



Department of Water  
Government of Western Australia

# Social water requirements for the Blackwood groundwater area

Department of Water

Environmental Water Report series

Report no. 2

February 2007

## Acknowledgments

The author would like to acknowledge the time and effort of all stakeholders that contributed to this study.

Thanks to Jo Ann Beckwith of Beckwith Environmental Planning Pty Ltd and staff from the Department of Water for their guidance and reviewing the report.

### **Department of Water**

Level 4, 168 St Georges Terrace  
Perth Western Australia 6000

<[www.water.wa.gov.au](http://www.water.wa.gov.au)>

Telephone +61-8-6364 7600

Facsimile +61-8-6364 7601

For more information about this report, contact,

A. Goodreid

Environmental Officer

Environmental Water Planning Section

February 2007

ISSN 1833-6582

# Contents

Contents .....	iii
Summary .....	v
1 Introduction.....	1
1.1 Background.....	1
1.2 Aims of the study.....	3
2 Methodology.....	4
2.1 Background.....	4
2.2 Methodology .....	4
2.3 Study limitations .....	5
2.4 Study area.....	6
3 Key sites and features.....	11
3.1 Blackwood River National Park.....	12
Ecological Values .....	12
Cultural Values .....	13
Social Values.....	13
Scientific, research and educational use .....	14
3.2 Proposed St John Brook and Jarrahwood Conservation Parks .....	14
Ecological Values .....	15
Cultural values.....	15
Social values .....	16
Scientific, research and educational use .....	16
3.3 D’Entrecasteaux National Park .....	16
Ecological values.....	16
Cultural values.....	17
Social values .....	17
Scientific, research and educational use .....	18
4 Social use.....	20
4.1 Outdoor education.....	20
4.2 Commercial tourism .....	21
4.3 Recreational fishing.....	24
Marroning 24	
Freshwater Angling.....	24
Social water requirements for recreational fishing .....	25
5 Determination of social water requirements .....	26
6 Conclusion.....	32
Appendices.....	35
Glossary .....	39
References .....	41

## Appendices

Appendix A — Stakeholders contacted in this study .....	35
---	----

Appendix B — Physiography of the study area .....	36
Appendix C — Description of ecological water requirements referred to in this study .....	37

## Figures

Figure 1: The South West groundwater management areas, highlighting the Blackwood Groundwater Area .....	8
Figure 2: Study area highlighting the Blackwood River National Park, D'Entrecasteaux National Park, proposed St John Brook and Jarrahwood Conservation Parks and Department of Environment and Conservation recreation sites. ....	9
Figure 3: Part of the study area illustrating the Blackwood River from Darradup to Hut Pool. ....	10

## Tables

Table 1: Social attributes and use of key sites.....	19
Table 2: Use of the Blackwood River by school groups and commercial tour operators. ....	23
Table 3: Social values and stakeholder views on social water requirements for those values. ....	30
Table 4: Summary of the social water requirements in the study area. ....	31

## Summary

The Department of Water (the Department) is currently developing a Regional Groundwater Allocation Plan for the South West groundwater areas<sup>1</sup>. Concurrent with this work is the Department's assessment of Water Corporation's application to abstract 45 GL/yr from the South West Yarragadee Aquifer. The groundwater allocation plan is necessary to give context to Water Corporation's licence assessment and to guide development of the South West's groundwater resources.

As part of the allocation planning and licence assessment work, the Department is gathering information on the in situ social values and social water requirements of the study area. Social water requirements are considered in the analysis of various groundwater allocation options, the outcome of which is establishment of an environmental water provision and an allocation limit in the allocation plan.

The focus of this study was the Blackwood groundwater area, which contains the Blackwood River and the Scott coastal plain. These sites have high ecological and social value and have the potential to be impacted as a result of increasing the groundwater abstraction from the South West Yarragadee Aquifer.

As part of this study, major stakeholders and recreational groups were contacted and information was gathered on locations regarded to have high social value, and important elements of the water regime they believed were required to maintain those values.

A substantial proportion of the study area is managed by the Department of Environment and Conservation (formerly Department of Conservation and Land Management, CALM), notably National Parks and State Forest. These parks are the Blackwood River National Park, the D'Entrecasteaux National Park and the proposed St John Brook and Jarrahwood Conservation Parks. These parks are important recreation and tourism locations in the South West.

Located within parks are areas of high use and therefore high social value including, Sues Bridge to Hut Pool on the Blackwood River, Barrabup and Workmans Pools on St John Brook and Lake Jasper.

In broad terms, the following in situ social values of the area were highlighted by the respondents as being most important:

- A sense of wilderness and enjoying nature;
- Summer water quality;
- Summer flow and pool permanence;
- Blackwood River canoeing and kayaking environment: able to be paddled in summer, winding river, novice grade rapids and sense of wilderness; and
- Ecology of the waterways, including the presence of fish species caught by recreational fishers.

---

<sup>1</sup> See Appendix 1 Groundwater areas

More specifically, the results showed that the Blackwood River downstream of Nannup is an iconic outdoor education site. The importance of the river is highlighted by the large number of high school students that use this portion of the river for outdoor education activities, such as canoeing, nature walks and camping.

The same part of the Blackwood River also sustains some of the most active recreational marron fishing compared to that in any other river in the State.

Groundwater baseflow is the primary source of summer flows and is therefore critical for the ecology and recreational use of the Blackwood River downstream of Nannup over the summer period.

The social water requirements that were identified as a result of this study were based on the values above. In most cases, the people interviewed gave qualitative responses to describe the water regime that would be required to protect the social values regarded to be of importance.

These responses were linked to ecological water requirements, which are criteria to protect ecological values, to represent the social values. The ecological water requirements used to define social water requirements generally represent protection of summer flows and water quality and maintenance of aquatic and riverine ecosystems.

# 1 Introduction

## 1.1 Background

In 2003, Water Corporation applied for a groundwater licence to take 45 GL/yr from the Yarragadee Aquifer in the South West region.

While it is proposed that the water be taken from the Busselton-Capel groundwater area, the planned abstraction is also likely to affect the water resources, dependent ecosystems and social values in the Blackwood and Bunbury groundwater areas (Figure 1).

At the time, no groundwater management plan existed for the Blackwood groundwater area, and the management plans for the Bunbury and Busselton-Capel groundwater areas contained insufficient information to assess such a large licence adequately.

As the 45 GL/yr request was a significant portion of the likely sustainable yield of the aquifer, a decision could not be made on the licence without considering the future water requirements of the region.

A substantial groundwater investigation and drilling program began and other broad scale social, economic and environmental studies were started to assist in revising the existing allocation limits.

As part of this allocation planning and licence assessment work, the Department is gathering information on the in situ social values and assessing how these values may be impacted by groundwater abstraction from Water Corporation's proposal and groundwater abstraction in general.

In 2003, in response to Water Corporation's proposal, the Department engaged CSIRO's Australian Research Centre for Water in Society to identify social values and views of residents from the South West Region and Perth regarding the water resources of the Blackwood groundwater area. This was undertaken by a telephone survey of 414 people in May 2003.

The CSIRO (2003) study found that South West residents regarded the natural environment as having the greatest importance for groundwater use. The community also held strong intrinsic values for both the environment generally and groundwater specifically. These are the values derived simply from the knowledge that a natural resource exists and is maintained (CSIRO 2003).

The CSIRO (2003) study was a broad assessment of the social values associated with the water resources of the Blackwood groundwater area. This study adds to the

CSIRO work by looking in greater detail at the in situ social values of water-dependent ecosystems and the water requirements to sustain these values.

In situ social values are the non-consumptive values of groundwater and surface water resources. They are referred to as 'in situ' values because they refer to water found in its natural position or place (CSIRO 2003; Beckwith Environmental Planning 2006).

The value placed on a river pool for swimming and recreating by members of the public is an example of an 'in situ' social value. By contrast, consumptive social values and use include such things as the use of groundwater for irrigation or drinking water and are accounted for in the 'economic values' of the water allocation planning process.

When undertaking water allocation planning, the Department undertakes to define areas that have high social values related to their association with water. These areas may be readily identified; for example, a wetland or a river. Alternatively, the association may be less obvious; for example, a popular area of forest in a National Park the health of which depends on the level of the groundwater table beneath it.

In situ social values are identified through stakeholder consultation. Once the values have been identified, the Department then determines water regime criteria to sustain these values. For example, the social value to swim at a popular river pool may be supported by a criterion that sets a minimum water level in that pool to allow people to swim there. Such a criterion is known as a 'Social Water Requirement'.

Social water requirements are considered in the analysis of various groundwater allocation options, the outcome of which is establishment of an Environmental Water Provision (EWP) and an allocation limit in the allocation plan. The environmental water provision comprises a set of water regime criteria that support both social and ecological water requirements.

In the context of this study it is also important to understand what 'Ecological Water Requirements' are because there are instances where they have been used as a surrogate for social water requirements.

Ecological water requirements are scientifically determined hydrological regimes such as river flows, groundwater levels and lake water levels needed to maintain ecological values at a low level of risk. These values may include; biodiversity (eg fish, plant species), ecological processes (eg migration and breeding), habitat (eg riffle zones and riparian vegetation) and channel characteristics (eg rapids, pools).

Using ecological water requirements to describe some social water requirements has been adopted in this study.

This has occurred in instances where it was difficult for stakeholders to recognise the water regimes and requirements to sustain particular social values. For example,

defining the water requirements to sustain the social value of catching a fish in a river is inherently difficult because the ability of the fish to survive and breed is dependent on a host of variables that relate to the health and functioning of the river ecosystem. In this example it is obvious that a reference to a scientifically supported process is required and illustrates how ecological water requirements work can help to define the water regimes to support some social values.

In developing a better understanding of the social values and their water requirements in the Blackwood Groundwater, this study considers:

- Recreational and tourist pursuits; for example, day use and camping, swimming, paddle sports, recreational fishing;
- Landscape and aesthetic values; for example, sense of wilderness, observing nature;
- Educational and scientific values; and
- Aboriginal and other Australian heritage.

## 1.2 Aims of the study

The following aims were used to frame the questions applied in the interviews and in the review of data.

- Identify the social use of the water resource and the major users of the resource;
- By way of consultation with major users and key groups, identify and quantify the significant social values of the study area;
- Specifically, identify the key sites of high social value;
- Determine seasonal patterns of use for key sites identified by users;
- Quantify the usage of these sites; and
- Determine the social water requirements for the key sites based on descriptions of social values.

## 2 Methodology

### 2.1 Background

Previous work on social values for water resources in the Blackwood groundwater area by CSIRO (2003) sought general community participation via a random telephone survey (382 interviews) and direct contact with 32 key stakeholders. The study canvassed a relatively even number of people from the South West region and Perth.

The aims of the CSIRO (2003) study were to identify the social values associated with water resources of the Blackwood groundwater area and assess how these values may be affected by Water Corporation's proposal to pump 45 GL/yr from the Yarragadee Aquifer.

It is important to note that the CSIRO (2003) study was quite broad in its approach and considered both the in situ and consumptive use social values. In addition, a key aim of the study was to examine the attitudes of people towards the proposal, particularly the issue of removing water from the South West for consumptive use in Perth.

This study adds to the CSIRO (2003) work by looking in greater detail at the in situ social values of water-dependent ecosystems in the Blackwood groundwater area. In defining social water requirements criteria for these social values it also marks an important component of the work required to establish an environmental water provision and an allocation limit in the water resources management plan.

### 2.2 Methodology

By contrast with the CSIRO (2003) study, this research sought only to contact key stakeholders and only to gain information about the in situ social values and the water requirements to sustain these values.

This approach was selected partly due to the time frame, but also specifically to target key social users of the water resources. Consequently, a broad scale phone survey, such as that used in the CSIRO (2003) study was not adopted. Other methodologies such as a large scale mail out of surveys or public consultation forums were also not undertaken.

The CSIRO (2003) study highlighted the regional community's view that the greatest importance for groundwater use is the natural environment. This is an important finding; however, the rationale for this study was to gain input from people that were very familiar with the water-dependent features in the study area to focus on the water requirements to sustain these social values.

An example of this approach was the objective to identify members of the paddling (eg canoeing; kayaking) community who had many years experience on the Blackwood River. The knowledge of these people was considered essential to identify flow requirements and stretches where lower water levels may affect the ability of all users to paddle the river.

In total, 36 stakeholders contributed to this study. In most cases, face-to-face interviews were conducted, while other cases involved a phone interview or email response. Interviews were conducted between July and September 2005.

During the interviews, stakeholders were asked about their use of the study area, including frequency of use, the activities they conducted, perspectives on the in situ social values of the area, and specific details about the water regimes and water requirements to maintain those values.

Key stakeholders (Appendix 1) included state agencies and local governments, commercial tour operators, recreational sporting bodies and individuals. As the majority of the study area is located in Department of Environment and Conservation managed State Forests and National Parks, that Department was a key source of information on the number of visitors (visitations), recreational activities and licensed commercial tour operators.

Employees from the Department of Environment and Conservation contacted in this study included regional and district managers, national park rangers, nature conservation officers and parks and visitor services officers. Recreational sporting bodies included Recfishwest, the State's primary recreational fishing body, Canoeing Western Australia and the South West Canoe Club.

## 2.3 Study limitations

A limitation of this study is that, in targeting specific users, broader community consultation on specific in situ social values was not undertaken.

The methodology adopted in this study meant that some key stakeholders may have missed the opportunity to have input to this process. However, a deliberate aim of this study was to contact those organisations who were essentially representatives of the broader community. Organisations such as the Department of Environment and Conservation, Recfishwest, Canoeing Western Australia, local governments and commercial tour operators have a strong understanding, and indeed a charter, to protect the values of their stakeholders. For example, a commercial tour operator running canoeing and camping expeditions on the Blackwood River would have intimate knowledge of the environmental factors valued by customers participating in their tours.

It is assumed therefore, that for this study these views and this knowledge is in fact representative of the much broader community. For example, if this study failed to capture the input of a paddling enthusiast that visited the Blackwood River only once every few years it is not unreasonable to assume that this person's values were also captured by one of these 'representative' groups.

## 2.4 Study area

The study area is contained within the Department of Water's Blackwood groundwater area, an administrative boundary for management purposes, in the South West of Western Australia (Figure 1). Within the management area, two key physiographic regions were considered; the southern Blackwood Plateau and the Scott coastal plain<sup>2</sup>.

These regions, regarded as having high ecological and social values, may be affected by groundwater abstraction from Southern Perth Basin Aquifers<sup>3</sup>, particularly the South West Yarragadee Aquifer. More specifically, they include the areas most likely to be affected by pumping, by both local users and Water Corporation's proposal, as they coincide with the locality where the Yarragadee Aquifer is not confined by the Leederville Aquifer.

The Leederville Aquifer is generally comprised of clays and shales and therefore limits the impacts that drawdown of water levels in the Yarragadee Aquifer may cause. Where the Yarragadee Aquifer is not overlain by the Leederville Aquifer, generally speaking, there is greater potential for drawdown in the water table, which may directly support the ecosystems above it. Within the Blackwood groundwater area these areas occur around the Blackwood River in the Darradup area (see Figure 3).

On the eastern Scott coastal plain the Yarragadee Aquifer is mostly overlain by the Leederville Aquifer. However, this area is subject to both local groundwater pumping and potential combined affects of Water Corporation's proposal.

The Donnelly River and the area east of the river was not included in this study because modelling of the groundwater system indicated that there was unlikely to be impacts from pumping (Varma 2006).

---

<sup>2</sup> See Appendix C for figure of the physiography of the study area.

<sup>3</sup> The Southern Perth Basin refers to the southern part of a deep sedimentary basin (the Perth Basin) that lies between the Darling Range and the Leeuwin-Naturalist Ridge. The Perth Basin extends from just south of Geraldton to the Southern Ocean. The Southern Perth Basin is the portion between Geographe Bay and the Southern Ocean. The basin is made up of layers of rock formations, which have been formed over geological timescales. The formations consist of a wide variety of rock types including sand, gravel, sandstone, clay and coal seams. The Yarragadee Aquifer is one of these formations (Water Corporation 2005).

This study concentrated on sites within these hydrogeological areas that were also considered to have high in situ social values. These included the Blackwood River National Park, D'Entrecasteaux National Park and the proposed St John Brook and Jarrahwood Conservation Parks (which are currently vested as State Forest) (Figure 2). Within these areas, specific sites of focus included the Blackwood River between Darradup and Hut Pool (Figure 3), Lake Jasper on the Scott coastal plain and Workmans and Barrabup Pools on St John Brook.

Within the Blackwood River study area, private land holdings also surround parts of the river. These holdings are located between Darradup and downstream to the confluence with Poison Gully (Figure 2).



Figure 1: The South West groundwater management areas, highlighting the Blackwood Groundwater Area.

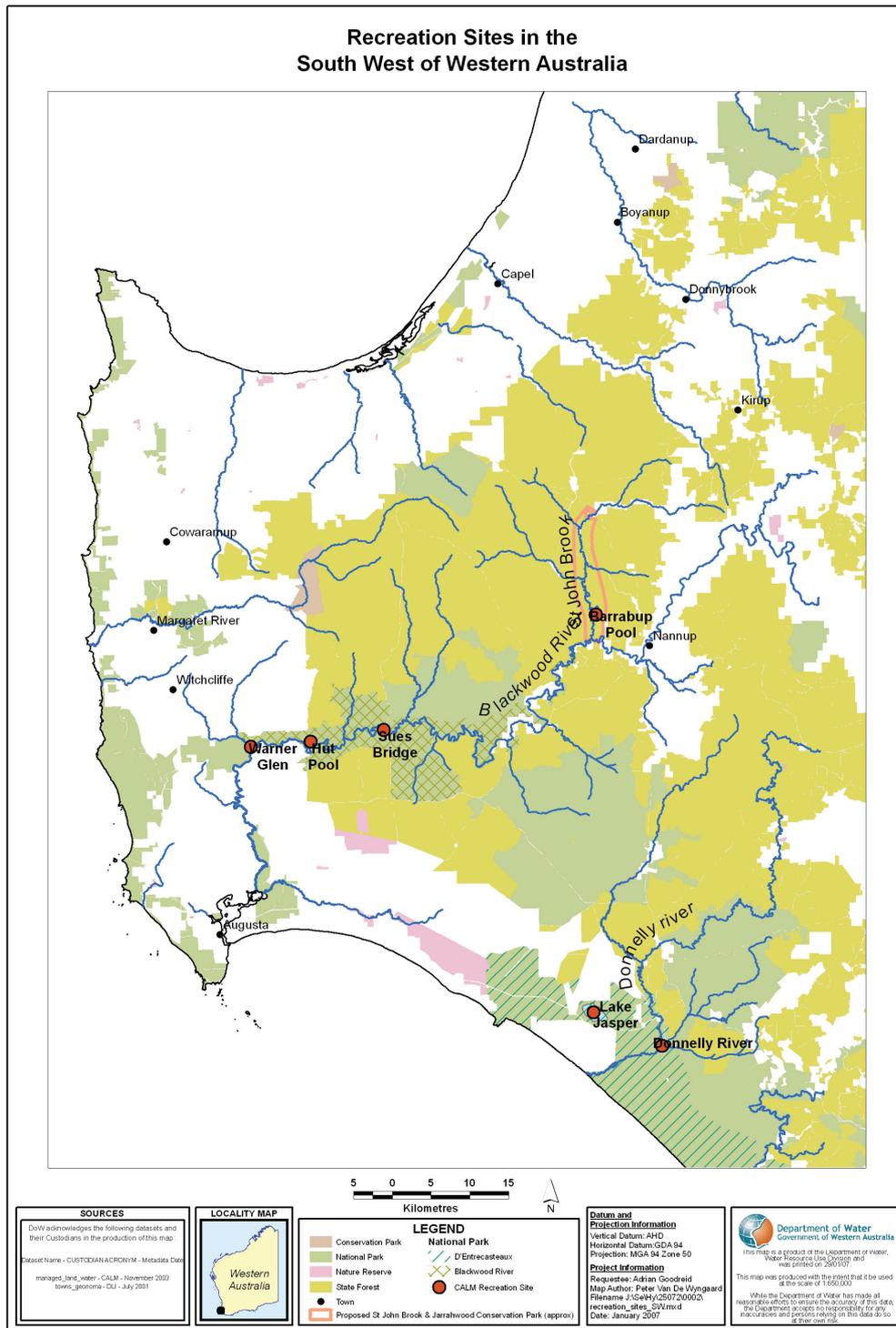


Figure 2: Study area highlighting the Blackwood River National Park, D'Entrecasteaux National Park, proposed St John Brook and Jarrahwood Conservation Parks and Department of Environment and Conservation recreation sites.

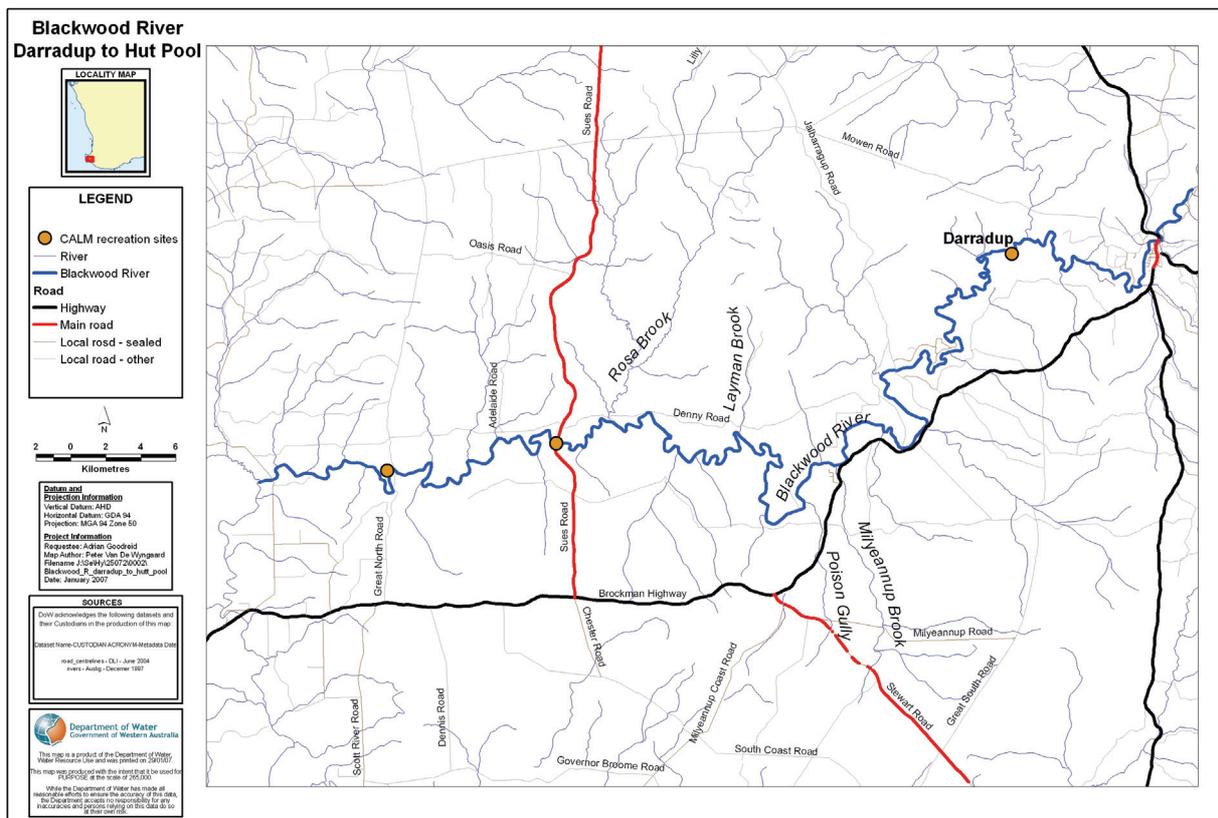


Figure 3: Part of the study area illustrating the Blackwood River from Darradup to Hut Pool.

### 3 Key sites and features

The following section discusses the key sites and their associated features for the study area. National Parks and multiple-use State forest comprise the key accessible recreational areas within the study area. The key parks identified are the:

- Blackwood River National Park;
- Proposed St John Brook and Jarrahwood conservation parks (for the main part this is currently contained within the Cambray State Forest); and
- D'Entrecasteaux National Park.

These areas are managed by the Department of Environment and Conservation for conservation values and as a recreational resource.

The conservation values of the parks are a function of their large area and wide diversity of wetland, woodland and forest ecosystems. The parks provide large intact fauna habitats, and protect restricted vegetation communities and rare and priority flora and fauna within the South West (CALM 2004; 2005b).

The parks also provide a valuable recreational and tourism resource developed around the Blackwood River and other waterways for local residents, domestic tourists and international visitors (Commonwealth of Australia & the State of Western Australia 1998).

Sites and natural features for the parks were assessed to determine the level of in situ social value. Those sites and features with a 'high' in situ social value have most, but not necessarily all, of the following attributes (Beckwith Environmental Planning 2006):

High level of security in terms of land management (eg National Park with statutory management plan);

- Large in size (ie area);
- Large number of users;
- Visitor catchment is regional or larger (including international tourists);
- Location is actively managed;
- Not easily substituted if social values were lost;
- Significant ecological values; and

- Multiple types of in situ social values.

The key parks satisfy many of the attributes listed above and therefore can be categorised as having a very high in situ social value rating. The attributes and in situ social values for each of the listed parks are discussed more specifically in the following section of the report.

For each of the sites, the in situ social values are discussed under the headings: ecological value, cultural values, social values and scientific, research and educational use. The in situ social values for key sites and features in the study area are summarised in Table 1.

### 3.1 Blackwood River National Park

The Blackwood River National Park is approximately 16,000 hectares and is split between the Nannup and Augusta-Margaret River shires. The park contains the Blackwood River between Darradup and Warner Glen/Chapman Pool. A series of small private landholdings occupy the margin between Darradup and Poison Gully (Figure 1). There is currently no management plan for the park, but it is managed actively by Department of Environment and Conservation.

#### Ecological Values

The Blackwood River is the largest river system in the South West of Western Australia. Over much of its length its flows are seasonal, depending directly on rainfall. From a location between Nannup and Darradup, however, the river flows continuously downstream due to perennial groundwater discharge into the river and tributaries.

In the absence of summer rainfall events, summer flows in the Blackwood River are derived from groundwater discharge from the Yarragadee Aquifer, which occurs between Darradup and Layman Brook, and the Leederville Aquifer<sup>4</sup> primarily from Layman Brook onwards.

Each of these aquifers contributes relatively equal volumes of water (in the order of 20 GL per annum) to the Blackwood River. These groundwater sources provide most of the summer river flow and are therefore very important for maintaining the environmental flows and water quality needed to sustain the ecology and recreational use of the Blackwood River over the summer period.

The National Park contains very significant ecological values, particularly in the lower reaches of the Blackwood River (downstream of Sues Bridge). The wetlands and

---

<sup>4</sup> The Leederville Aquifer (formation) is a younger sedimentary layer that overlays parts of the Yarragadee Aquifer in the Southern Perth Basin.

tributaries within these lower reaches are listed in the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996) and are home to the rare frog species *Geocrinia vitellina* and *Geocrinia alba* (URS 2004).

Upstream of Sues Bridge forested tributaries also have high ecological values as they are places of refuge for endemic fish species. Land clearing in the upper Blackwood River catchment and the development of dryland salinity has resulted in winter streamflows that are often highly saline (Strategen 2004). Native fish that cannot withstand the high salinities of the main river channel utilise the fresh flow in the tributaries.

Further, Murdoch University studies have highlighted Milyeannup Brook as being particularly important, possibly containing the only population of the threatened native fish Balston's Pygmy Perch (*Nannatherina balstoni*) within the Blackwood River system. The system is also habitat to another rare species, the mud minnow (*Galaxiella munda*) (Morgan & Beatty 2005).

### **Cultural Values**

The Blackwood River and its tributaries is a significant Aboriginal site that has been listed on the permanent register of Aboriginal Heritage sites by the Department of Indigenous Affairs under the *Aboriginal Heritage Act 1972 (WA)*. There are many other registered sites in the park that are discussed in more detail in Goode (2003; 2006).

### **Social Values**

There are several named and many unnamed recreation sites along the Blackwood River between Darradup and Hut Pool that are used by self-guided tourists, school groups and commercial tour operators. These sites are extremely popular during the Christmas holidays, marron season (January) and in late summer for school camps. The sites share multiple types of in situ social values, including aesthetics, observing nature, waterside picnicking, camping, recreational fishing, outdoor education, swimming, canoeing and bushwalking.

Respondents to the survey component of this study were unanimous in their opinion that good summer flow levels and water quality were the key factors that led to the use of the river in summer. Further, commercial tour operators and schools that used the Blackwood River National Park for outdoor education and canoeing stressed that these social values would not be substituted easily if they were compromised or lost. This is discussed further in Section 3.1.

Sues Bridge is a day-use, camping site and tourist venue that is actively managed by Department of Environment and Conservation. It is located at the Sues Road crossing of the Blackwood River. Department of Environment and Conservation

records estimate that in 2004-05, Sues Bridge received around 18,000 visits<sup>5</sup>, mainly in the summer months and school holidays (CALM 2005a).

People value this site for its clean summer water, good rate of flow and the main pool below the car park. The camping area is also popular as the site facilitates both wading and swimming activities. Sues Bridge is recognised for canoeing and has a purpose-built canoe launching facility.

Hut Pool is approximately 17 km downstream of Sues Bridge. It is a day-use area that has good summer access to both sides of the river via a bitumen river crossing. The site is often used as a pick-up or drop-off point for canoeists. In 2004-05, the site recorded 4,769 visits, which was an increase from 3,167 in 2003-04 (CALM 2005a).

The Warner Glen – Chapman Pool Recreation Site is another popular camping and water-based recreation site managed by Department of Environment and Conservation. It is located on the Chapman Brook at the confluence with the Blackwood River approximately 12 km downstream from Hut Pool. In 2004-05 this site recorded around 13,600 visits (CALM 2005a). This site's location in the vicinity of the tidal-influenced area of the Blackwood River means that it is unlikely to be affected by groundwater abstraction.

### **Scientific, research and educational use**

The Blackwood River is of the focus of 'Blackwood Waterwatch', which forms part of the Statewide 'Ribbons of Blue Waterwatch WA' Program, administered through Department of Environment and Conservation. The program involves individuals, school students and community groups in monitoring water quality, macroinvertebrate snapshots, revegetating riparian zones and a host of other environmental and educational activities. In the study area, the Nannup primary and high schools are very active in this program.

Data collected from the sampling provides valuable information for identifying environmental problems and preparing management plans. More specifically, the rare fish and frog species found in the river system are an important impetus for biological and ecological research.

## **3.2 Proposed St John Brook and Jarrahwood Conservation Parks**

The proposed St John Brook and Jarrahwood Conservation Parks are located in the Nannup Shire. The park is approximately 3,500 hectares and has a linear shape that

---

<sup>5</sup> A visit is the number of people per day visiting a specific location. The visit figure comprises both recorded numbers of visits from traffic counter devices, surveys and other data sources as well as estimated numbers of visits based on field observation (CALM 2005b).

encircles St John Brook (Figure 1). The proposed park currently forms part of large areas of multiple-use State Forest that covers the majority of the Blackwood Plateau (CALM 2004). The park is actively managed by the Department of Environment and Conservation and has a Draft Management Plan (CALM 2004).

### **Ecological Values**

St John Brook is a perennial tributary of the Blackwood River that enters the river from the north, to the west of Nannup. The brook flows in a deeply incised valley and as it approaches the Blackwood River, contains several interconnected permanent pools, including Barrabup Pool and Workmans Pool.

St John Brook cuts into the Leederville Formation, which occurs at the surface in this area and is the source of groundwater-fed summer flow in the brook.

The proposed St John Brook Conservation Park functions as a riparian wildlife corridor, facilitating the movement of native animals from the upper catchment of St John Brook to proposed reserves along the Blackwood River (CALM 2004).

Protection of these areas is a focus of the draft management plan. Additionally, the park contains several seasonally or permanently inundated wetlands, potentially containing endemic flora species and important populations of fauna.

### **Cultural values**

St John Brook is a significant Aboriginal cultural and heritage site and is listed on the permanent register of Aboriginal Heritage sites. Barrabup, Workmans and Cambray Pool were identified as sites of mythological significance, in association with Waugal beliefs. This is discussed in more detail in Goode (2003; 2006).

The proposed St John Brook and Jarrahwood Conservation Parks also contain cultural sites of the early settlement and timber cutting days. Historic features such as foundation remnants, restored mill structures, remains of the oval and cricket pitch, and a concrete storeroom ruin mark the former townsite of Barrabup and the Barrabup mill.

The townsite and mill are nearby to Barrabup and Workmans Pools. These pools supplied the town and mill with water for many years. Barrabup Pool was the site of the mill manager's house, and was reputedly used exclusively by him, while Workmans Pool played host to all mill workers. These facets of early European heritage are important cultural identifiers for people of the region and provide an enriched learning experience for visitors (CALM 2004).

## Social values

The proximity of the proposed St John Brook and Jarrahwood Conservation Parks to Nannup and Busselton make them particularly popular with visitors for picnicking, sightseeing, swimming, fishing, camping, motorbike riding, four-wheel driving and bushwalking. Barrabup Pool attracted approximately 21,000 visits per annum during 2003-04 and about 17,200 visits during 2004-05 (CALM 2005a). Most of these visitors are travelling to the popular day-use area at Barrabup Pool, the day-use and camping area at Workmans Pool and to Cambray Siding.

Barrabup and Workmans Pools are highly valued for their scenic amenity, especially the native forest that surrounds the pools. Swimming and recreating around the water's edge are popular activities in the pools. Visitors value the water quality, the waterfall effect of water entering Barrabup Pool over the rocky streambed, and the depth of water in the pools, which makes for excellent swimming. The pools are extremely important to locals in the area and are often referred to as 'the town's swimming pools'.

## Scientific, research and educational use

The St John Brook area is a popular location for local school excursions, including activities associated with the Statewide Ribbons of Blue and Waterwatch WA Program, as discussed above.

## 3.3 D'Entrecasteaux National Park

D'Entrecasteaux National Park is located in the Nannup and Manjimup shires. It covers an area of approximately 116,686 hectares along a coastline of 130 kilometres, from Black Point in the west to Long Point in the east (CALM 2005b). The Park is actively managed by the Department of Environment and Conservation and has a Draft Management Plan (CALM 2005b). The main area of interest in this study is that part of the National Park that lies west of the Donnelly River.

## Ecological values

D'Entrecasteaux National Park and the neighbouring Gingilup Swamps Nature Reserve contain many high value ecological features. The Gingilup-Jasper Wetland System is listed in the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996) as being an outstanding example of a near pristine, extensive system of freshwater lakes, marshes and shrub swamps including the deepest, large freshwater lake in south-western Australia (Lake Jasper).

This system comprises all wetlands on the coastal plain between the Donnelly and Scott Rivers, notably Lake Jasper and associated swamps Lake Wilson and Lake Smith, Quitjup Lake and Gingilup Swamps. It should be noted that only Lake Jasper has suitable access and is promoted for social activities.

Many of the wetlands in the National Park have been assessed recently and categorised as 'conservation category' wetlands (VCSRG 2005). The conservation category is applied to wetlands that support a high level of ecological or cultural attributes. The wetlands of Lake Jasper site were recognised as conservation category due to their function as a habitat for freshwater fish. It is also recognised as a significant breeding site for birds (Australian Nature Conservation Agency 1996). Lake Jasper has Aboriginal cultural significance and is a registered Heritage site.

The Department of Environment and Conservation has identified the *Reedia* Swamp Community in the park as a threatened ecological community, which has been referred to the Minister of Environment for endorsement. This community is dominated by peat paluslopes and sandy mud floodplains. The perennially high water tables of these freshwater wetlands support a number of priority plant species that are concentrated in these wetlands (CALM 2005b).

### **Cultural values**

Lake Jasper is of particular archaeological and cultural significance to Aboriginal people. Numerous Aboriginal stone artefacts occur on the lakebed up to 10 metres below current surface levels. Several of these sites also occur at the edge of Lake Jasper making them vulnerable to physical disturbance and exposure from changes in water levels.

Lake Jasper marked a significant campsite along a traditional pathway leading from the Blackwood River following Milyeannup Brook and Barlee Brook to Lake Jasper through the Gingilup Swamps to the Hardy Inlet (Goode 2003; 2006). Numerous sites along this pathway are listed on the permanent register of Aboriginal Heritage sites.

European involvement within the parks mostly started in the late 1800s with droving of cattle to the coast for grazing. Stockmen's huts, bridges and stockyards are significant European structures in the parks; however, none of these features are present in the study area (CALM 2005b).

### **Social values**

D'Entrecasteaux National Park has long been valued for its rugged coastlines, beaches and dune systems as well as extensive and nationally significant wetland systems that provide habitat for a range of endemic flora and fauna.

Visitors to the park value the unspoilt surroundings, sense of remoteness, nature/wilderness, scenic views and the four-wheel driving and camping opportunities the park (CALM 2005).

The Department of Environment and Conservation estimates that about 22,800 visitors per year enter the park via the major entry points such as Black Point Road,

Lake Jasper Road and Donnelly Boat Landing. Visitation is likely to continue to increase with a prediction for a growth in nature-based tourism of 20 per cent per annum in Western Australia (Commonwealth of Australia & the State of Western Australia 1998).

Sightseeing and driving for pleasure are important recreational pursuits for many visitors. A large proportion of visitors experience the park and gain their enjoyment and appreciation of the natural environment in this way (CALM 2005b).

Lake Jasper is a key recreational site in the park and is often included as a stop-off point for people engaging in scenic drives from the forest to the coast or for overnight camping. Camping and day-use facilities are provided by the Department of Environment and Conservation; however, these have been closed for the past year due to fire damage. Commercial tour operators also regularly visit the lake.

Visitors value the lake for its relative isolation, scenic beauty, bush walking, as a place to observe nature and general recreation. Respondents to the survey valued the lake for its large water area, sandy beaches and shallow wading zone for swimming, particularly for children. Swimming, paddling, and marroning are popular pursuits for visitors.

Currently, power boats and water skiing are allowed on the lake; however, this is subject to a recommendation in the Shannon and D'Entrecasteaux National Parks Draft Management Plan (CALM 2005b) to close the lake to power craft.

### **Scientific, research and educational use**

The natural and cultural values of national parks make them highly desirable sites for research and educational use (CALM 2005b). Lake Jasper is occasionally used for educational excursions; however, this is limited by access and travelling time from the nearest towns.

Table 1: Social attributes and use of key sites.

Feature	Aesthetic/ Scenic Amenity	Aboriginal Heritage	Non-Aboriginal Heritage	Passive Recreation	Bird Watching	Nature observation	Picnicking	Active Recreation	Camping	Fishing	Marroning	Paddlesports	Powerboating	Swimming\ wading	Bushwalking	Used by Commercial Tour Operators	Education	Scientific or cultural research	Peak Seasonal use	Spring	Summer	Autumn	Winter
Blackwood River: Darradup to Hut Pool	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			
Sues Bridge	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Hut Pool	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Barrabup/ Workmans Pool	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Warner Glen\ Chapman Pool	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Lake Jasper	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		

## 4 Social use

The previous section of the study detailed sites within the study area with a 'high' level of in situ social value and social use. The following section is a more detailed look at key recreational activities and quantifiable social use in the study, especially for the Blackwood River.

### 4.1 Outdoor education

The results of this study indicate that the Blackwood River downstream of Nannup is a key outdoor education site for the State. The importance of this part of the river is highlighted by the large number of high school students that use it for outdoor and nature-based education activities such as paddling, nature walks and camping.

Excursions to the river occur through individual school-based programs and through commercial tour operators. It is estimated that in recent years around 1,700 school students per annum use the Blackwood River for outdoor education (Table 2).

Explorus Adventure Learning is a large commercial tour operation that caters for a large percentage of the outdoor education camps that occur on the Blackwood River. Explorus currently spends approximately 1,000 student days<sup>6</sup> for canoeing and 1,800 student days for camping and nature walks in the Blackwood River area, which equates to approximately 800 students per annum. These students represent in the order of 10 to 20 schools, the majority being metropolitan-based.

Most of the outdoor education activity along the river occurs between Layman Brook and Warner Glen (See Figures 1 & 2). A typical program run by commercial tour operators and school groups includes camping, bush walking and canoeing over a few days. The most popular summer paddling routes begin from Sues Bridge or just upstream towards Layman Brook down to Hut Pool. The paddle may be broken up into two days or stages with students paddling between camps.

The three commercial tour operators and four individual schools contacted in this study identified the Blackwood River as being a key component of their outdoor education programs and cited a number of factors that highlight the uniqueness of the river for paddling and nature-based activities.

These factors include:

- Accessibility – relative closeness to Perth;
- Virtually the only river available for summer paddling in the South West, in terms of water quality and length of paddle;

---

<sup>6</sup> A student day refers to the number of days spent participating in that activity, for example, 50 students completing a 1.5 day paddle would equate to 75 student days.

- Mobile telephone reception (CDMA) in case of emergencies;
- River is readily accessible along its length in case of emergency;
- Ability to paddle on to camps, important to get kids warm and dry shortly after a paddle is finished;
- Accessibility to other outdoor activities, eg caving and abseiling at Margaret River;
- Sense of wilderness and adventure;
- Good water quality;
- Excellent paddling. The winding river and novice grade rapids make for a challenging and stimulating experience, as opposed to long and wide open stretches of water;
- Bush camping;
- Surrounding State Forest and National Park for nature-based educational and walking activities; and
- Logistically very difficult to paddle and camp on other rivers with similar 'sense of wilderness' in the lower South West and the South Coast.

Logistics and safety factors were highlighted by respondents as critical considerations for making camps affordable and fulfilling duty-of-care responsibilities in an environment where schools and commercial tour operators are subjected to increasingly expensive public indemnity insurance.

For all of the reasons listed above, it is clear that these social values for the Blackwood River would not be substituted easily if they were either lost or compromised to a point whereby these social needs were no longer met.

## 4.2 Commercial tourism

Commercial tour operators also conduct canoeing and camping expeditions for tourists, corporate groups and families. In the study area, the most popular sites for tours were the Blackwood River National Park (see Table 2) and D'Entrecasteaux National Park. Tours conducted ranged from four-wheel-drive adventure tours to the coast via Lake Jasper, to custom-designed tours including paddling, bush walking and wildflowers at Lake Jasper, the Warren River and other key locations throughout the park.

In the Blackwood River National Park, canoeing tours are generally promoted between Darradup and Hut Pool to take advantage of the adjoining national park and the sense of wilderness it offers paddlers. The winding nature of the river and low-grade rapids are features that make for good paddling. Tours are generally day trips or weekend camp-overs, with peak season occurring during spring and summer.

Use of the area for paddling by members of the public, other than through commercial tour operators and schools, is difficult to quantify. However, an indication of the area's popularity for water-based activities, including swimming, and waterside recreation, is reflected in the Sues Bridge annual visitation numbers (18,000 visits/yr).

The commercial tour operators surveyed have been paddling on the Blackwood River for many years and were therefore knowledgeable of paddling conditions and river flows. Key points about their use of the Blackwood River included:

- Depth of flow is extremely important because it determines how much of the expedition is spent seated and paddling in the canoe or kayak. Excessive portage, where occupants have to get out of the canoe and walk it over a shallow section or an exposed obstacle such as a fallen log was cited as being one of the main factors that detracts from the enjoyment of paddling. During February and March the river best paddling conditions occur down-stream of Sues Bridge. The operators all suggested that in peak summer of 2004-05 that the paddling route between Sues Bridge and Hut Pool was approaching a level where any further reduction in flow could result in excessive portage. A standard Canadian canoe occupied by two grown adults requires at least 10 cm depth of flow to float the boat without scraping the river bed. Lower summer flows than in 2004-05 would threaten the business of the commercial tour operators and the ability of people to paddle the river during peak summer months.
- Good water quality in summer was a highlight of the river and a crucial factor to sustaining commercial use of the area. Adequate summer water quality maintained a healthy and enjoyable water environment, including the ecological integrity of the river and the riverine environment.
- The operators and their clientele highly valued the health of the ecosystem and the sense of remoteness, wilderness, unspoiled surroundings and scenic views that the bush of the National Park offered. Correspondingly, protection of these ecosystems was seen as critical to maintaining these values.

*Table 2: Use of the Blackwood River by school groups and commercial tour operators.*

User Group	Dates	Locations	No. (approx/annum)	
			Students	Other
Hale School	Feb, March, May	Feb-March – Warner Glen. May – 6km upstream Sues Bridge to Hut Pool	175	
Presbyterian Ladies College	May-Aug	Sues Bridge-Hut Pool	200	
Bunbury Catholic College	Nov-Dec June	Sues Bridge-Hut Pool	120	
Methodist Ladies College	May	Sues Bridge-Hut Pool	140	
Explorus	March-May	Punch Rd $\approx$ 8km upstream of Sues Bridge to Hut Pool then to Warner Glen	800	
Representing in the order of 10-20 schools	Sept-Nov			
Blackwood River Canoeing	Year round; Nov to Easter core business	Jalbarragup to Hut Pool	50-100	500
Outdoor Discoveries	Intermittent year round, summer paddling Dec-March is core business	Mid-summer from Hut Pool 10 km upstream Sues Bridge to Hut pool	100	100
Adventure Out Australia	Sept-Dec	Jalbarragup to Hut Pool	50	50
Dekked Out Adventures	Late Jan – Feb	Layman Brook to Warner Glen	40	50
		TOTAL	1,725	700

## 4.3 Recreational fishing

Fishing for freshwater crayfish, Marron (*Cherax tenuimanus*), and freshwater angling are very popular recreational pursuits in the study area. In 2003-04, around 21,000 recreational fishing licences were issued by the Department of Fisheries for these two activities. However, this includes a large number of 'umbrella' licences (covering all licensed recreational fisheries), which generally correlates with a lower participation rate, because licence holders may not fish for each recreational fish species listed on the umbrella licence (Molony 2005a).

### Marroning

Marroning is a popular activity in the Blackwood River and its tributaries and Lake Jasper during open season (usually a short period over January/February). The marron fishery in the 2003 season involved approximately 3,364 licence holders and their families undertaking about 9,100 fishing days, and provided a major recreational activity in regional areas of the South West of the State (Molony 2005a).

In 2004, the Blackwood River received more recreational marron fishing effort<sup>7</sup> (~19 per cent) than any other river in WA (M. De Graaf 2006, pers. comm., 6 January) In 1999, the fishing effort in the Blackwood River was 22 per cent, of which approximately 35 per cent occurred downstream of Nannup in the study area (Molony & Bird 1999; B Molony pers. comm. cited in Morgan & Beatty 2005).

### Freshwater Angling

Recreational freshwater anglers in the State's South West primarily target introduced species such as rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) populations of these species are artificially maintained through stocking programs) and redfin perch (*Perca fluviatilis*). The freshwater cobbler (*Tandanus bostocki*) is a native species that is also sought (Molony 2005b). The fishery is a significant tourist attraction for the region, generating valuable income for regional centres.

A large number of freshwater angling licences are sold annually. For the 2002-03 season, a total of 15,984 licences were sold, including 'umbrella' licences (Molony 2005b). Approximately 10 per cent of all freshwater angling during 2002-03 occurred in the Blackwood River (Molony, Bird & Baharthah, unpub., cited in Morgan & Beatty 2005).

Recreational fishers value the Blackwood River for its 'big river' feel, its relatively 'untouched' state and the quality of the trout it produces (J McConigley 2005, pers.

---

<sup>7</sup> Fishing effort is a reference to how much fishing occurred in a particular area. It is usually determined by a phone or postal survey of licence holders to determine the number days they spent fishing in a particular area.

comm., 7 September). The river is also closer to the Perth and Bunbury population centres than the Donnelly and Warren Rivers and hence easier to visit.

The peak period for trout fishing on the Blackwood River is October-November (J McConigley 2005, pers. comm., 7 September). The requirements for summer fishing on the river are larger pools to hold the trout during the hot weather, and water flow between the pools. Trout is caught mainly in moving water as they tend to use the current to bring food to them.

According to recreational fishers, poor summer flows means poor summer fishing. As much of the summer flow comes from small trickles and creeks such as St John Brook and Red Gully) when these cease to flow, the river slows accordingly.

The better the summer flow in the creeks, the better the survival chances of the trout (creeks are generally cooler) and the better the fishing (J McConigley 2005, pers. comm., 7 September).

### **Social water requirements for recreational fishing**

Native and introduced species sought by recreational fishers are under pressure from a variety of catchment-scale land and water management issues. The marron fishery has been in decline in the past decade due to habitat change, particularly secondary salinisation and eutrophication of inland waterways, hydrological change (such as reduced flows from damming water courses and groundwater abstraction), and predation by introduced teleosts, particularly Redfin Perch (Molony, Morrissy & Bird 2002; Morgan & Beatty 2005).

Trout are an introduced species and the fishery is artificially maintained by stocking programs. Nonetheless, the activity has wide appeal, contributes to the regional economy (Molony 2005a ;b) and will be considered in the setting of social water requirements. In terms of water quality, trout are tolerant to a wide range of salinities but require high levels of dissolved oxygen and cooler water temperatures.

The key water quality parameter that can be more closely linked to groundwater abstraction is flow rates to maintain adequate levels of dissolved oxygen in river pools. River pools are places of refuge for many aquatic species, including marron and trout, in summer. Therefore, the social water requirement to maintain recreational fishing is related to the ecological water requirement developed for pool water quality (dissolved oxygen) (CENRM 2006).

Further detail about the ecological water requirement for dissolved oxygen, and accounting for catchment scale land and water management issues in the water allocation planning process are discussed in Section 5.

## 5 Determination of social water requirements

In this study, key groundwater-dependent social values within the study area were identified. People interviewed in this study were asked to describe the features of the water regime they believed necessary to support or maintain those social values.

Stakeholders generally found it difficult to specify water regimes, levels or flows to support their values. Instead they usually described the features of a site that they valued and a qualitative statement about the water regime they preferred. A typical example would be “we visit this area of the river in summer because the water quality is quite good and there is a good amount of flow; if the flow slowed or the water quality declined we would have to go somewhere else”.

Consequently, social water requirements were not usually specified quantitatively or empirically by stakeholders. The descriptive nature of the social water requirements is documented in Table 3. In order to account for social water requirements in a quantitative and scientific way, the Department was required to interpret the statements made by stakeholders and define a water regime to support social values. Two key factors were considered when assigning such a water regime for social values:

1. The Department’s Environmental Water Provisions Policy guiding principles which state that “water regimes identified to meet social values (ie social water requirements) will form part of Environmental Water Provisions where they do not unacceptably impact on significant ecological values” (WRC 2000, p.4). An example of where such conflict between ecological and social water requirements may occur is where the social value to maintain a scenic view in a wetland or lake may require the permanent presence of open water; however, maintaining a healthy ecosystem may require seasonal drying of the water body.
2. The intrinsic relationship that exists between social values and the ecology of the study area. The ecology of the study area is a major drawcard for tourists (eg CALM 2005; Commonwealth of Australia and State of Western Australia 1998) and lifestyle choice for people who desire to reside in regional areas that offer a connection with the natural environment (eg CSIRO 2003; Shire of Augusta-Margaret River and CSIRO Sustainable Ecosystems 2006). Consequently, it is not unreasonable to assume that by protecting these ecological values the in situ social values are also maintained in most cases.

Maintaining these ecological values, especially in areas where water-dependent ecosystems occur, at a low level of risk is achieved through the setting of ecological water requirements. Therefore, where feedback from the community did not stipulate specific water regimes to support in situ social values but where a functioning

environment was the key part of the social values themselves, the Department has used relevant ecological water requirements criteria as a surrogate for social water requirements.

A summary of the ecological water requirements proposed by the Department in the South West groundwater areas can be found in Hyde (2006).

This process has been adopted to determine social water requirements for many of the social values identified at key recreational sites in the Plan Area (summarised below in Table 4). For example, the social water requirement to support the social value to swim and wade at Sues Bridge in summer would be supported by the ecological water requirements related to summer water quality and flow on the Blackwood River. Therefore, the ecological water requirement and the social water requirement are the same.

Stakeholders held strong values for the forest, the bush, and the wetland and riverbank vegetation throughout the study area, including education, bush walking, observing nature, enjoying the scenery while driving, to purely intrinsic values where the social value is derived from the knowledge of the bush 'just being there' and being maintained.

Defining a social water requirement to protect these values required a reference to the ecological water requirements for groundwater-dependent vegetation, including wetland, riparian and terrestrial vegetation (see Table 4). These ecological water requirements mark an important surrogate for social water requirements because they define the groundwater level, or more specifically the amount of groundwater drawdown and the rate at which this drawdown occurs, to support the vegetation, aesthetics and sense of wilderness that people enjoy when visiting the area. This is another example where the social water requirement and the ecological water requirement are the same.

The social value of canoeing on the Blackwood River is an instance where it is not clear whether the social water requirement will be fully supported by ecological water requirements. In a study of the ecological water requirements of the Blackwood River from Nannup to Hut Pool, CENRM (2005) recommended permanent flows and a minimum depth of five cm over riffle zones should be maintained every month to support passage of macro-invertebrate fauna.

Further work on ecological water requirements for water quality recommended that a minimum summer flow of three megalitres (ML) per day was required to maintain pool dissolved oxygen levels, which is considerably less than current summer flows in most areas downstream of Nannup (CENRM 2006).

Respondents who were familiar with paddling on the river suggested that a 10 cm depth of flow is required for canoes laden with two adults to pass over shallow riffle

zones. Therefore, in this instance the flows required to meet social values may be higher than those to meet ecological values during summer.

A criteria defining a depth of flow is inherently difficult to measure and monitor due to the large number of rapids and riffle zones that may be present, the dynamic changing nature of the riverbed morphology and the presence of woody debris. Ideally data would be available to create a flow model of the Blackwood River so that the 10 cm flow level for paddle craft could be translated into a discharge rate at specific points on the river. This is not possible at present.

Additional investigations planned by the Department for the Blackwood River will help to better define flow volumes against flow heights to monitor the water levels required for both ecological and social values.

Maintaining or improving water quality, especially summer flows in the Blackwood River, was a recurring topic raised by stakeholders throughout this study. People considered water quality to be of prime importance to sustain activities such as swimming and canoeing, maintaining the ecological health of waterways for both intrinsic reasons and recreational activities such as marron fishing, and including sustaining the artificially managed recreational trout fishing industry.

The historically fresh Blackwood River has become brackish to moderately saline due to land clearing for agriculture and the development of dryland salinity in the large upper catchment. The highest salt concentrations occur when the accumulated salts are flushed by early winter rainfalls. Downstream of Darradup, in summer, salinities are lower as there are minimal surface water inflows and fresh groundwater inflows from both the Yarragadee and Leederville aquifers dilute the river's salinity. The Blackwood River also suffers from high nutrient levels, particularly nitrogen, and associated algal blooms, which is related to nutrient contributions from agricultural land in the upper catchment.

These issues are related to land use practices in the catchment and are relatively difficult to cater for in the water allocation planning process alone. Management and amelioration measures to improve the water quality in the Blackwood River depend on catchment-scale land planning, management and mitigation efforts.

A water quality issue that is more closely related to the direct impacts of groundwater pumping is the potential for reduced dissolved oxygen levels in pools along the river. River pools are important refuges for fauna such as fish and freshwater crayfish during summer low-flow conditions. Adequate concentrations of dissolved oxygen are fundamental for the survival of these aquatic fauna and for the maintenance of ecological processes. This is because when dissolved oxygen reaches very low levels (hypoxic conditions), fish kills and the release of nutrients from sediments may occur.

While there are many processes, both physical (re-aeration) and biological (metabolic), which determine the dissolved oxygen content of a river pool, adequate

flow is required to buffer the effect of high benthic respiration and other processes which remove dissolved oxygen. Groundwater pumping has the potential to reduce the flows that are required to aerate these river pools adequately.

Clearly, maintaining dissolved oxygen levels in the Blackwood River Pools is very important for maintaining the ecological health and the social values of the system. Recognising this importance, the Department engaged the Centre for Natural Resource Management at the University of WA to define an ecological water requirement for this water quality issue. This is documented in CENRM (2006). Stakeholders' values for good water quality in the Blackwood River will be supported by this ecological water requirement in this study.

Lake Jasper, being a near pristine, coastal, large freshwater lake is an iconic natural feature in the South West. It has traditionally been very popular with local residents and visitors for camping and recreation. People value the lake as a water body for recreation, sense of wilderness, observing wildlife, fishing, wildflowers, and bush walking. Lake Jasper is also a registered Aboriginal heritage site with significant archaeological features and spiritual values.

The social and cultural values associated with Lake Jasper are intrinsically related to the ecological health of the Gingilup-Jasper wetland ecosystem. The Department engaged ecologists to develop ecological water requirements for the groundwater-dependent vegetation, specifically around Lake Jasper, and on the eastern Scott coastal plain generally (see Froend & Loomes 2006). These criteria mark important criteria for protecting the ecological health and social values of the area, and are referred to in Table 4.

To develop further our understanding of the ecosystem processes of Lake Jasper, the Department intends to establish an expert panel to define other ecological water requirements. These would apply to such things as the water requirements for waterbirds and waders and peak spring levels. These are described below.

A number of waterbird and wader species that use Lake Jasper are known to be groundwater-dependent, eg Australasian Bittern (*Botaurus poiciloptilus*) (Australian Nature Conservation Agency 1996; CALM 2005b). Wading species generally require shallow water or a 'wading zone' in summer and early autumn, and high winter levels to prevent inundation of the wading zone in the lake basin with vegetation (Froend et al. 2004).

Wetlands require certain water levels to be reached in spring to create habitat for the reproduction and growth of flora and fauna, and are a major influence on vegetation distribution. This is especially important for emergent (emergent plants have their roots underwater, often rooted in the sediment, and most of their leaves above water) and riparian vegetation.

**Table 3: Social values and stakeholder views on social water requirements for those values.**

Feature	Social Value	Stakeholder Views On Social Water Requirements
Applicable to all sites:	Canoeing	Summer paddling is popular. Water levels should be high enough to maintain canoeing and other paddle sports and water quality must be maintained for health and enjoyment, particularly between Sues Bridge and Hut Pool.
	Swimming	Swimming is popular at accessible sites along the river. Water quality and flow need to be maintained through summer.
Blackwood River: Darradup to Hut Pool.	Aesthetic	People value the scenery and sense of wilderness that the forest and wetland/riparian environment offers when recreating in and around the river. Groundwater levels must maintain this vegetation.
	Observing Nature	The vegetated riparian environment provides habitat to birds and other native animals. Water levels must be maintained to support their habitat.
Lake Jasper.	Marroning	Marroning is an extremely popular recreational pursuit on the river. Water levels and water quality in the river must be improved or maintained to sustain marron populations.
	Other Recreational Fishing	Freshwater angling is popular on the river. Water levels and water quality in the river must be improved or maintained to sustain fish populations.
	Day Use and Camping	A healthy bush and pleasant visual amenity is important. Water levels must be maintained to sustain the bush and river edge vegetation.

Table 4: Summary of the social water requirements in the study area.

Site	In situ Social Value	Social water requirement
Blackwood River, Darradup to Hut Pool	Recreational fishing	As for the ecological water requirement for pool water quality; maintaining adequate dissolved oxygen concentrations in river pools <sup>8</sup>
	Paddle sports	10 cm flow depth over riffle zones between Darradup and Hut Pool
	Aesthetics & visual amenity	As for the ecological water requirement for riparian vegetation; maintaining groundwater levels that support riverbank vegetation <sup>9, 10</sup>
	Observing nature	As for the ecological water requirement for wetland & terrestrial vegetation; maintaining groundwater levels to support groundwater-dependent vegetation <sup>10</sup>
St John Brook	Swimming	Maintain current summer water levels (equates to ~0.5 m <sup>3</sup> /s discharge rate at Sues Bridge) As for the ecological water requirement for pool water quality; maintaining adequate dissolved oxygen concentrations in river pools <sup>8</sup>
	Swimming	Maintain current summer water levels in pools
	Aesthetics & visual amenity	As for the ecological water requirement for riparian vegetation; maintaining groundwater levels that support riverbank vegetation <sup>9, 10</sup> As for the ecological water requirement for wetland & terrestrial vegetation; maintaining groundwater levels to support groundwater-dependent vegetation <sup>10</sup>
Lake Jasper	Aesthetics & visual amenity	As for the ecological water requirement for wetland & terrestrial vegetation; maintaining groundwater levels to support groundwater-dependent vegetation <sup>10</sup> As for the ecological water requirement for peak Spring water levels; maintaining the water regime to inundate fringing vegetation around the lake in Spring <sup>11</sup> Maintain natural water levels
	Observing Nature	As for the ecological water requirement for waterbirds and waders; maintaining lake water levels to support waterbirds <sup>11</sup>

<sup>8</sup> CENRM (2006)<sup>9</sup> CENRM (2004)<sup>10</sup> URS (2004) and Froend & Loomes (2006)<sup>11</sup> Not yet developed for Lake Jasper

## 6 Conclusion

The South West of Western Australia is valued highly by residents and visitors for its environment and natural values (eg Commonwealth of Australia and State of Western Australia 1998; Tourism WA 2006) This is reflected in population growth, and tourism in the region.

Defining the water-dependent in situ social values that the residents and visitors identify with in the region and then determining the water requirements to sustain these values was a key objective of this study.

The in situ social values of the Southern Blackwood Plateau and the Scott coastal plain were determined through a survey of key stakeholders. People interviewed in this study identified the Blackwood River National Park, the D'Entrecasteaux National Park and the proposed St John Brook and Jarrahwood Conservation Parks as places of high social value for recreation, heritage and tourism in the South West.

More specifically, key sites within the parks included the Blackwood River downstream of Nannup, Workmans and Barrabup Pools on St John Brook, and Lake Jasper. The popularity of these places with local residents, domestic tourists and international visitors was affirmed by visitor statistics collected by the Department of Environment and Conservation, which showed an increasing trend in the numbers of visitors.

An important finding was the identification of the Blackwood River downstream of Nannup as an iconic outdoor education site in the State. Over 1,700 hundred students from local and metropolitan schools use the river during Spring and Summer for outdoor education activities, such as canoeing, nature walks and camping. The qualities of the river, including the sense of wilderness offered by surrounding National Park, the winding nature of the river and low-grade rapids and accessibility, define this part of the river as one of the most important river-based outdoor education sites in the State.

The same part of the Blackwood River also sustains some of the most active recreational marron fishing in WA.

These social values affirm the importance and dependencies people have of water in these locations and were used to define the social water requirements for the study area. People interviewed in the study were asked to describe the water requirements they considered would sustain these values. Their responses were generally descriptive, using imagery and personal feelings to describe their perspectives.

Social values where specific water requirements were defined by stakeholders included:

- 10 cm depth of flow over shallow riffle zones to maintain the ability to canoe on the Blackwood River; and
- Maintaining current summer pool levels for swimming and water-side recreation at Sues Bridge on the Blackwood River; Barrabup and Workmans Pools on St John Brook; and Lake Jasper.

In this study, there were also many instances where it was difficult for stakeholders to recognise the water regimes and requirements to sustain particular social values. For example, defining the water requirements to sustain the social value of catching a fish in a river is inherently difficult because the ability of the fish to survive and breed is dependent on a host of variables that relate to the health and functioning of the river ecosystem. In this example it is obvious that a reference to a scientifically based process, such as that used to determine ecological water requirements, is required.

Ecological water requirements are scientifically determined hydrological regimes such as river flows, groundwater levels and lake water levels needed to maintain ecological values at a low level of risk. These values may include; biodiversity (eg fish, plant species), ecological processes (eg migration and breeding), habitat (eg riffle zones and riparian vegetation) and channel characteristics (eg rapids, pools).

In this study, the following ecological water requirements were used to support social water requirements:

- Ecological water requirement to maintain wetland and terrestrial groundwater-dependent vegetation at a low level risk. This vegetation includes the forest, bush and wetland plants that sustain many of the social values in the study area. For example, bush walking, sense of wilderness, intrinsic values, habitat to support fauna and the aesthetic values of the landscape;
- Ecological water requirement to maintain riparian vegetation at a low level risk. This is the vegetation that is found along river banks. It requires flooding in winter, but more relevant to this study is the requirement of accessible groundwater in summer;
- Ecological water requirement for pool water quality. This is related to river flows to maintain adequate concentrations of dissolved oxygen in river pools. This is an important criterion to sustain social values such as water quality for swimming, and healthy habitat for aquatic fauna, particularly those sought by recreational fishers;
- Ecological water requirement for waterbirds and waders. Observing these species is an experience that people value when visiting Lake Jasper. Waterbirds generally require shallow water or a 'wading zone' in summer and

early autumn, and high winter levels to prevent inundation of the wading zone in the lake basin with vegetation; and

- Ecological water requirement for peak spring water levels. Wetlands require certain water levels to be reached in spring to create habitat for the reproduction and growth of flora and fauna, and are a major influence on vegetation distribution. At Lake Jasper this is a criterion that supports the social values of enjoying and maintaining the natural aesthetics of the fringing vegetation and habitat for fauna.

This study has used both qualitative descriptions and empirical data derived for ecological water requirements to determine the water regimes required to maintain the social water requirements of the Blackwood Plateau and the Scott coastal plain.

The results of this study will be used by the Department in the determination of Environmental Water Provisions and groundwater allocation limits in the Blackwood groundwater area.

# Appendices

## Appendix A – Stakeholders contacted in this study

Department of Conservation and Land Management (CALM) now the Department of Environment and Conservation (DEC)

RecfishWest

Western Australian Trout and Freshwater Angling Association

Fisheries WA

Southwest Canoe Club

Canoeing Western Australia

Department of Sport and Recreation, South West

Dekked Out Adventures

Blackwood River Canoeing

Pemberton Discovery Tours

Pemberton Hiking and Canoeing

Explorus Adventure Learning

Outdoor Discoveries

Adventure Out Australia

Western Australian Paddling News

Methodist Ladies College

St Hilda's College

Presbyterian Ladies College

Hale School

Bunbury Cathedral College

Bunbury Catholic College

WA Plantation Resources – Blackwood Waterwatch

Shire of Augusta-Margaret River

Shire of Nannup



## Appendix C – Description of ecological water requirements referred to in this study

The ecological water requirements referred to in this study to support social water requirements are described in general detail below.

### **Ecological water requirement for pool water quality (CENRM 2006)**

Adequate concentrations of dissolved oxygen (DO) are fundamental for the survival of aquatic fauna and for the maintenance of ecological processes. Both physical (re-aeration) and biological (metabolic) processes determine the DO content of a river pool.

Sufficient flows are required over summer to maintain dissolved oxygen levels above critical levels in Blackwood River pools. This report documents these flow requirements for a range of pool sizes, but does not consider other water quality issues such as salinisation and nutrient loads.

### **Ecological water requirement for riparian vegetation (URS 2004; CENRM 2004)**

Riparian vegetation is defined as vegetation on any land which adjoins or directly influences a body of water. Sufficiently large river flows are required to flood the riparian zone and stimulate seed-set and enable subsequent recruitment of vegetation. Riparian vegetation is dependent on the availability of surface water or groundwater. Short-term and long-term changes in water availability to these systems can lead to changes in these communities and compromise ecological health.

### **Ecological water requirements for wetland and terrestrial vegetation (URS 2004)**

Wetland vegetation is dependent on the availability of surface water or groundwater. Short-term and long-term changes in water availability to these systems can lead to changes in these communities and compromise ecological health. URS (2004) developed the following notional, scientifically based, ecological water requirements for the Blackwood groundwater area to maintain groundwater-dependent vegetation at a low level of risk:

Less than 0.25m maximum groundwater drawdown at wetlands at a rate of less than 0.1m/yr; and

Less than 0.5m maximum groundwater drawdown in areas of phreatophytic (groundwater-dependent) terrestrial vegetation at a rate of less than 0.1m/yr.

## **Ecological water requirements for wetland and terrestrial vegetation (Froend & Loomes 2006)**

Froend & Loomes (2006) established ecological water requirement criteria for wetland and terrestrial vegetation at various sites on the southern Blackwood Plateau and eastern Scott coastal plain. They established site-specific criteria, based on the vegetation species identified at each site.

The most susceptible species to groundwater level change was identified within the transect. This was the species whose normal water level range would be exceeded first if groundwater levels were to decline. The degree to which water levels would have to decline before they were outside that species' water level range was calculated and this represented the ecological water requirement.

### **Ecological water requirement for waterbirds and waders**

This ecological water requirement has not yet been developed for Lake Jasper. A number of waterbird and wader species that use Lake Jasper are known to be groundwater-dependent, eg Australasian Bittern (*Botaurus poiciloptilus*) (Australian Nature Conservation Agency 1996; CALM 2005b). Wading species generally require shallow water or a 'wading zone' in summer and early autumn, and high winter levels to prevent inundation of the wading zone in the lake basin with vegetation (Froend et al. 2004).

### **Ecological water requirement for peak spring water levels**

This ecological water requirement has not yet been developed for Lake Jasper. Wetlands require certain water levels to be reached in spring to create habitat for the reproduction and growth of flora and fauna, and are a major influence on vegetation distribution. This is especially important for emergent (emergent plants have their roots underwater, often rooted in the sediment, and most of their leaves above water) and riparian vegetation

# Glossary

<b>Abstraction</b>	Withdrawal of water for anthropogenic purposes, usually by means of pumping (and often regulated), from surface water sources such as rivers and streams, and groundwater sources such as aquifers (via boreholes and wells).
<b>Aquifer</b>	A geological formation or group of formations able to receive, store and transmit significant quantities of groundwater.
<b>Baseflow</b>	That portion of river and stream flow coming from groundwater discharge.
<b>Ecosystem</b>	A term used for a specific environment, eg wetland, or part thereof, to include all the biological, chemical and physical resources and the interrelationships that occur between those resources.
<b>Environmental water provisions</b>	The water regimes that are provided as a result of the water allocation decision making process taking into account ecological, social and economic impacts. They may meet in part or in full the ecological water requirements.
<b>Ecological water requirements</b>	The water regimes needed to maintain ecological values of water-dependent ecosystems at a low level of risk.
<b>Formation (geological)</b>	A group of rocks or sediments which have certain characteristics in common were deposited about the same geological period, and which constitute a convenient unit for description.
<b>Gigalitre (GL)</b>	One million kilolitres KL (1 KL = 1,000 L).
<b>Groundwater</b>	Water found under the land surface that occupies the pores and crevices of soil or rock.
<b>Groundwater discharge</b>	Groundwater, under pressure, which flows upwards through the soil profile to discharge at the land surface or into water bodies.
<b>Perennial</b>	Maintained throughout the year as opposed to behaving on a seasonal basis.
<b>Riparian</b>	Of or on the riverbank, as in riparian vegetation.
<b>Riverine area</b>	Riverine area includes the in-stream habitat, stream bed and banks, and wetlands on the adjacent floodplain. It also includes the vegetation communities, which require intermittent flooding to ensure their viability. Riverine areas define an interface between (including both) land and water-based ecosystems.
<b>Social Water Requirements</b>	Elements of the water regime that are identified to meet social (including cultural) values.
<b>Surface water</b>	Water flowing or held in streams, rivers and other wetlands on the surface of the landscape.
<b>Water regime</b>	A description of the variation of flow rate or water level over time; it may also include a description of water quality.

**Water  
resources**

Water in the landscape (above and below ground), with current or potential value to ecosystems and the community.

## References

- Australian Nature Conservation Agency 1996, *A directory of important wetlands in Australia*, 2nd. ANCA, Canberra.
- Beckwith Environmental Planning 2006, *In situ social values of groundwater-dependent features on the Gnangara Mound*, Report for the Department of Water, Beckwith Environmental Planning Pty Ltd, Perth.
- CALM 2004, *Proposed St John Brook and Jarrahwood Conservation Parks - draft management plan 2004*, Department of Environment and Conservation, Kensington.
- CALM 2005a, VISTAT Database, *Total annual visits to National Parks, State Forest and other reserves from 1994/95 to 2004/05*, Internal database of the Department of Environment and Conservation, Kensington.
- CALM 2005b, *Shannon and D'Entrecasteaux National Parks – draft management plan 2005*, Department of Environment and Conservation, Kensington.
- CENRM 2004, *Ecological water requirements of the Blackwood River and tributaries – Nannup to Hut Pool*, Report No. CENRM 11/04 for the Water Corporation by the Centre of Excellence in Natural Resource Management, University of Western Australia, Perth.
- CENRM 2006, *Blackwood River: refining ecological water requirements for the allocation planning process (Nannup to Hut Pool)*, CENRM Report No. 3/06, Report for the Department of Water, Centre of Excellence in Natural Resource Management, University of Western Australia, Perth.
- Commonwealth of Australia & the State of Western Australia 1998, *Economic profile of the tourism and recreation industries in the Regional Forest Agreement Area*. Vol. 1 & 2, Commonwealth and Western Australian Regional Forest Agreement Steering Committee, Canberra.
- CSIRO 2003, *Social values and impact study South West Yarragadee Blackwood Groundwater Area*, Report for Department of Environment, Australian Research Centre for Water in Society CSIRO, Canberra.
- Froend, R, Loomes, R, Horwitz, P, Bertuch, M, Storey, A & Bamford, M 2004, *Study of ecological water requirements on the Gnangara and Jandakot Mounds under Section 46 of the Environmental Protection Act*. Task 2: Determination of Ecological Water Requirements, Report for the Department of Environment, Centre for Ecosystem Management, Edith Cowan University, Perth, School of Animal Biology, University of Western Australia, Perth, and Bamford, MJ & AR Consulting Ecologists, Perth.

- Froend, R & Loomes, R 2006, *Determination of ecological water requirements for wetland and terrestrial vegetation – southern Blackwood and eastern Scott Coastal Plain*, Report for the Department of Environment, Centre for Ecosystem Management, Edith Cowan University, Perth.
- Goode, B 2003, *Southwest Yarragadee Blackwood Groundwater Area Aboriginal cultural values study*. Report for the Department of Environment by Brad Goode and Associates, Consulting Anthropologists and Archaeologists, Dunsborough.
- Goode, B 2006, *A survey of Aboriginal social water requirements for the southern Blackwood Plateau and the Scott Coastal Plain*, South West, Western Australia, Report for the Department of Environment, Brad Goode and Associates Consulting Anthropologists and Archaeologists, Dunsborough.
- Hyde, NL 2006, *Ecological Water Requirements of groundwater-dependent ecosystems in the South West Groundwater Areas – a summary*, Department of Water, Government of Western Australia.
- Molony, B 2005a, *'Licensed recreational marron fishery status report'*, in State of the Fisheries Report 2003/04, ed. JW, Penn, WJ, Fletcher & F, Head, Fisheries Western Australia, Perth.
- Molony, B 2005b, *'Licensed South West recreational fresh water angling status report'*, in State of the Fisheries Report 2003/04, ed. JW, Penn, WJ, Fletcher & F, Head, Fisheries Western Australia, Perth.
- Molony, B, & Bird, C 1999, *Annual report on the monitoring of the marron recreational fishery*, 1999, Fisheries Western Australia, Perth.
- Molony, B, Bird, C & Baharthah, T (unpub.), *Assessment of the recreational South West freshwater angling fishery for the 2002-03 fishing season*, Fisheries Western Australia, Perth.
- Molony, B, Morrissy, NM & Bird, C 2002, *'The West-Australian recreational marron fishery (Cherax tenuimanus) (Smith 1912) history and future challenges'*. Freshwater Crayfish, vol. 13, pp. 207-220.
- Morgan, DL & Beatty, SJ 2005, *Baseline Study on the fish and freshwater crayfish fauna in the Blackwood River and its tributaries receiving discharge from the Yarragadee Aquifer*, Report for the Department of Environment, Centre for Fish and Fisheries Research, Murdoch University, Perth.
- Shire of Augusta-Margaret River and CSIRO Sustainable Ecosystems 2006, *Augusta-Margaret River sustainable future*, CSIRO Sustainable Ecosystems, Canberra.
- Strategen 2004, *South West Yarragadee – Blackwood Groundwater Area*, water study report, Report for the Water and Rivers Commission, Strategen, Perth.
- Tourism Western Australia 2005, *Australia's South West Perspective 2004*. Government of Western Australia.
- URS 2004, *Establishment of interim ecological water requirements for the Blackwood Groundwater Area, WA – Stages 1 and 2*, Report for the Department of Environmental Protection/Water and Rivers Commission, URS, Perth.

Varma, S 2006, *Southern Perth Basin groundwater resource assessment using SWAMS and ESCP models*, Department of Water, Government of Western Australia, Hydrogeological Report No.251.

VCSRG 2005, *Wetland mapping, classification and evaluation*, southern Blackwood Plateau and eastern Scott Coastal Plain, Report for the Department of Environment, V & C Semeniuk Research Group, Perth.

Water Corporation 2005, *South West Yarragadee – hydrogeological investigations and evaluation Southern Perth Basin*. Planning and Development Division, Water Corporation, Perth.

WRC 2000, *Statewide policy No. 5 - environmental water provisions policy for Western Australia*, Water and Rivers Commission, Water and Rivers Commission, Perth.