/yr) to the south, and joins the main river on the coastal plain near Burekup.

The basin's estimated sustainable yield (165 GL/yr) makes provision for current and potential developments on the Collie River (~120 GL/yr), potential

new developments on the Brunswick River (~35 to 40 GL/yr), and current and potential new small storage developments on Henty Brook (~ 5-10 GL/yr).

Current use and commitments

Harris Dam provides 71 GL of storage on Harris River and has a sustainable yield of 17 GL/yr. Currently 15 GL/yr is licensed to be diverted for drinking water purposes (10 GL/yr to the GSTWS and up to five GL/yr for the IWSS).

Wellington Dam, located about 35 kilometres downstream of Collie, provides storage and regulates the downstream flow of the Collie River. Harvey Water holds entitlements to divert water from the Collie River at the Burekup Weir, about 12km downstream, based on releases of 68 GL/yr from the Wellington Reservoir. This is used for irrigation in the Collie River Irrigation District, located on the coastal plain between Bengier in the north and Boyanup in the south. As discussed above, the salinity of this supply is marginal and efforts to improve its quality are continuing.

Further improvements are expected to be centred on diverting brackish and saline flows in the east Branch into temporary storage in mine voids in the Coal Basin and for its subsequent use following treatment, or its diversion from the catchment via existing pipelines. Currently, Wesfarmers Coal is licensed to divert up to 7.2 GL/yr of brackish inflow from the South Branch of the Collie River to fill mine voids in the Cardiff Sub-basin.

The Brunswick River and tributaries of the Collie River below Burekup Weir are also used to supply water for mineral processing, water supply and small-scale irrigated viticulture. Worsley Alumina extracts 2.1 GL/yr from the upper reach of the Brunswick River for mineral processing and Water Corporation diverts 0.56 GL/yr from the middle reach of the Brunswick River for water supply purposes. Small scale diversions also take place from the lower Brunswick catchment and the Henty and Flaharty Brooks, mainly to supply water for irrigated viticulture.

Preston River Basin

The Preston River Basin covers a total area of 1,134km² and drains the western and central portions of the Darling Range. The upper reaches of the Preston River and its major tributary, the Ferguson River, are predominantly forested (State Forest or conservation reserve) and rise in years of 850-900mm rainfall. These rivers flow westward to the coastal plain, through valleys that are extensively cleared, before discharging into the Leschenault estuary.

In the lower reaches, watercourses have been artificially modified to improve drainage from coastal plain areas, exacerbating local sediment and water quality problems. In particular, the Preston River has been extensively modified in the past with areas drained, redirected, straightened, and lined

with levee banks. The river is heavily used for irrigation, particularly in the Donnybrook and Boyanup Shires as part of the Preston Valley Irrigation District, operated by the Preston Valley Irrigation Co-operative (PVIC).

The lower reaches of the Preston River are affected by the tides in Leschenault Inlet, with salinity levels ranging from fresh to brackish depending upon the time of year. The upper reaches and tributaries (Ferguson River and Thompson Brook) have relatively fresh salinities (300-500 mg/L TDS) despite up to 60 per cent of their catchments being cleared. This is likely due to the cleared areas having relatively low levels quantities of stored salts in their soil profiles prior to clearing.

Much of the clearing has occurred in the higher rainfall and side slopes of these catchments, where the depth of weathering is shallow and rainfall is sufficient of avoid major salt accumulation. Moreover, little or no clearing has occurred in areas where annual average rainfall is less than 900 mm/year, where major salt stores have accumulated in other parts of the Darling Ranges.

The Preston River and the main tributaries of the Ferguson River, Thompson River and Joshua Brook, are the main water resources of the basin. As dam sites are limited and generally of poor quality, the sustainable yield is low relative to the mean annual flow. The Preston River can only be developed as a pipehead diversion (~10 to 15 GL/yr) and potential dam sites on the tributaries occur well up in the catchment (potential yields totalling ~35 to 40 GL/yr).

The area is substantially cleared for agriculture, except for the upper reaches where the land tenure is typically State Forest. As most clearing has occurred in areas with rainfalls in excess of 1,000 mm/yr, the resources are classified as fresh. However, Thompson Brook has an average salinity just in the fresh range (<500 mg/L TDS) and salinities at the high end of the marginal range (1,000 mg/L TDS) in drought years

Current use and commitments

Current licensed use supports private irrigation in the Preston, Ferguson and Thompson valleys. Mixed horticulture and apple orchards are the dominant land and water use. Glen Mervyn Dam at the upper end of the Preston Valley is the largest storage and provides water to customers of the PVIC (~1.5 GL/yr).

Lyll Mill Creek public water supply dam and catchment is protected under the *Country Areas Water Supply Act* (the CAWS Act) and has a drinking water source protection plan.

Busselton Coast Basin

The Busselton Coast Basin consists of 26 river and creek systems that discharge along the coast between Bunbury and Augusta. It covers an area of 2,650km².

From Bunbury and Cape Naturaliste, nine short rivers and creeks drain the Whicher Range and/or the Swan Coastal Plain and discharge into Geographe Bay. The more substantial systems are the Capel, Ludlow, Abba, and Sabina Rivers, which have headwaters in the forested Whicher Range. From Cape Naturaliste to Augusta there are 17 minor creeks along the Leeuwin-Naturaliste Ridge, three of which flow into Geographe Bay on the western side of Cape Naturaliste. The main river system to pass through the ridge is the Margaret River, which drains the north-western corner of the forested Blackwood Plateau.

Much of the land on the Swan Coastal Plain has been cleared for agriculture along with drainage systems. These drainage systems have resulted in modification of many creeks and rivers with drainage lines often discharging into previously natural waterways.

More than half of these waterways are used for water supply purposes, with many streams and tributaries dammed for use. Poor water quality restricts the use of many of the modified rivers on the coastal plain area between Capel and Dunsborough. Many of the waterways have become degraded, have marginal to brackish water quality, and are highly modified, with many only being utilised as natural drains for the low lying landscape.

Where water quality is fresh, there are dams and pumps in streams extracting water for irrigation and domestic use.

Riparian and private extractive uses including horticulture, viticulture, stock water, aesthetics, public service and recreation occur on most unproclaimed surface water rivers in the Busselton Coast Basin.

The Margaret River is the only true river system within the Cape to Cape subregion, with an approximate length of 60km and a catchment area of 470km². The majority of the catchment in the upper reaches on the Blackwood Plateau is State Forest and pine plantations. The river supports many endemic fish and crustacean species and feeds swamps and floodplains along its branches.

The middle reaches of the Margaret River drain farmland and provide irrigation water for dairy, pasture, viticulture, horticulture and plantation products. The lower reaches of the river have rural and special rural blocks, with viticulture and horticulture prevalent. The lower reaches have been modified with the construction of weirs to regulate the flow of water. Recent modifications to the banks of the river at each of the weirs include fish

ladders, with more work ongoing to ensure the continuation of fish migration. The Margaret River remains fresh throughout the year with a salinity range between 100-300 mg/L.

The current licensed land use activities using water extracted from the Margaret River and its tributaries are for the irrigation of viticulture, horticulture, dairy, pasture, tourism, plantation production and the supply of domestic water. The predominant land use in the Margaret River catchment is native vegetation within State Forest, National Parks, road reserves, and Crown land reserves.

The Capel River has a catchment size of 653km², and is the largest river in the Geographe Bay catchment. Historically, the Capel River discharged into the Wonnerup Estuary through a series of wetlands (Stirling Wetlands) running parallel to the coastal sand dunes. The river discharge point was modified in 1946 to allow the water to discharge directly into the ocean through a cut. The river has been highly modified with drainage lines, weirs, and levees regulating water flow in drainage channels and the ocean outlet.

The Upper Capel River has salt concentrations within the range of fresh water guidelines, with the highest salt loads occurring in autumn. The Lower Capel River has salt concentrations classified as marginal for most of the year. Flow in the Capel River is lowest in summer when the most pressure on the resource is occurring.

Most of the basin's sustainable yield (over 55%) is expected to be harnessed by small self-supply dam developments distributed across the basin. Two larger potential developments on Margaret River (~40 GL/yr) and Willyabrup Brook (~15 to 20 GL/yr) account for the remaining 45 per cent. Salinities are generally fresh, although streams that drain cleared land containing soils derived from granitic or gneissic rocks where salts have accumulated, have marginal salinities – especially in dry years. Examples include the Capel River and Willyabrup Brook.

Current use and commitments

Current licensed use (3 GL/yr) is for small-scale self-supply purposes (mainly for viticulture) and public water supply (mainly for the town of Margaret River). Estimated self-supply use in the unlicensed areas is estimated to be a further 3.5 GL/yr and would be licensed when these areas are proclaimed. Total commitments are therefore about 6.5 GL/yr.

Donnelly River Basin

The Donnelly River Basin covers 1,725km² of predominantly State Forest or National Park with about 11 per cent being cleared private farmland.

The headwaters of the Donnelly River Basin rise in flat, poorly drained land of the southern Darling Ranges to the north-east of Manjimup with annual average rainfall of 800 mm/year. Most of the basin's clearing occurs in these headwaters and in the catchment of Manjimup Brook, the major tributary in the upper part of the basin. The Donnelly River then flows south and east through an increasingly incised valley of high rainfall karri and jarrah-marri forests to reach the coastal heaths and sand dunes of the D'Entrecasteaux National Park to the west of the Darling Fault. The river discharges to the Southern Ocean where the average annual rainfall is around 1,200 mm/year.

Two main tributaries (Carey and Fly Brooks) rise in higher rainfall (1,400 mm/year) and drain mainly National Park karri forests to join the Donnelly River from the east in its lower reaches. A third major lower tributary (Barlee Brook) rises in 1,150 mm/year rainfall and drains mainly jarrah-marri forest to the north and west of the main river valley and joins upstream of Carey Brook from the west.

While increased salinity is apparent from clearing in the upper parts of the basin, the relatively small amount of clearing and fresh runoff from the high rainfall parts of the basin ensures that main resources of the basin are all fresh. Pockets of clearing also exist on private land in the lower parts of Beedelup, Carey and Fly Brooks. The basin's sustainable yield is based on:

- the potential development of a large storage on the Donnelly River (Dam Site 40) contributing about 67 per cent (over 60 GL/yr) of the basin's sustainable yield;
- provision for self-supply diversions on upstream and downstream tributaries (~ 15 GL/yr);
- possible pipehead development on the lower reach of the Donnelly River; or
- alternative storage development on Barlee Brook (10 to 15 GL/yr).

Current use and commitments

The current licensed allocations are for existing small scale dams providing water for irrigated horticulture and stock (~7 GL/yr in the upper catchment and ~2 GL/yr in the lower tributaries).

Blackwood River Basin

The Blackwood River Basin has a combined catchment area of about 22,520km², and extends from the central parts of the Western Australian Wheatbelt east of Dumbleyung, to the south-west corner of the State, near Augusta.

About 19,500km² or 87 per cent of the total basin drains the Darling Range and inland parts of the Yilgarn Block. However, the upper catchment areas of

the Northern Arthur (996km²) and Coblinine (7,800km²) Rivers only contribute water (and salts) to the Blackwood River infrequently. This occurs when sufficient rains have occurred to generate enough flood runoff to fill and overflow the system of salt lakes that characterise their watercourses.

Annual rainfalls in the upper part of the basin average about 400 mm/yr and increase to around 1,000 mm/yr where the Blackwood discharges from the Darling Range near Nannup. The catchment area is 85 per cent to 90 per cent cleared with the higher rainfall sections containing significant areas of State Forest and conservation reserves in the rainfall areas above 750 mm/year.

While parts of this landscape included naturally occurring salt lakes, Wheatbelt clearing has substantially increased the areas of salt-affected land and greatly increased the export of salts down the river system. The headwater tributaries and upper reaches of the Blackwood River are saline (commonly >3,000mg/L TSS). Average salinities of the Blackwood River at Winnejup (between Boyup Brook and Bridgetown) are 4,300 mg/L TSS, where the main forest parts of the basin commence (average rainfall 700 mm/yr). The river is progressively diluted by fresher tributaries that enter downstream, reaching an average of 2,980 mg/L TSS by Nannup (average rainfall 1,000 mm/yr).

Records from Nannup in the 1940s show that the lower Blackwood River was once fresh (<500 milligrams TDS). Over the years, the river has become progressively more saline as the export of salt from cleared areas in the middle and upper parts of the basin (areas with average rainfalls < 900 mm/yr) has continued to increase.

The remaining 3,000km² (13%) of the Blackwood River Basin drains the Blackwood Plateaux, downstream of the Darling Range. The river flows from Nannup, west across the plateaux, before discharging to the Hardy Inlet and the Southern Ocean, near Augusta. The catchments of the Blackwood River and its tributaries within the Blackwood Plateaux area have average rainfalls in the range of 1,000 to 1,100 mm/yr.

Land tenure is predominantly State Forest or conservation reserves and the vegetation mainly jarrah-marri forest. Significant areas of pine plantations have been established in parts of the Plateaux and some clearing of private land occurs in pockets to the east and west of the area. The tributaries of the Blackwood Plateaux (and particularly the larger ones such as St John's, Rosa and Chapman Brooks) contribute additional fresh water to the Blackwood, further diluting its salinity before it discharges to the Southern Ocean.

At average annual flow rates, the salinity of the river at Hut Pool has been estimated to average about 2,100 mg/L, and reduce further to about 1,800 mg/L TDS by Twinems Bend and the Hardy Inlet. During summer months, when contributions from the upper catchment cease, flow in the lower

Blackwood is sustained by discharge from groundwater, and especially the Yarragadee aquifers in the Blackwood Plateaux area. This is reflected in salinities of the lower Blackwood during the summer when values of less than 1,000 mg/L TDS are observed.

The Blackwood River represents 90 per cent of the basin's mean annual discharge and, at a salinity of 1,800 mg/L TDS, is classified as brackish. The remaining 10 per cent comes from the fresh Scott River, which drains the western Scott Coastal Plain, and flows directly into the Blackwood River estuary from the east, about 10km from the Southern Ocean.

The basin's sustainable yield is a combination of yields from a range of potential developments on the higher rainfall tributaries of the Blackwood and Scott Rivers where salinities are either fresh or marginal. Typical developments could yield between one and 10 GL/yr depending on catchment area, location and whether pipehead or storage dam developments are proposed. Two larger pipehead developments have also been identified, on St John's Brook and Scott River. When combined these contribute about 40 per cent of the basin's sustainable yield.

Current use and commitments

The only proclaimed areas in the basin are the source catchments for the Town Water Supply Schemes of Nannup, Bridgetown-Boyup Brook, Greenbushes-Balingup, Hester and Kirup. The licensed allocations total 1.1 GL/yr. Irrigation and stock water use in non-proclaimed parts the basin is about 12.5 GL/yr.

Warren River Basin

The Warren River Basin drains an area of 4,410km². It extends from cleared farmland about 15 kilometres south of Kojonup, through mixed farming and forested areas to the south-west, and drains to the Southern Ocean near Pemberton.

Rainfall across the basin ranges from 550mm/yr near Kojonup to 1,400 mm/year near the south coast. About 33 per cent of the basin is cleared farmland, most of which is located in the lower rainfall parts of the catchment (< 800 mm/yr), especially in the Tone River catchment, where over 70 per cent of the area is cleared. However, a patchwork of clearing and forested areas occur in many of the tributaries in the higher rainfall parts of the basin. These date from the small land releases made as part of the early soldier-settler schemes following World War I. Examples include Dombakup Brook (1,400 mm/yr) and Lefroy Brook (1,220 mm/yr) where 15 per cent and 30 per cent of their catchments are cleared respectively.

The cleared land supports sheep and cattle grazing and cropping in the drier parts of the basin. Rotations of barley, wheat, lupins and canola are

commonly grown. The remaining area is either State Forest or conservation reserve and managed by the Department of Environment and Conservation (formerly CALM). Vegetation ranges from low density jarrah-marri forest (700 mm/yr rainfall areas) to dense karri forests (in 1,000 to 1,400 mm/year rainfall areas).

The Tone and Perup Rivers drain most of the cleared land where annual rainfall is less than 900 mm/year and have become brackish. The Warren River, like the Blackwood, is diluted by fresher tributaries as it flows through progressively higher rainfall and forested areas of the basin and is of marginal salinity when it discharges to the sea. Despite its level of clearing, Lefroy Brook remains fresh² and makes a major contribution to the dilution of the Warren River in its lower reaches.

The sustainable yield estimated for the 2000 Water Audit was made up of yields from a large storage on the main river upstream of Lefroy Brook at Dam Site 55 (~ 100 GL/yr of marginal salinity), a large storage on Dombakup Brook (Dam site 1.6), a high rainfall tributary south of Pemberton (~30 GL/yr of fresh water), an associated pump-back diversion (Ph18) from the lower Warren (~25 GL/yr of marginal salinity), and small farm dams and town water supply dams developments in the mid and lower parts of the basin (~50 GL/yr of marginal or fresh salinity, depending on their location).

The Warren River's salinity has been increasing since the mid-1960s. Clearing controls were extended to the Warren River catchment in 1978 and, like the Collie River catchment, extensive permanent clearing in areas with rainfall less than 900 mm/yr has subsequently been strictly limited. While the Collie and Denmark catchments have been higher priority for promoting restorative actions to improve salinities since 1978, some non-commercial and significant private commercial plantations have been established in the catchment. Plans are being formulated to promote catchment management strategies more actively to improve the salinity of the Warren River.

Current use and commitments

The current commitments are related to the existing Town Water Supply Scheme for Manjimup and Pemberton, the Pemberton Trout Hatchery and small farm dam developments that provide water for irrigated horticulture and stock in the basin.

Shannon River Basin

The Walpole, Deep, Shannon and Gardner River systems form the Shannon River Basin. The headwaters of the Deep and Shannon Rivers arise near

² The clearing is almost all in areas with average rainfall in excess of 1100 mm/yr. There has been sufficient rainfall to ensure that salts did not accumulate in the deep soils and weathering profiles of the catchment.

Lake Muir and flow south reaching the Nornalup and Broke Inlets respectively before discharging into the Southern Ocean. Rainfall ranges from 800 mm/yr in the headwaters of the Deep River to over 1,400 mm/yr near the coast.

Their catchments are fully forested and lie within the greater Walpole Wilderness Area. All streamflow is fresh. The shorter Walpole River, to the east of the Deep River, rises in 1,200 mm/yr rainfall and discharges to the Walpole Inlet and onto the Nornalup Inlet. While predominantly in the Walpole Wilderness Area, it contains some private land in its lower reaches. The Gardner River and its tributaries drain the western third of the basin, discharging directly into the Southern Ocean due south of Northcliffe. The catchment rises in 1,200 mm/yr rainfall and contains a patchwork of cleared and forested land. As the clearing occurs in areas of high rainfall, stream salinities remain fresh.

The basin's sustainable yield (58.1 GL/yr) is 4.9 GL/yr lower than the 2000 Water Audit estimate. This reduction reflects the loss of a potential pipehead development on the Wold River, a tributary of Deep River, because of the establishment of the new Deep-Ordance (Mt Frankland South) National Park that forms part of the Walpole Wilderness Area. The new National Park, together with the existing Shannon River National Park, means that no developments are now considered possible on the Deep or Shannon Rivers.

The basin's sustainable yield is, therefore, restricted to contributions from small dam developments on private land (~20 GL/yr), pipehead developments on Canterbury and Walpole Rivers, and Buldanina and Collier Creeks (~25 GL/yr), and a storage development on Boorara Creek (10-15 GL/yr).

Current use and commitments

No areas in the basin have been proclaimed, so there are no licensed allocations. Current use is estimated to be about 4.8 GL/yr and consists mainly of water use from private farm dams in the cleared areas of the Gardner River catchment. Armstrong Spring provides a small Town Water Supply to Northcliffe (0.03 GL/yr) and a small pipehead diversion on the Walpole River provides the source for the Walpole Town Water Supply (0.08 GL/yr).

High value waterways and wetlands

The South West has many highly valued waterscapes including waterways, wetlands and estuaries. Many of these are recognised internationally or nationally for their importance and are listed for protection.

The Convention on Wetlands, signed in Ramsar Iran in 1971, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are two Ramsar wetlands in the South West region.

In addition, the Register of the National Estate (RNE) is an inventory of Australia’s natural and cultural heritage places that are worth protecting for the future. The Directory of Important Wetlands in Australia (DIW) is a joint venture between the Commonwealth and States to list and recognise wetlands that meet criteria to be designated of international importance.

Table 5: Listing of internationally and nationally important waterways and wetlands in the South West Region

	RAMSAR	RNE	DIW
Peel -Yalgorup system	✓		
Muir-Unicup Wetlands	✓		
Vasse-Wonnerup system	✓		
Lower reaches of the Blackwood River		✓	
Donnybrook sunklands area		✓	
Blackwood River conservation park		✓	
Milyeannup Nature Reserve'		✓	
St Johns Brook Conservation Park		✓	
Rapids Conservation Park		✓	
Powalalup Nature Reserve		✓	
Broadwater area		✓	
Ludlow-Wonnerup Area		✓	
Whicher Priority Mgt Area		✓	
Minninup Dunes Area		✓	
Brunswick River		✓	
East Brook Area		✓	
Giblett-Hawke area		✓	
Collie River (mouth to 4km upstream)		✓	
D'Entrecasteaux area		✓	
Wellesley River (downstream of Well. Rd)		✓	
Harvey Estuary Nature Reserve		✓	
Scott National Park		✓	
Shannon Area		✓	
Warren National Park		✓	
Benger Swamp			✓
Broke Inlet System			✓
Byenup Lagoon System			✓
Doggerup Creek and Lake System			✓
McCarleys Swamp			✓
Cape Leeuwin system			✓
Gingilup-Jasper Wetland System			✓
Maringup Lake			✓

An overview of water availability and use

The 2000 Land and Water Audit estimated that 57 per cent of the sustainable yield of the South West Drainage Division was allocated and 28 per cent used. These allocation and usage figures for the Division are much higher than the average for the State. This is indicative of population and economic pressures in the metropolitan area and the South West region. Note also that these estimates have not been adjusted for the drier years since 1975.

The CSIRO prepared a *Context Report on South West Water Resources for the Expert Panel Examining Kimberley Water Supply Options* in March 2005. Table 6 summarises the status of groundwater and surface water availability and licensed entitlements. Some estimate is also provided of unlicensed surface water use, though the accuracy of this figure cannot be confirmed. There is very little usage data available from the South West to confirm how much unlicensed use is occurring, or how much of licensed entitlements are actually being used at any given time.

It should be noted that the sustainable yield figures for surface water and groundwater are nominal. They have not been fully proven in terms of the amount of water that may actually be taken from the system, nor do they include any provisions for environmental water.

Table 6: Summary of estimated water availability and allocations

	Surface water ¹ Megalitres per year	Ground water ² Megalitres per year	Total Megalitres per year
Sustainable yield (estimated)	967,490	236,260	1,145,660
Total licensed allocation	292,726	187,376	480,102
Reserves held (groundwater)	0	9,312	9,312
Estimated unlicensed use (surface water)	20,755	0	0
Total effective committed	313,481	196,688	505,369
Additional allocation requests pending	22,249	83,460	105,709
Committed and pending	335,730	280,148	611,078
Percentage of sustainable use committed and pending	35%	>100%	53%
Potential balance for further allocation	631,760	- 43,888	534,582

¹Source: CSIRO Context Report for Kimberley Expert Panel 2005

²Source: Department of Water Allocation Report, April 2006

Note that “Total effective committed” for surface water is the sum of estimated unlicensed use plus total licensed allocation; and for groundwater is the sum of total licensed allocation and reserves held.

It should be noted that two licences of 47,000 ML/yr have been issued to coal mining companies for dewatering purposes in the Collie Groundwater Area. This accounts in part for the total over-extraction of groundwater.

An overview of water allocation and use by major sector

Water ‘allocation’ is the amount of water that water allocation licence holders are legally able to take on an annual basis. Water ‘use’ is the amount actually used by licence holders and may be lower, or higher, than the allocation.

In 2006, the majority of water allocated to water allocation licensees in the South West was to the agricultural sector, with mining and public water supply use to households being 16 per cent and 15 per cent respectively.

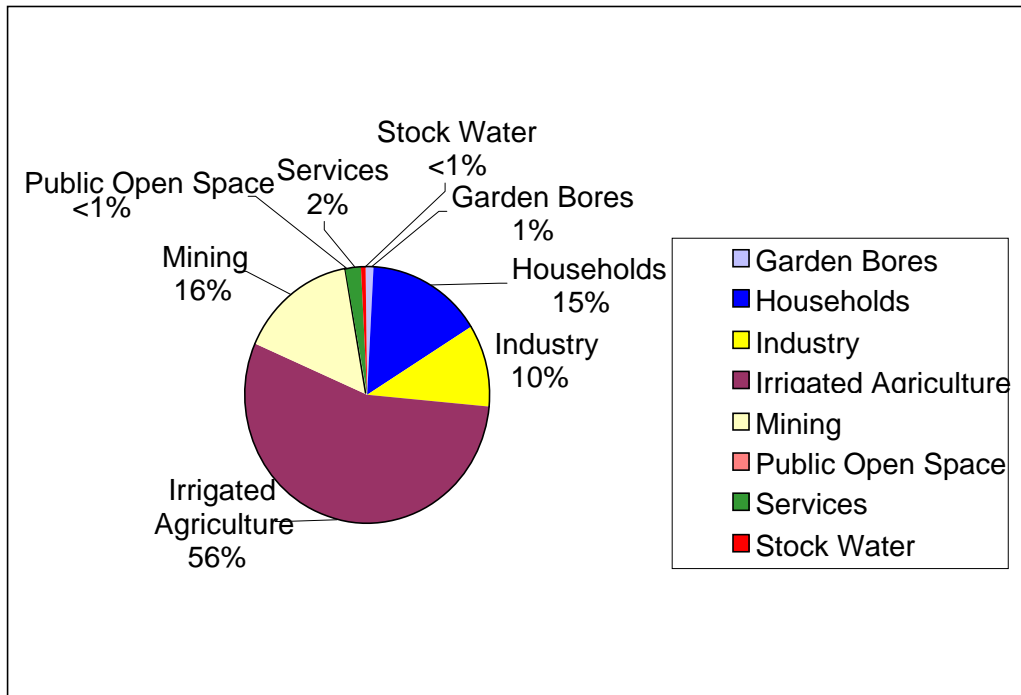


Figure 3: Total Entitlements by Sector (2006)

An analysis has been completed to review the estimated use of water, by sector. Figure 4 was derived from the National Land & Water Audit estimates (2000) and updating to 2006.

The sectoral breakdown for water use indicates different proportions of actual water use from licensed water allocations. Agriculture (66 per cent) and mining (18%) use a greater percentage of water, and household use falls dramatically from 15 per cent of licensed entitlements to an estimated four per cent of actual use.

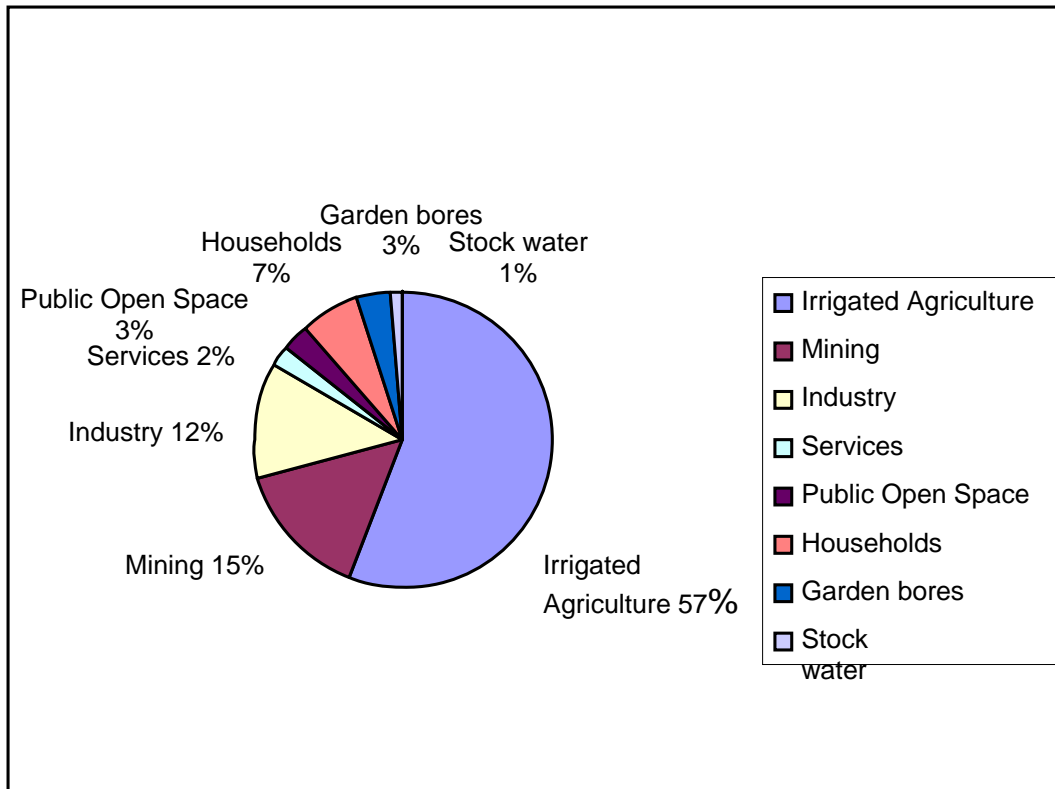


Figure 4: Estimated Water Use by Sector (2006)

Governance

A Water Resources portfolio was created in 2005, recognising the strategic importance of water to Western Australia and the need to provide direction across the breadth of water matters. The Hon John Kobelke MLA is the Minister for Water Resources and has responsibility for the Department of Water (“DoW”), the Busselton Water Board, Aqwest (Bunbury Water Board), and Water Corporation.

Prices for customers of the Water Boards and the Water Corporation are set by the Minister for Water Resources, in Cabinet.

Department of Water

The Department of Water (incorporating the Water and Rivers Commission) is responsible for the investigation, licensing, management and planning of water resources across Western Australia. It provides these functions through powers delegated under several Acts including the *Rights in Water and Irrigation 1914* (the “RiWI Act”).

In order to manage a water resource actively, the surface or groundwater system must be proclaimed under the RiWI Act. Under this Act, the right to flow, control and use groundwater is reserved in the Crown. The Act requires the compulsory licensing of the taking and use of groundwater in the South West region. Surface water resources are proclaimed on a needs basis.

The Bunbury office of the Department supports water management through regional administration and strategic management. Programs for the region, delivered out of the Bunbury office, include:

- Water allocation licensing and management;
- Drinking water source and catchment water quality protection;
- Land use planning;
- Environmental water provision management;
- Operation of the hydrometric network collecting information on surface water, groundwater and meteorological information;
- Flood warning and response; and
- Agency land management.

There are also two district offices located in Busselton and Manjimup.

All water policy matters will be the sole responsibility of the Department to provide advice and support to the Minister for Water Resources, effective 1 July 2006.

Service provision

Water Boards and Water Corporation

The Busselton Water Board, Aqwest, and Water Corporation are wholly government-owned water service providers. The Water Boards are governed by the *Water Boards Act 1904* and Water Corporation by the *Water Corporation Act 1995*.

The Water Boards are overseen by a Board of Directors appointed by the Governor in Executive Council, through an appointment process coordinated by the Department of Water.

A Board of Directors appointed by the Minister for Water Resources oversees Water Corporation. The Corporation has a five-year Strategic Development Plan, reviewed each year and a Statement of Corporate Intent covering 12 months. The Statement of Corporate Intent is a public document in the form of an agreement with the Minister for Water Resources. It contains an outline of the Corporation's objectives and performance targets for the year.

Irrigation Cooperatives

There are two irrigation cooperatives in the South West. One is Harvey Water (formerly known as the South West Management Irrigation Cooperative) operational in the Harvey Irrigation district that extends from Waroona to Collie and the Preston Valley Irrigation Co-operative (PVIC) operational in the Donnybrook Shire.

These irrigation cooperatives were devolved to private ownership in 1996 and 1998 respectively from the State Government. Harvey Water and PVIC are licensed by the Economic Regulation Authority (ERA) to provide irrigation water services to members of the cooperatives.

Other service providers

There are no local government or private licensed potable water or sewerage service providers in the South West. Non-potable services are provided by a range of service providers, including local government.

Regulatory environment

There is a complex regulatory environment overseeing water resource management and service delivery in Western Australia.

The Department of Health (DoH) regulates drinking water quality and administers the Australian Drinking Water Guidelines. The DoH, together with the Department of Environment and Conservation (DEC) are also responsible for licensing the use of recycled water on public areas (eg irrigating recreational parks) and for the application of biosolids to land for agricultural or other purposes.

The Economic Regulation Authority (ERA) may review water-pricing principles, levels and tariff structures from time to time, on referral from the Treasurer. These findings are not binding on government. The ERA also issues an Operating Licence to all service providers outlining the area where services are permitted and licence conditions, including customer service requirements. The ERA reports to the Minister for Water Resources on compliance with these operating licences.

The Environmental Protection Authority (EPA) assesses the environmental impact of significant project proposals and provides independent advice to the State Government.

Unless specifically exempted by legislation, the sector is also subject to Native Title, land planning, and other regulatory safeguards.

Community values for water use

In 2003, the CSIRO Australian Research Centre for Water in Society (ARCWIS) undertook a study to identify the social values associated with the groundwater resources of the South West region and their use. This study was commissioned as a part of a series of investigations undertaken for the South West Yarragadee residents from the City of Bunbury; regional townships (Busselton, Dunsborough, Margaret River, Augusta and Nannup) and associated rural areas were included in the study.

One component of the study involved a survey of South West residents about the general importance of 35 different uses for groundwater, without reference to where the water might be used, such as in the South West or Perth. The uses were then sorted into three importance categories named primary, secondary and least important. The groundwater uses of primary importance to the community are, in order:

1. Household water use for towns in the Blackwood area.
2. Irrigation of fruit and vegetables.
3. Household and stock use in rural properties.
4. Wetlands including Lake Jasper.
5. Future environmental needs.
6. Blackwood River.
7. Wild animals and birds.
8. Future population growth of regional towns.
9. Natural vegetation.
10. Conservation forests.
11. Pastures.
12. Household use in Busselton and Dunsborough.
13. Household and stock use in special rural properties.
14. Future needs of existing industry.

The ARCWIS study also surveyed community attitudes towards water allocation decisions. They found that there was strong agreement on the need for:

- Extensive community involvement in water allocation;
- Long term sustainable management over short term gains; and
- Efficient water use.

A significant community value not explored in the ARCWIS report is the importance of recreational water bodies, including dams, in the South West. Community consultation is now being undertaken on this matter, in the context of management decisions regarding the usage of Logue Brook Dam.

In addition, multi-criteria analysis is being undertaken as part of the water management plan for the Bunbury-Capel, Blackwood and Busselton groundwater areas.