Department of Water
Government of Western Australia

Leeuwin Spring Catchment Area and Fisher Road Water Reserve Drinking Water Source Protection Plan

Augusta Town Water Supply

Water Resource Protection Series

REPORT NO. 79
June 2007

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Subject of cover photograph

Leeuwin Spring, taken by Lazarus Leonhard

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Preface

The Department of Water (DoW) has prepared this Drinking Water Source Protection Plan to report on the activities and risks to water quality within the Leeuwin Spring Catchment Area and Fisher Road Wellfield Water Reserve and to recommend management strategies to address these risks.

A safe drinking water supply is critical to the well being of the community and catchment protection is necessary to help avoid, minimise or manage risks to water quality. The Department is committed to protecting drinking water sources to ensure the continued supply of 'safe, good quality drinking water' to consumers.

The Australian Drinking Water Guidelines (ADWG) recommend a risk based, multiple barrier approach to protect public drinking water sources. Protection of drinking water catchments is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes understanding the catchment, the hazards and hazardous events that can compromise drinking water quality, and developing and implementing preventive strategies and operational controls to ensure the safest possible water supply from our surface water dams and groundwater aquifers.

The plan details the location and boundary of the Leeuwin Spring Catchment Area and the Fisher Road Wellfield, which provide potable water to the Augusta Town Water Supply. It describes the water supply system, discusses existing and future usage of the water source, identifies risks and recommends management approaches to protect water quality.

The plan should be used to guide State and local government land use planning decisions. It should be recognised in the Shire of Augusta-Margaret River Town Planning Scheme, consistent with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7 – *Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the recommended Leeuwin Spring Catchment Area.

The stages involved in preparing a Drinking Water Source Protection Plan are:

	Stages in development of a Plan	Comment
1	Prepare Drinking Water Source Protection Assessment	Assessment document prepared following catchment survey and preliminary information gathering from government agency stakeholders.
2	Conduct stakeholder consultation	Advice sought from key stakeholders using the assessment as a tool for background information and discussion.
3	Prepare Draft Drinking Water Source Protection Plan	Draft Plan developed taking into account input from stakeholders and any additional advice received.
4	Release Draft Drinking Water Source Protection Plan for public comment	Draft Plan released for a six week public consultation period.
5	**Publish approved Drinking Water Source Protection Plan**	**Final Plan published after considering advice received in submissions. Includes recommendations on how to protect the catchment.**

Summary

The town of Augusta is located approximately 320 kilometres south-south west of Perth in the Shire of Augusta-Margaret River approximately 330 608 metres east and 6 201 808 metres north (GDA94 Zone 50) or east. The town is situated in the most south westerly corner of Western Australia on the shore of the Hardy Inlet where the Blackwood River emerges into Flinders Bay between the Leeuwin-Naturaliste and the Scott National Parks.

The northern portion of Augusta is supplied from the Fisher Road Wellfield located approximately 6 kilometres north-east of the town centre on Fisher Road. The Wellfield comprises 3 bores, bore 1/94 located within Sussex Land Location Lot 1 and bores 1/98 and 1/99 situated within Sussex Land Location (pt) Lot 25. These bores extract groundwater from confined aquifers within the Lesueur Sandstone and Warnbro Member of the Southern Perth Basin.

Drinking water for the southern portion of Augusta is obtained from the Leeuwin Spring Weir situated within Sussex Land Location 5322 adjacent to Skippy Rock Road about 6 kilometres south-southwest of the town. The weir is located in the discharge area of the Leeuwin Spring, a natural spring draining a small sand and karstic limestone catchment (Leeuwin Spring Catchment Area) at the southern tip of the Leeuwin Naturaliste Ridge.

This plan has been developed to protect drinking water quality for public health. The plan:

- identifies potential drinking water quality contamination risks from land use activities within the catchment; and
- recommends strategies to manage these potential risks whilst recognising current land use rights.

The land used for the town water supply, existing land use and proposed gazetting are described as:

1) Leeuwin Spring Catchment Area, Sussex Land Location Lot 4608 (pt) Crown Reserve A32376, is part of the Leeuwin-Naturaliste National Park, where the land is used for bush walking and tourist vehicle traffic along Skippy Rock Road. It is recommended that the catchment be managed as a Priority 1 Public Drinking Water Supply Area.
2) Leeuwin Spring Weir and pump station, Sussex Land Location 5322, comprising freehold land owned by the Water Corporation. Sussex land Location 5322 situated west and south of Skippy Rock Road will be managed as a Reservoir Protection Zone. Sussex Land Location 5321 situated north east of Skippy Rock Road will be managed as a Priority 1 Public Drinking Water Supply Area as part of the Leeuwin Spring Catchment Area.

3) Fisher Road Wellfield Bore 1/94 and the groundwater treatment facilities, Bore 1/94 is contained within Sussex Land Location Lot 1 that comprises freehold land owned by the Water Corporation. Lot 1 will be managed as a Priority 1 Public Drinking Water Supply Area.

4) Fisher Road Wellfield Bores 1/98 and 1/99,

Bores 1/98 and 1/99 are within Sussex Land Location (pt) Lot 25, comprising privately owned freehold land, for which Water Corporation have advised it has a temporary easement granting access to the bore compound. The bore compound situated on Lot 25 will be managed as a Priority 1 Public Drinking Water Supply Area.

1 Drinking water source overview

1.1 Existing water supply system

The Augusta Town Water Supply is sourced from a fresh water spring (Leeuwin Spring Weir) and a wellfield (Fisher Road Wellfield). The town is separated into two supply zones, north and south. Water from the Leeuwin Spring Weir supplies the southern section of Augusta, with groundwater developed from the Fisher Road Wellfield supplying the northern section of the town (see Figure 1). Total annual abstraction from the Leeuwin Spring Weir and the Fisher Road Wellfield between 1997 and 2004 has ranged between 296 069 kilolitre (kL) and 361 013 kL (Table 1).

Table 1 Annual abstraction (kL) from Fisher Road Wellfield and Leeuwin Spring Weir

SOURCE	2005/06	2003/04	2002/03	2001/02	2000/01	1999/00	1998/99	1997/98
Bores								
1/94	115 045	92 097	133 692	87 810	193 010	206 875	246 107	216 800
1/98	38 048	43 048	34 035	24 512	40 071	33 353	4 213	–
1/99	64 691	91 893	40 008	89 846	6 062	0	–	–
Subtotal	**217 784**	**227 038**	**207 735**	**202 168**	**239 143**	**240 228**	**250 320**	**216 800**
Weir	–	117 010	110 514	93 901	95 826	92 935	110 693	110 204
Annual Total	**–**	**344 048**	**318 249**	**296 069**	**334 969**	**333 163**	**361 013**	**327 004**

The Leeuwin Spring is located on Cape Leeuwin approximately 3 km west-southwest of the Augusta township. Water is abstracted from a weir constructed immediately north of the natural spring's location but still within the spring's discharge zone. The Leeuwin Spring is fed by rainfall within a catchment that measures approximately 50 ha. The annual statement to the Water and Rivers Commission for the 01 July 2005 to 30 June 2006 reported that there had been a noticeable decline in the level of the Leeuwin Spring outflow, and in the levels of the swamp (west of Sussex Land Location 5322) and Leeuwin Spring Weir. Water Corporation has speculated that this "is likely to be due largely to the sequence of poor winters over the past 5 years" (Water Corporation, 2007).

Both the weir and the spring are located on Sussex Land Location 5322, which is zoned for Public Purpose (water) and is surrounded by the Leeuwin-Naturaliste National Park. The Leeuwin Spring was first commissioned as a water supply source in 1962. Water from the Leeuwin Spring Weir is treated and transferred to the 1125 kL Summit Tank off Leeuwin Road (see Figure 1). Water from Summit Tank is gravity fed to the reticulation system in the southern section of the town, which accounts for approximately one-third of the Augusta's total demand.

The Fisher Road Wellfield comprises 3 bores, 1/94, 1/98 and 1/99 that are located along Fisher Road in Kudardup about 8 km north east of Augusta (see Figure 1). The wellfield was commissioned in 1994 to augment the Leeuwin Spring drinking water supply and comprises three licensed production bores (Licence 99071(4) – expiry date of 30/09/2009) abstracting groundwater from confined aquifers of the Southern Perth Basin. The Fisher Road Wellfield is licensed with abstraction not to exceed 320 000 kL per annum without prior approval from the Department of Water. Summary borehole location and groundwater production details are shown in Tables 1 and 2.

Table 2 Fisher Road Wellfield — Summary details

Bore	Location	mE & mN Zone 50 *	Maximum Recommended Pumping Rate kL/day)	Pumping Rate kL/day 2003 – 2004	Groundwater Subarea
1/94	Lot 1, Fisher Road KUDARDUP	332 250 6 207 527	1 300	1 358	Augusta
1/98	Lot 25, Fisher Road KUDARDUP	333 032 6 207 644	700	426	Blackwood
1/99	Lot 25, Fisher Road KUDARDUP	333 032 6 207 644	1 100	1 223	Blackwood

* Easting and Northing as metres east and metres north in GDA94

Water from the Fisher Road Wellfield is treated at facilities within Lot 1, Fisher Road. The treated water is then transferred to the Allnutt Terrace tank site (see Figure 1). Water transferred to Allnutt Terrace is held in a 2500 kL ground level water storage tank for transfer to the 200 kL elevated tank on the same site. Supply is boosted from the elevated tank into the distribution system for the northern section of the town, which accounts for approximately two-thirds of the town's total demand.

1.2 Water treatment

Raw untreated water from Leeuwin Spring Weir is chlorinated then dosed at the Summit Tank site with Calgon™ (sodium hexametaphosphate) at a rate of 1.0 mg/L to hold the calcium carbonate (hardness level) in solution. Groundwater abstracted from the Fisher Road Wellfield bores is chlorinated prior to entry into the treatment plant located within Sussex Land Location Lot 1. Chlorination of the groundwater provides a disinfection barrier but also oxidises dissolved iron and manganese. The iron and manganese oxides precipitate and are removed through filtering prior to transfer to the Allnutt Terrace tank site.

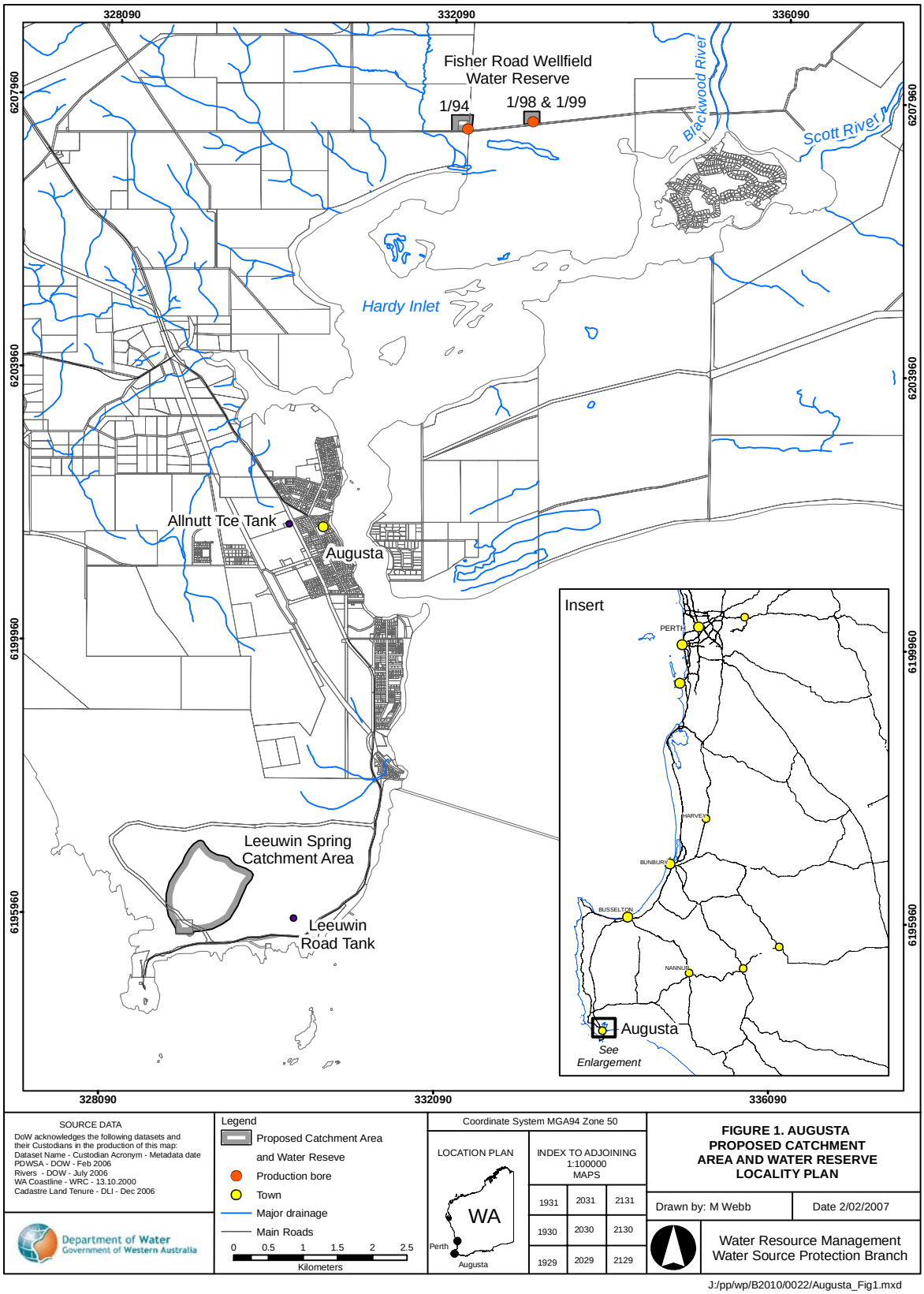

Figure 1 Augusta proposed catchment area and water reserve locality plan

1.3 Catchment details

1.3.1 Physiography

Leeuwin Spring is located at the southern extent of the Leeuwin Naturaliste Ridge (see Figure 2), a narrow strip, 0.2 to 6 km wide, which stretches between Cape Naturaliste in the north to Cape Leeuwin in the south. The Leeuwin Naturaliste Ridge appears as a undulating ridge of coastal limestone and sand, with the coastal shelfs abutting the Indian Ocean formed by bedrock exposures of granitic gneiss. The eastern boundary of the Leeuwin Naturaliste Ridge follows the foot or eastern edge of the coastal limestone, which is generally defined by the Bussell Highway.

The Fisher Road Wellfield is situated north of the Hardy Inlet and west of the Blackwood River within the Scott Coastal Plain physiographic province (see Figure 2). The wellfield is situated on an erosional plain formed at the foot of the Blackwood Plateau. This area is composed of colluvial sand overlying alluvial silt and clay associated with the Blackwood River and Hardy Inlet. The plain's surface is flat to gently undulating with a surface elevation around 5 m Australian Height Datum and falls in a general south to south-easterly direction. Although this area is included in the Scott Coastal Plain physiographic province, it is bounded by the Blackwood River and Hardy Inlet and has a geomorphological character similar to that of the Swan Coastal Plain.

1.3.2 Climate

Augusta experiences a mild Mediterranean-type climate. Daily mean maximum temperatures range from a high of 23.3°C in February to 16.3°C in July (Table 3). Daily mean minimum temperatures range from a high of 10.0°C in February to 3.3°C in June. The hottest months of the year commonly fall between November and April with the highest daily temperatures rarely exceeding 30°C.

The total annual rainfall for Cape Leeuwin between 2000 and 2005 ranged between 531 mm and 982 mm, with an average of 803 mm/annum, which is approximately 18% less than the long term average of 976.9 millimetres (mm). A decline in rainfall in the South West, amounting to about 10% of the long-term average, has been documented over the past 30 years (Playford, 2005). The total rainfall between November 2005 and October 2006 was 677.2 mm. The wettest period of the year generally falls between May and August with 65 % of the mean annual rainfall.

Table 3 Climate averages for Cape Leeuwin

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature – deg C	23	23.3	22.6	21.2	19.1	17.3	16.3	16.4	17	18.2	20.1	21.8	19.7
Lowest daily Min Temp – deg C	9.4	10	8	7.2	5.3	3.3	4.4	5	4.2	4.3	5	9.4	3.3
Mean monthly rainfall – mm	16.5	16.5	29.6	62	143.5	184.6	186.6	139.2	92.3	68.1	37.9	21.8	998.5
Highest monthly rainfall – mm	76.6	132.2	130.6	192.6	313.8	368.4	335.3	317.4	231.6	184.4	157.6	113.9	
Lowest monthly rainfall – mm	0	0	1.6	10.5	43.2	71.4	44.4	55.9	23.1	8.6	3.8	1.4	
Highest recorded daily rainfall – mm	54.9	102.4	84.8	88.4	123.2	119	104.4	174	76.2	49.5	76.2	95	174

* Climate averages for Station: 009518 Cape Leeuwin, Commenced: 1897; Last record: 2004

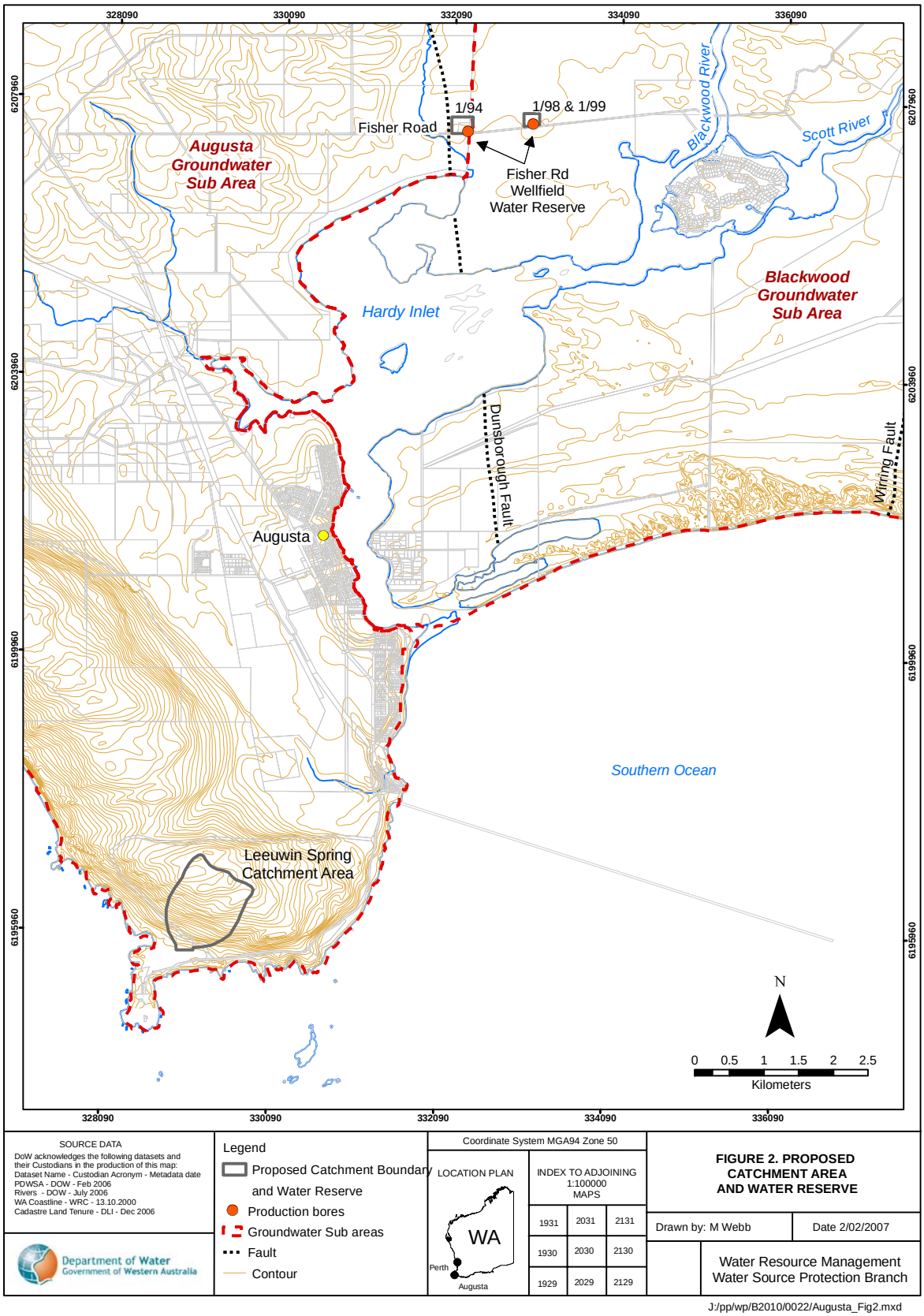

Figure 2 Proposed catchment area and water reserve

1.3.3 Hydrography/Hydrogeology

1.3.3.1 Leeuwin Spring

The area comprising the Leeuwin Naturaliste Ridge and including the Leeuwin-Naturaliste National Park between Cape Leeuwin and Augusta is located on bedrock of the Proterozoic Leeuwin Complex. The bedrock comprises primarily impermeable granitic gneiss and is unconformably overlain by variably cemented, sandy limestone (calcarenite) of the Tamala Limestone. The Tamala Limestone was deposited as coastal aeolian dunes in the Quaternary between 120 000 thousand years to 1 million years ago (Appleyard, 1989). The Leeuwin Complex is bound by the Dunsborough Fault to the east.

The Leeuwin Spring occurs at the contact between gneissic bedrock of the Leeuwin Complex and the overlying Tamala Limestone. The presence of the spring is probably related to karstic features, such as solution voids and doline structures within the Tamala Limestone ridge east of the spring (Appleyard, 1989.). This has resulted in a concentration of groundwater discharge to a very small area of the catchment. The groundwater is recharged by the infiltration of rainfall within the catchment situated up slope to the ridge crest of the Tamala Limestone. The majority of the rain falling on this area will be lost to evapotranspiration, with only a small fraction recharging groundwater feeding the Leeuwin Spring system (Appleyard, 1989).

Groundwater flow is controlled by the topography of the bedrock of the Leeuwin Complex and the presence of solution chambers and voids (karstic features) that form conduits which channel groundwater in preferred directions. The transmissivity of the Tamala Limestone will be large due the presence of karstic features, high porosity and low specific retention, which restricts the development of an extensive water table for this catchment (Appleyard, 1989).

Groundwater moves towards the coast, in a west to south-westerly direction discharging at the limestone / bedrock contact across an area occupied by the spring and a shallow swampy seepage basin of reeds and rushes. (Appleyard, 1989).

1.3.3.2 Fisher Road Wellfield

The Fisher Road Wellfield is abstracting groundwater from the confined aquifers of the Lesueur Sandstone and Warnbro Group of the Vasse Shelf of the Southern Perth Basin. This area is bounded by Dunsborough Fault (Leeuwin Complex) to the west and the Busselton Fault to the east (Baddock, 1995). The wellfield is located approximately 600m east of the Dunsborough Fault in a complex faulted and fractured area of the Southern Perth Basin that includes the Alexandra Bridge Fault and parallel faulting system following the Dunsborough Fault that probably corresponds to the Wirring Fault (Wharton 1981). The Dunsborough Fault prevents groundwater flow from the west and flows from the east are limited by the Sue Coal Measures.

The 3 main geological units underlying the wellfield are the Sue Coal Measures overlain by the Lesueur Sandstone and the Warnbro Group. The Warnbro Group is obscured under a thin horizon of Quaternary sand and silt at the wellfield. It is lateritized across the Blackwood Plateau north of the wellfield, with weathering

extending to a depth of about 30 m (Baddock, 1995). Although the Leederville Formation can not be distinguished in the Warnbro Group underlying the Fisher Road Wellfield, hydrogeological evaluation of bores 1/98 and 1/99 suggest that the developed aquifers are equivalent to the Lower Leederville Formation and the Pinjar Member of the Upper Leederville Formation (Table 4). Water Corporation pump testing and groundwater level drawdown analysis of these bores indicate that these aquifers are confined.

The Lesueur Sandstone, a confined aquifer that constitutes the primary water bearing unit for this area, is overlain unconformably by the Warnbro Group (Baddock, 1995.). The Lesueur Sandstone consists of very fine to coarse grained, cross-bedded quartz sandstone and overlies sandstone and shale of the Sue Coal Measures between the Dunsborough and Wirring Faults (Wharton, op cit.). Recharge to the Lesueur Sandstone aquifer is primarily in the State Forest to the north of the Blackwood River, and to a limited extent through leakage from the overlying Warnbro Group (Water Corporation, 1998).

The upper Warnbro Group, underlying the Fisher Road Wellfield, is hydraulically separate from the lower Warnbro Group (Water Corporation, 1998). Groundwater in the Warnbro Group is recharged by rainfall on the Blackwood Plateau where the formation outcrops, and moves southwards to discharge into the Southern Ocean along the south coast (Wharton, op cit.).

Table 4 Fisher Road Wellfield — Bore details

Bore	Casing (m AHD)	Total Depth (m bgl)	Screen Interval (m AHD)	Lithology	Aquifer	Standing Water Level (m AHD)	Aquifer type
1/94	3.78	256.82	–166.66 to –172.67	Sand, fine to gravel sized	Lesueur Sandstone	–3.5	Confined
			–180.70 to –192.72	Sandy clay			
			–202.73 to – 256.42	Clayey sand to sandy clay			
1/98	6.54	125.90	–89.90 to –125.60	Coarse sand & gravel and interbedded clayey sand	Warnbro Group Equivalent Lower Leederville	–0.7	Confined
1/99	6.49	62.51	–32.51 to –56.75	Coarse sand with dark grey / black mud and coal	Warnbro Group Equivalent Pinjar Member of the Upper Leederville	–0.79	Confined

* AHD = Australian Height Datum where 0 m AHD = approx high tide mark
** SWL measured on 08/09/99

1.4 Future water supply requirements

The Fisher Road Wellfield is not currently operating at full capacity such that this source and Leeuwin Spring Weir are considered adequate to meet current demands (Water Corporation, 2005).

Continued use of Leeuwin Spring Weir as a drinking water source is uncertain because it is not currently licensed under the *Rights in Water and Irrigation (RIWI) Act 1914* (see 'Current allocation licence', Section 1.5.2) and is subject to strict environmental flow requirements. Climatic variability (see 'Climate', Section 1.3.2) resulting in reduced and changing rainfall patterns will affect rainfall recharge to the Leeuwin Spring, increasing the uncertainty of the sustainability for current abstraction levels from the spring.

The Water Corporation have advised the Department that it is investigating new bore site locations to address the concerns about the future water supply for Augusta.

1.5 Protection and allocation

1.5.1 Existing water source protection

Catchment Areas and Water Reserves have not yet been proclaimed under the *Country Areas Water Supply (CAWS) Act 1947* to protect the Leeuwin Spring and Fisher Road Wellfield public drinking water sources from potential contamination.

1.5.2 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation (RIWI) A*ct *1914.* Under the Act, the right to use and control surface and groundwater is vested with the Crown. *RIWI,* Act 1914 requires licensing to draw water from surface water and groundwater areas proclaimed under the Act (except for domestic and stock use) and all artesian wells throughout the State. The Fisher Road Wellfield lies within the Augusta and Blackwood Groundwater Areas (which were proclaimed in 1989 under the *RIWI,* Act 1914*).*

The Leeuwin Spring is not located within a proclaimed surface water catchment area under the *RIWI* Act 1914 and therefore a licence is not required to abstract water from the spring.

The Water Corporation is licensed to draw 320 000 Kilolitres (kL) per annum (Groundwater Well Licence No. 99071(4)) from the Fisher Road Wellfield for public water supply purposes.

The current number of services supplied in Augusta in 2003/2004 is 942. The total amount of water abstracted in 2003/04 from the wellfield was 227 038 kL. Water drawn from the Leeuwin Spring over the same period equals 117 010 kL.

2 Water quality monitoring and contamination risks

The Water Corporation regularly monitors the raw untreated water quality from the Leeuwin Spring Weir and Fisher Road Wellfield for microbiological contamination, health related and aesthetic (non-health related) characteristics in accordance with the Australian Drinking Water Guidelines (ADWG). The results of this monitoring are then reviewed by an intergovernmental committee, chaired by the Department of Health, called the Advisory Committee for the Purity of Water.

A water quality summary for the Leeuwin Spring Weir and Fisher Road Wellfield from 01 February 2006 to 31 January 2007 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent Drinking Water Quality Annual Report at <www.watercorporation.com.au> > Water > Water Quality > Downloads > most recent Annual Report.

2.1 Microbiological contaminants

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses. In water supplies the pathogens of concern that can cause illness, such as stomach upset, diarrhoea and even death, are mostly found in the faeces of humans and domestic animals. Thermotolerant coliform counts are a way of measuring these pathogens and are an indicator of faecal contamination. A count less than 20 colony forming units (cfu) per 100 mL is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark (World Health Organisation, 1996).

Pathogen contamination of a drinking water source is influenced by the existence of pathogen carriers (ie humans and domestic animals, such as dogs or cattle); their subsequent transfer to and movement in the water source; and the ability of the pathogen to survive in the water source.

Pathogens may enter a water source through activities involving direct contact of people and domestic animals with the main water body or its tributaries (such as fishing, marroning and swimming), primarily through the transfer of faecal material, or indirectly through their presence (eg runoff moving faecal material into the water).

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (eg *Salmonella*, *Escherichia coli* (*E. coli*) and *Cholera*), parasites (eg *Cryptosporidium*, *Giardia*) and viruses. The percentage of humans in the world that carry various pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich, 1996).

The ability of pathogens to survive in surface water differs between species. For example, *Salmonella* may be viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich, 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) may survive weeks to months in freshwater (NHMRC & ARMCANZ, 2004).

The effects of pathogen contamination in drinking water varies significantly, ranging from illness to death, as was the case in Walkerton, Canada in 2000 where seven people died due to contamination by a particularly virulent strain of *E. coli* in the town water source and supply. Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk.

Microbiological testing of the raw-untreated and treated water from the Augusta Town Water Supply is conducted on a routine basis. The results are reported in the annual water source reviews. The Water Corporation reported in January 2005 (Augusta Water Source Review 2004) that all results, with the exception of one sample from Turner Street were below the 1996 National Health and Medical Research Council (NHMRC) guidelines (see Table 5).

Table 5 Microbiological parameters analysis summary

Parameters	Unit	SG010 Guideline	WTP Raw Water Inlet SP (1997–2004)	Alnutt Tce SP– north (1997–2004)	Victoria St SP & Dawson St. SP – north (1999–2004)	Leeuwin Spring Weir SP (1998–2004)	Turner St. – south (1999–2004)
Thermotolerant coliforms	CFU/100mL	0	0	0	0	0–23*	0
Total coliforms	CFU/100mL	0	0	0	0–1	0–100	0–12 *
Naegleria	Present (?)	No	–	No	No	No	No

Source Water Corporation 2004 Water Source Review

- Non compliant results

2.2 Health related characteristics

The raw untreated water from Leeuwin Spring Weir and the Fisher Road Wellfield has been analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the sources between October 1999 and October 2004 comprise Barium, Boron, Selenium, Uranium, Fluoride and Nitrate/Nitrite. These values are summarised in Table 8, Appendix A.

The quality of water from the Leeuwin Spring Weir and Fisher Road Wellfield is monitored in accordance with ADWG and the program set out in the Augusta Water Resource Management Operating Strategy (Water Corporation, 2002). All detected health parameters are at levels that pose no health concern. Monitoring is ongoing on a regular basis.

2.3 Aesthetic characteristics

Aesthetic water quality analyses for raw untreated water from Leeuwin Spring Weir and the Fisher Road Wellfield are summarised in Table 7, Appendix A. The values are taken from ongoing raw untreated water monitoring for the period February 2006 to January 2007. The water quality parameters that have on occasion exceeded the ADWG aesthetic guideline for supplied drinking water are shaded.

The raw untreated water from Leeuwin Spring Weir complies with ADWG aesthetic guidelines with the exception of elevated hardness level of up to 300 mg/L, but this is within the NHMRC guideline of 500 mg/L (refer to Table 7, Appendix A). The raw untreated water from the Fisher Road bores exceeds the ADWG aesthetic guidelines for turbidity, iron and manganese, while pH levels are more acidic than the guideline. The colour level in all bores is occasionally above the guideline.

Subsequent treatment of the raw untreated water by the Water Corporation mitigates these issues. ADWG gives guidance on the quality of water that should be provided to consumers at the point of use.

3 Land use

3.1 Potential water quality risks

Pesticides are toxic and some are potentially carcinogenic. Pesticides used to manage weeds, especially along roadside verges could migrate into the drinking water sources. Hydrocarbons (fuels, oils, solvents) and other chemicals are potentially toxic and carcinogenic, and harmful by-products may be formed when they are combined with chlorine. Fuel and oil leakage from vehicles traffic could create a potential contamination risk for nearby drinking water sources.

Pathogen contamination of a drinking water source is influenced by the existence of pathogen carriers (ie humans and domestic, feral and native animals) and opportunity for their subsequent transfer into the drinking water source, the ability of the pathogen to survive and the concentration required to cause illness. Pathogens may enter a drinking water source through physical contact with the source or infiltration of water containing faecal material.

3.1.1 Leeuwin Spring Weir

The risks to water quality associated with activities in and around the Leeuwin Spring Weir include contamination from pathogens, pesticides, chemicals and hydrocarbons. Hydrocarbon and chemical contamination could result from leakage or spillage from vehicle travelling along Skippy Rock Road and the adjacent beach access track. Pesticide use for the control roadside verge vegetation (weeds) along Skippy Rock Road and the adjacent beach access track would increase the risk of contamination.

Pathogens pose the most significant risk to public health. Pathogens could access the Leeuwin Spring Weir through animal contact with the spring. Bush walking activities within the Leeuwin Spring Catchment Area increases the risk of pathogen contamination.

3.1.2 Fisher Road Wellfield

Bore holes drilled in close proximity to a drinking water source bore have the potential to contaminate the drinking water source. Under the provisions of Sections 26D and 5C of the *RIWI* Act 1914*,* a licence is required to construct a bore or extract water within a proclaimed groundwater area, such as the Augusta and Blackwood Groundwater Subareas. All bores should be constructed in accordance with *Minimum Construction Requirements for Water Bores in Australia* (National Minimum Bore Specifications Committee 2003).

3.2 Existing land uses

3.2.1 Leeuwin Spring Weir — Sussex Land Location 5322

The Leeuwin Spring Weir is located on freehold land (Sussex Land Location 5322) owned by the Water Corporation, which is zoned for Public Purpose (water) and surrounded by the Leeuwin-Naturaliste National Park (Sussex Land Location 4608, part Crown Reserve A32376) (see Figure 3). Groundwater discharge associated with the Leeuwin Spring is collected behind the weir which creates a small, open water body which can be accessed by animals, such as foxes and rabbits. A chain lock fence around the south western quarter of Sussex Land Location 5322 restricts human access to the weir and pump station.

3.2.2 Leeuwin Spring Catchment Area

The Leeuwin Spring is fed by groundwater originating as rainfall recharge in a small 50 ha catchment (Leeuwin Spring Catchment Area) east of the weir (see Figure 4). The Leeuwin Spring Catchment Area is situated within the Leeuwin-Naturaliste National Park where bush walking is the primary land use.

Wildfires occur in the area each year. Past wildfires have been attributable to escaped fuel reduction burns, camp sites fires and rubbish tip fires originating on the eastern side of the Leeuwin Naturaliste Ridge within unallocated Crown Land and Crown Land managed by the Shire of Shire of Augusta-Margaret River and Margaret River.

3.2.3 Fisher Road Wellfield

The Fisher Road Wellfield is located on freehold land that is classified as rural (see Figure 3). The area west of Blackwood River, north of Fisher Road and South of Brockman Highway is classified as General Agriculture and Priority Agriculture in the Shire of Augusta-Margaret River, District Town Planning Scheme.

Due to the confined nature of the Lesueur and Warnbro aquifers the risk from the overlying land use is considered negligible.

3.2.4 Roads and tracks

Skippy Rock Road and a small beach access track cross the lower portion of the Leeuwin Spring Catchment Area and the eastern portion of Sussex Land Location 5322. The beach access track comes within 70 m of the Leeuwin Spring Weir, while the Skippy Rock Road Reserve is situated about 120 m north east of the weir (see Figure 4).

3.3 Proposed land uses

Catchment land uses and activities identified in this assessment are not expected to change significantly in the short term. Future land uses upslope of the Leeuwin Spring Weir within the proposed Leeuwin Spring Catchment Area should be conducted in accordance with DoW's Water Quality Protection Note – *Land use compatibility in Public Drinking Water Source Areas*.

There is a proposal to develop a short-stay eco-tourism development on Lot 3 Leeuwin Rd. This proposed site for the eco-tourism development is situated outside and downstream of the Leeuwin Spring Catchment Area and will not impact water quality within the Leeuwin Spring Catchment Area. There is a risk of increased tourist recreation within the nearby Catchment Area associated with the development and measures to prevent this would need to be considered during the planning stage of the development.

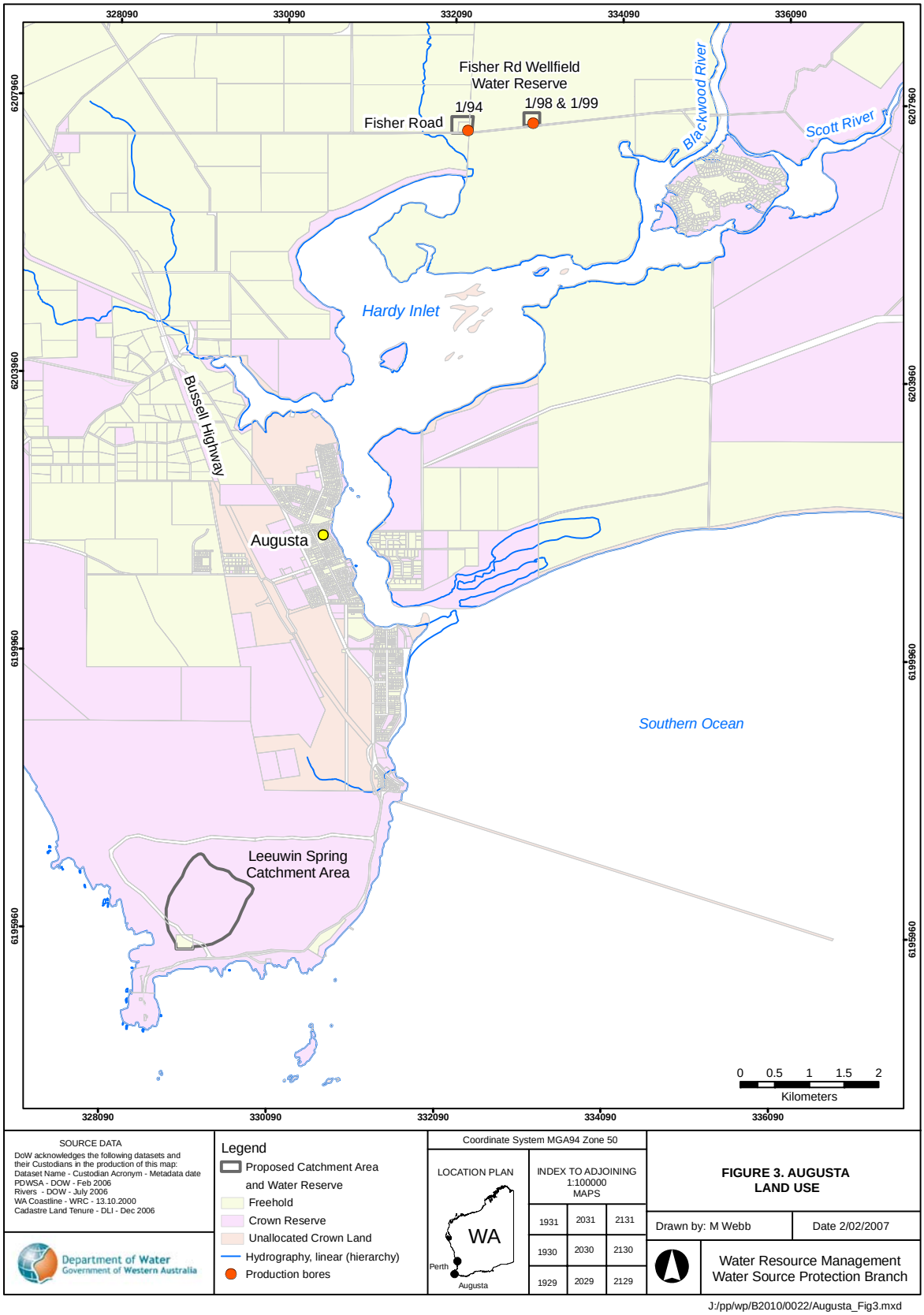

Figure 3 Augusta land use

4 Catchment protection strategy

4.1 Protection objectives

The objective of water source protection is to preserve water quality at its current level, and where practical, achieve an improvement to protect water quality for public health.

This plan recognises the right of existing approved land uses within the Leeuwin-Naturaliste National Park. However, the Leeuwin Spring Catchment Area should be managed to reduce risks to the water quality by reducing impacts related to tourist access and bush walking. The minimisation of risks to water quality for public supply is imperative for the protection of public health.

4.2 Proclaimed area

The present land utilised for the Augusta Town Water Supply comprising the Leeuwin Spring Weir, within Sussex Land Location 5322 (Figure 4), and Fisher Road Wellfield (Figure 5) have not been gazetted under the *CAWS* Act 1914 (*Act*). It is recommended that the Leeuwin Spring Catchment Area and Sussex Land Location 5321 and 5322 (east of Skippy Rock Road Reserve) are proclaimed as the 'Leeuwin Spring Catchment Area' (See Figure 4) to ensure adequate protection of the water supply source, through application of the by-laws under the *Act*. Additionally, Sussex Land Location 5322 (west of Skippy Rock Road Reserve), will be managed as the 'Leeuwin Spring Reservoir Protection Zone' to ensure adequate protection of the weir and open water body associated with the weir

The land encompassing the Fisher Road Wellfield, consisting of Sussex Land Location Lot 1 and part Lot 25 will be proclaimed as the Fisher Road Wellfield Water Reserve (West and East), to ensure adequate protection of the bores and infrastructure, through application of the by-laws under the *Act*.

4.3 Priority classifications

4.3.1 Leeuwin Spring Catchment Area

Sussex Land Location 5321 and the Leeuwin Spring Catchment Area will be classified for Priority 1 drinking water source protection (see Figures 4 and 6). This classification is appropriate because:

- Rain within the Leeuwin Spring catchment supplies the Leeuwin Spring Weir that constitutes a strategic supply to the town of Augusta so it should be afforded the highest feasible level of protection.
- The vegetation within the Leeuwin Spring Catchment Area is currently providing a significant degree of water quality protection to the Leeuwin Spring.

- Existing land uses in these areas are considered mostly compatible with Priority 1 protection objectives.

The Department's *Water Quality Protection Note – Land Use Compatibility in Public Drinking Water Source Areas* (see References) outlines activities that are acceptable, compatible with conditions or incompatible within a Priority 1 area.

4.3.2 Fisher Road Water Reserve

The Water Corporation's bore compounds along Fisher Road comprising Sussex Land Location Lot 1 and part Lot 25 (see Figure 5) will be classified as Priority 1 (P1), in order to provide the highest level of protection to the bores and infrastructure.

Given the confined nature of the groundwater source, the water reserve need only apply to land within the bore compound. Land uses outside the compounds are not expected to impact on water quality. The only limitation created by the water reserve would be in the development of additional bores that might impact on the operation of production bores in this water reserve.

4.4 Protection zones

4.4.1 Leeuwin Spring Reservoir Protection Zone

Water Corporation owned land comprising Sussex Land Location 5322 will be classified as a Reservoir Protection Zone (RPZ) (see Figures 4 and 6). This classification is appropriate because:

- Water from this source from the Leeuwin Spring Weir constitutes a strategic supply to the town of Augusta so it should be afforded the highest feasible level of protection.
- The Leeuwin Spring Weir constitutes an open body of water that should be afforded the highest feasible level of protection.
- Signage along Skippy Road can identify the RPZ to increase park visitors awareness of the Priority 1 Public Drinking Water Source Area.
- Existing land uses in these areas are considered compatible with Priority 1 drinking water source protection objectives.

4.5 Land use planning

It is recognised under the State Planning Strategy (Western Australian Planning Commission, 1997) that the establishment of appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of drinking water sources. As outlined in Statement of Planning Policy No. 2.7 – *Public Drinking Water Source Policy* (Western Australian Planning Commission, 2003) it is therefore appropriate that the Leeuwin Spring Reservoir

Protection Zone, Leeuwin Spring Catchment Area and the Fisher Road Wellfield Water Reserve, West (Sussex Land Location Lot 1) and east (Sussex Land Location (pt) Lot 25), Fisher Road, Kudardup be recognised in the Shire of Augusta-Margaret River Town Planning Scheme. Any development proposals within the Leeuwin Spring Water Reserve that are inconsistent with the Department of Water's Water Quality Protection Note – *Land Use Compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for advice and recommendations. Land use and activities in the Leeuwin Spring Catchment Area should be guided by this plan and the Water Quality Protection Note – *Land Use Compatibility in Public Drinking Water Source Areas.*

4.6 Best management practices

There are opportunities to significantly reduce risks to water quality by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect water quality. On freehold land, the Department of Water aims to work with landowners to achieve best management practices for water quality protection through the provision of management advice, and assistance to seek funding if required.

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or Water Quality Protection Notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. The guidelines help managers reduce the risk of their operations causing unacceptable environmental impacts. They are recommended as best practice for water quality protection.

Education and awareness (eg signage and information material) is a key mechanism for water quality protection, especially for those people visiting the area who are unfamiliar with the Leeuwin Spring Catchment Area. A brochure will be produced once this plan is endorsed, describing the Leeuwin Spring Catchment Area, its location and the main threats to water quality protection. This brochure will be made available to the community and will serve to inform people in simple terms about the drinking water source and its protection.

4.7 Surveillance and by-law enforcement

The quality of public drinking water sources within country areas of the State is protected under the *Country Areas Water Supply Act 1947*. Declaration of these areas allows existing by-laws to be applied to protect water quality.

The Department of Water considers by-law enforcement, through on-ground surveillance of land use activities in Public Drinking Water Source Areas as an important water quality protection mechanism.

Signs are erected to educate the public and to advise of activities that are prohibited or regulated. This plan recommends delegation of surveillance and by-law enforcement to the Water Corporation.

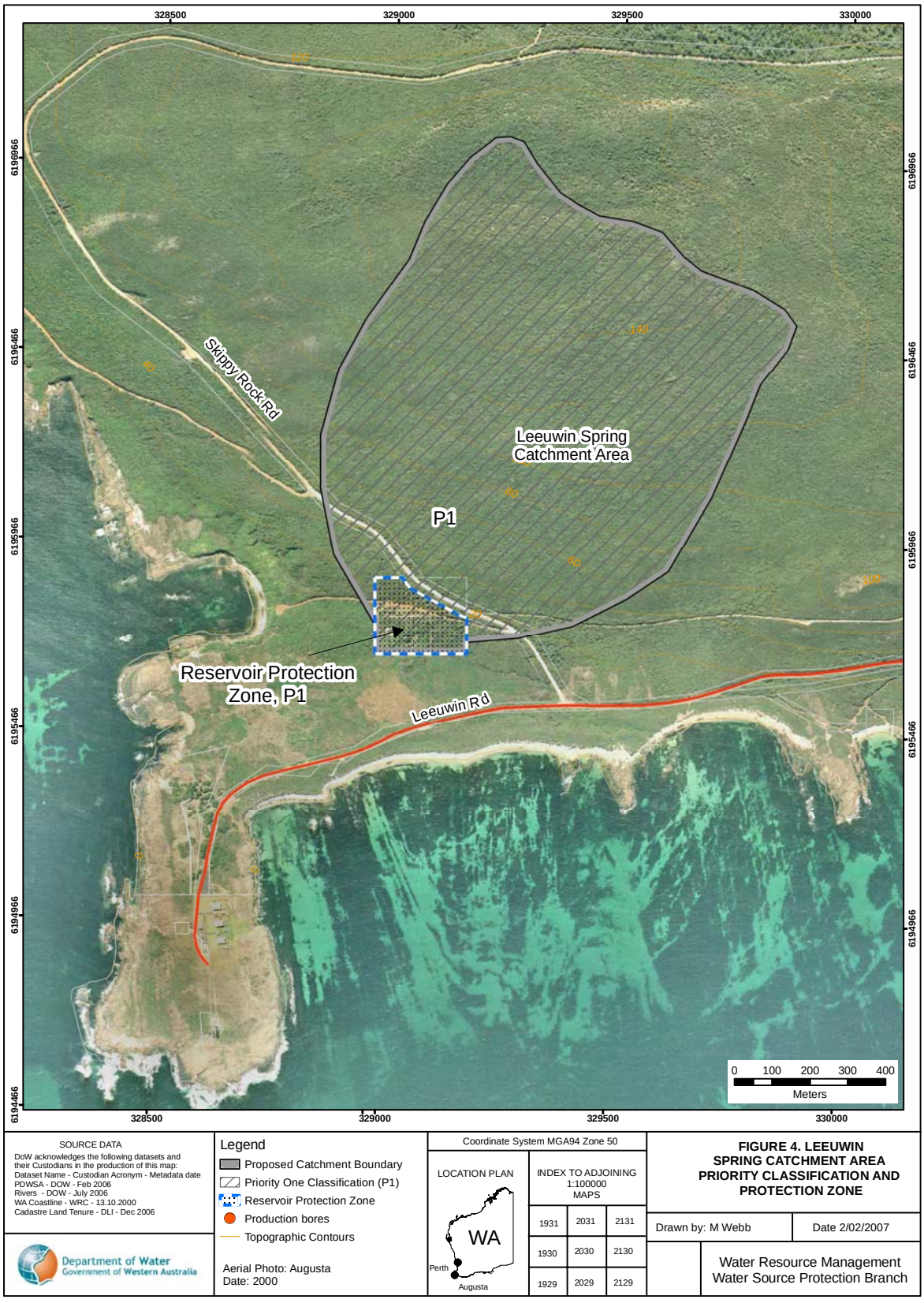

Figure 4 Leeuwin Spring Catchment Area

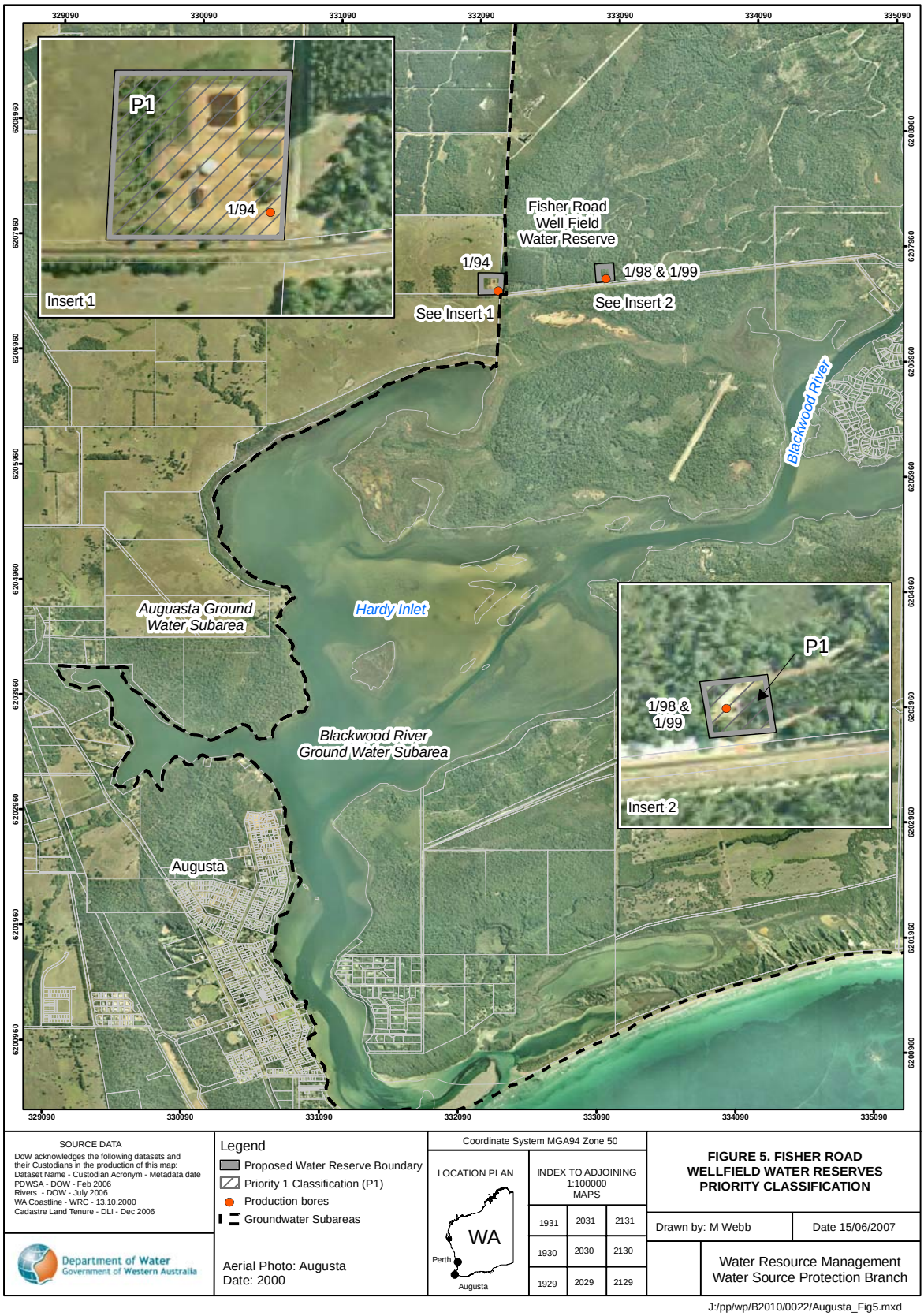

Figure 5 Fisher Road Wellfield Water Reserve priority classifications

4.8 Emergency response

Escape of chemicals during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Augusta-Margaret River Local Emergency Management Advisory Committee (LEMAC) through the Busselton – Leeuwin Naturaliste Emergency Management District should be familiar with the location and purpose of the Leeuwin Spring Catchment Area. A locality plan should be provided to the Fire and Rescue Services headquarters for the Hazardous Materials Emergency Advisory Team (HAZMAT). The Water Corporation should have an advisory role to any HAZMAT incident in the Leeuwin Spring Catchment Area.

Personnel who deal with WESTPLAN – HAZMAT (Western Australian Plan for Hazardous Materials) incidents within the area should have access to a map of the Leeuwin Spring Catchment Area. These personnel should receive training to ensure an adequate understanding of the potential impacts of spills on the water resource.

4.9 Recommended protection strategies

Table 6 identifies the potential water quality risks associated with existing land uses in the Leeuwin Spring Catchment Area and recommends protection strategies to minimise these risks.

The aquifers developed for drinking water supply for the Fisher Road Wellfield are confined. Bore details indicate that construction is appropriate for confined conditions. The potential water quality risks associated with land uses around the Fisher Road Wellfield are therefore considered negligible.

Following publication of the final Leeuwin Spring Catchment Area and Fisher Road Water Reserves Drinking Water Source Protection Plan, an Implementation Strategy will be drawn up based on the recommendations in Table 6. It will describe timeframes for the recommended protection strategies and identify responsible stakeholders and sources of funding. This is reflected in the Recommendations section of this plan.

Table 6 Leeuwin Spring Catchment Area — Land use, potential water quality risks and recommended strategies

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Tourism – Public access – Human contact with water	Pathogens	Medium	Public access to the reservoir is well restricted by fencing and signage. There is little evidence of unauthorised access.	• Fence around Leeuwin Spring Weir and pump station compound. • Water Corporation surveillance. • Water quality monitoring.	• Install signage along Skippy Rock Road, beach access track and perimeter of Sussex Ld. Loc. 5322. • Install signage along boundary of the Leeuwin Spring Catchment Area. • Maintain surveillance & monitoring • Inspect and maintain fence. • Produce a brochure for the public.
Fauna – Animal access to the weir	Pathogens	Medium	Evidence of rabbits and kangaroos around reservoir, possibly resident in the compound.	• Chain link fence around Leeuwin Spring Weir and pump station compound. • Water Corporation surveillance. • Water quality monitoring.	• Rabbit and fox proof fence around Leeuwin Spring Weir and pump station compound. • Maintain surveillance & monitoring. • Inspect and maintain fence.
Wildfire – Fire retardants & suppressants	Nutrients	Medium	• Fires are rare, as the area is reasonably wet all year. • Sandy environment with limited erosion risk. • DEC does not schedule burns for this area.	• Water Corporation surveillance • Water quality monitoring.	• Water Corporation staff to attend all fires in the catchment. • DEC/FESA to advise Water Corporation of any fires in the catchment. • Install signage along boundary of the Leeuwin Spring Catchment Area.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Vehicle use in the catchment – Accidents or spills	Hydrocarbons	Medium	• Tourism traffic along Skippy Rock Road • Beach access track by 4 wheel drive	• Water Corporation surveillance. • Water quality monitoring.	• Maintain fence around Leeuwin Spring Weir and pump station compound. • Install signage along Skippy Rock Road and beach access track with catchment. • Maintain surveillance & water quality monitoring. • Produce a brochure for the public.

Catchment Management Priority Scale Used: High, Medium and Low.

5 Recommendations

The following recommendations outline how this plan should be implemented. An implementation strategy detailing specific on the ground actions, responsible parties and funding sources will be developed after this plan is finalised, by the Department of Water.

1 Implement the recommended protection strategies as detailed in *Table 6: Leeuwin Spring Catchment Area – Land use, potential water quality risks and recommended strategies* of this plan *(Applicable stakeholders).*

2 The boundary of the Leeuwin Spring Catchment Area (pt Crown Reserve A32376) and Sussex Land Location 5321 and 5322 will be proclaimed under the *CAWS* Act 1914 as the 'Leeuwin Spring Catchment Area'.

3 Sussex Land Location 5322 (west of the western boundary of Skippy Rock Road) will be managed as the 'Leeuwin Spring Reservoir Protection Zone'.

4 Crown Reserve A32376 and Sussex Land Location 5321 will be managed for P1 protection classification.

5 Sussex Land Location Lot 1 (Fisher Road Wellfield – West) and Sussex Land Location (part) Lot 25 (Fisher Road Wellfield – East) will be proclaimed as 'Fisher Road Wellfield Water Reserves' and managed as Priority 1 PDWSA's under the *CAWS* Act 1914 (*Department of Water*).

6 Water Corporation should consult landowners in relation to any investigation of new water sources in this area.

7 Signs should be erected along the western edge of Skippy Rock Road and along the beach access track within Sussex Land Location 5322 to define the status of the land and promote public awareness of the need to protect water quality (*Water Corporation*).

8 Signs should be erected along the boundaries of the Leeuwin Spring Catchment Area and along the eastern side of Skippy Rock Road to define the location and promote public awareness of the need to protect water quality. Signs should include emergency response details and contact phone numbers (*Water Corporation*).

9 An investigation into the sustainability of Leeuwin Spring water source should be undertaken by Water Corporation, Department of Water, water licensing division and Department of Environment and Conservation.

10 Prepare an implementation strategy for this plan describing responsible stakeholders, timeframes and funding sources for the recommended protection strategies *(Department of Water, South West Region – Busselton Office).*

11 The Shire of Shire of Augusta-Margaret River Town Planning Scheme should incorporate this plan and reflect the 'Leeuwin Spring Catchment Area' (pt Crown Reserve A32376 and Sussex Land Location 5321) ,' Leeuwin Spring Reservoir Protection Zone' (Sussex Land Location Lot 5322), 'Fisher Road Wellfield Water Reserve – East' (Sussex Land Location Lot 1) and 'Fisher Road Wellfield Water Reserve – West' Sussex Land Location (pt) Lot 25 as Priority 1 Public Drinking

Water Source Protection Areas for the Shire of Augusta-Margaret River (*Department for Planning and Infrastructure, Shire of Augusta-Margaret River).*

12 All development proposals within the Leeuwin Spring Catchment Area that are likely to impact on water quality and/or quantity, or are inconsistent with Water Quality Protection Note – *Land use compatibility in Public Drinking Water Source Areas* or Statement of Planning Policy No.2.7 – *Public Drinking Water Source Policy* should be referred to the Department of Water for advice and recommendations (*Department for Planning and Infrastructure, Shire of Augusta-Margaret River).*

13 Incidents covered by WESTPLAN – HAZMAT in the Leeuwin Spring Water Reserve should be addressed through the following:

- the Busselton – Leeuwin Naturaliste LEMAC are familiar with the location and purpose of the 'Leeuwin Spring Catchment Area'.
- the locality plan for the 'Leeuwin Spring Catchment Area' is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team;
- the Water Corporation provides an advisory role during incidents in the 'Leeuwin Spring Catchment Area'; and
- personnel dealing with WESTPLAN – HAZMAT incidents in the area have ready access to a locality map of the 'Leeuwin Spring Catchment Area' and training to understand the potential impacts of spills on drinking water quality.

(*Department of Water, Water Corporation)*

14 A surveillance program should be implemented to identify any incompatible land uses or potential threats within the 'Leeuwin Spring Catchment Area'. Pursuant to Section 13(1) of the Water and Rivers Commission Act 1995, the Department of Water should delegate responsibility for the surveillance and enforcement to the Water Corporation (*Water Corporation*).

15 Signs should be erected along the boundary of the 'Leeuwin Spring Catchment Area' and the 'Leeuwin Spring RPZ' to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number (*Water Corporation*).

16 A brochure should be created for public distribution in this area to alert visitors to the Leeuwin-Naturaliste National Park of the need and ways to protect the quality of the water within the 'Leeuwin Spring Catchment Area' (*Department of Water*).

17 A review of this plan should be undertaken after five years (*Department of Water*).

Appendices

Appendix A — Water quality

The Water Corporation has monitored the raw untreated (untreated) water quality from Leeuwin Spring Weir and Fisher Road Wellfield in accordance with the Australian Drinking Water Guidelines (ADWG) and interpretations agreed to with the Department of Health. The raw untreated water is regularly monitored for:

- aesthetic related characteristics (non-health related); and
- health related characteristics including:
  - health related chemicals; and
  - microbiological contaminants.

Following is data representative of the quality of raw untreated water from Leeuwin Spring Weir and Fisher Road Wellfield In the absence of specific guidelines for raw untreated water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customers tap. Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw untreated water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment, to name a few, exist downstream of the raw untreated water to ensure it meets the requirements of the ADWG. For more information on the quality of drinking water supplied to the Augusta refer to the most recent Water Corporation Drinking Water Quality Annual Report at <www.watercorporation.com.au> > Publications > Annual Reports > Drinking Water Quality Annual Report.

Aesthetic related characteristics

Aesthetic water quality analyses for raw untreated water from Leeuwin Spring Weir and Fisher Road Wellfield are summarised in Table 7.

The values are taken from Water Corporation monitoring for the period: 01/02/2006 to 31/01/2007. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported, those that have on occasion exceeded the ADWG are shaded.

Table 7 Aesthetic related detections for Leeuwin Spring and Fisher Road Wellfield

Parameter	Range of Monitored Values (mg/L) Measure or Min – Max / Median				ADWG Aesthetic Guideline Value*
	Leeuwin Spring Weir	Bore 1/94	Bore 1/98	Bore 1/99	
Salinity (TFSS)	843	292	312	281	1 000 mg/L
Hardness ($CaCO_3$)	335	47	59	48	200 mg/L
Turbidity	0.1 – 0.2 0.1	5.6 – 140 77	2.4 – 22 8.3	0.7 – 6.6 3	5 NTU
pH	7.18 – 7.38 7.25	6.09 – 6.32 6.18	6.34 – 6.41 6.36	6.22 – 6.29 6.25	6.5-8.5
Colour	<1 – 6 <1	<1 – 3 1.8	<1 – 120 18	<1 – >200 38	15 TCU
Chloride	225	125	125	110	250
Sodium	120	72	68	64	50.5
Iron (unfiltered)	<0.003 – 0.008 0.004	11 – 14 12.4	11 – 13 12	10 – 12 11	0.3 mg/L
Manganese (unfiltered)	<0.002	0.18 – 0.22 0.2	0.141 – 0.16 0.16	0.105 – 0.128 0.116	0.1 mg/L
Aluminium (unfiltered)	<0.008 – 0.016 0.012	<0.008 – 0.01 <0.008	<0.008 – 0.02 <0.008	<0.008 – 0.01 <0.008	–

- An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.
- Shaded boxes indicate values exceeding ADWG
- For the Period : 01/02/2006 to 31/01/2007

Health related characteristics

Health parameters

Raw untreated water from Leeuwin Spring Weir and Fisher Road Wellfield has been analysed for health related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between October 1999 and October 2004 are summarised in Table 8.

Table 8 Health related detections for Leeuwin Spring Weir and Fisher Road Wellfield

Parameter	Range of Monitored Values Min – Max Median		ADWG Health Guideline Value*
	Leeuwin Spring Weir	**Fisher Road Wellfield**	
Metals			
Barium	0.011 – 0.072 0.012	<0.01 – 0.074 0.037	0.7 mg/L
Boron	0.04 – 0.06 0.05	0.04 – 0.07 0.055	4 mg/L
Selenium	<0.003 – 0.006 <0.003	No detections	0.01 mg/L
Uranium	No detections	<0.005 – 0.005 0.0025	0.02 mg/L
Inorganic			
Fluoride	0.2 – 0.45 0.25	<0.1 – 0.3 0.2	1.5 mg/L
Nitrate + Nitrite (as N)	0.86 – 1.05 1.00	No detections	11.3 mg/L

- A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption.
- Source: Water Corporation Western Australia

Appendix B — Photographs

Photo 1 Leeuwin Spring Weir looking east

Photo 2 Leeuwin Spring Catchment, looking east – north east

Photo 3 Fisher Road Wellfield, Sussex Land Location Lot 1, portraying infrastructure for pumping and treatment

Photo 4 Fisher Road Wellfield, Sussex Land Location Lot 1, Production Bore 1/94.

Glossary

Abstraction The pumping of groundwater from an aquifer.

ADWG The Australian Drinking Water Guidelines, outlining guideline criteria for the quality of drinking water in Australia.

Aeolian Eolian, pertaining to the wind, especially of deposits such as dune sand or of erosion and deposition accomplished by the wind.

Aesthetic guideline NHMRC guideline level ascribed to acceptable aesthetic qualities of drinking water such as taste, smell, colour and temperature.

AHD Australian Height Datum is the height of land in metres above mean sea level. For example this is +0.026 m at Fremantle.

Allocation The quantity of water permitted to be abstracted by a licence, usually specified in kilolitres per annum (kL/a).

Anisotropic Having different properties in different directions.

ANZECC Australian and New Zealand Environment Conservation Council.

Aquifer A saturated geological formation or group of formations capable of producing water.

ARMCANZ Agriculture and Resource Management Council of Australia and New Zealand.

Augment To increase the available water within a storage dam by pumping back water from a secondary storage/reservoir dam.

Bore A narrow, lined hole, also known as a well, drilled to monitor or extract groundwater.

Blackwood Plateau Physiographic region of the South West of Western Australia comprising the area of land positioned between the Dunsborough Fault and the Darling Fault (west & east), the Whicher Scarp and the Scott Coastal Plain (north and south). The Blackwood Plateau is underlain by Mesozoic sediments of the Southern Perth Basin.

Bore field A group of bores to monitor or withdraw groundwater.

Catchment The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.

CFU	Colony forming units is a measure of pathogen contamination in water.
Confined aquifer	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
Diffuse source	Pollution originating from a widespread area eg urban stormwater runoff, agricultural infiltration.
Dunsborough Fault	A system of echelon faults trending generally north-south, which separate the Leeuwin Complex crystalline rocks from the Mesozoic sediments of the Perth Basin.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
EC	Electrical conductivity estimates the amount of total dissolved solids (TDS), or the total amount of dissolved ions in a solution (water) corrected to 25^{o} Celcius. Measurement units include milliSiemens per metre and microSiemens per centimetre.
GL	Gigalitre (1 000 000 000 litres) or 1 million kilolitres
ha	Hectare (a measure of area) = 10 000 square metres
HAZMAT	Hazardous Materials
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Karst / Karstic	A type of topography that forms in limestone environments through the percolation of rainfall that results in the dissolution or dissolving of the limestone, and is characterised by depressions and sinkholes (dolines), caves and underground drainage.
kL	Kilolitre (1000 litres) or 1 cubic metre
km	Kilometre (1000 metres)
km^2	Square kilometre (a measure of area) = 1 000 000 square metres

Laterite / Lateritic	These terms refer to the horizon of in-situ material which has been formed from the total weathering of rock. The laterite profile, when intact, consists of sand, believed to have formed as the alluvial zone of the laterite profile, overlying ferruginous gravel or ferricrete which is underlain by clayey sand, sandy clay and clay, differentiated in some areas into a mottled and pallid zone, which grade, at depth, into a highly weathered rock. The term is commonly applied, in Western Australia, to define a massive, vesicular, or concretionary rocks, composed of iron and aluminium oxides which constitutes the hard, competent ferricrete portion of the laterite profile.
Lateritised / Lateritisation	A general terms for the weathering process that converts a rock to a laterite.
Leeuwin Complex	The Leeuwin Complex comprises a suite of intensely deformed (metamorphosed) Archaean plutonic igneous rocks (primarily granitic gneiss) which are present west of the Dunsborough Fault and underlie the Witchcliffe Uplands and Leeuwin-Naturaliste Ridge regions of the South West of Western Australia.
Leaching / leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
LEMAC	Local Emergency Management Advisory Committee
m	Metres
mg/L	Milligram per litre (0.001 grams per litre) as a measurement of a total dissolved solids (salt) in a solution.
ML	Megalitre (1 000 000 litres)
mm	Millimetre
MPN	Most probable number (a measure of microbiological contamination).
mSv	Millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2mSv/yr.
mS/m	MilliSiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.

NHMRC	National Health and Medical Research Council.
NTU	Nephelometric turbidity units are a measure of turbidity in water.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
Nutrient	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
Pathogen	A disease producing organism. Disease producing organisms that can cause disease through the consumption of water which include bacteria (such as Escherichia coli), protozoa (such as Cryptosporidium and Giardia) and viruses.
Perched	An unconfined aquifer, often ephemeral or seasonal, perched on top of an impermeable horizon near the land surface and separated from deeper groundwater by an unsaturated zone.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Point source pollution	Pollution originating from a specific localised source, eg sewage or effluent discharge, industrial waste discharge.
Pollution	Water pollution occurs when waste products or other substances, eg effluent, litter, refuse, sewage or contaminated runoff, change the physical, chemical biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses.
Public Drinking Water Source Area (PDWSA)	PDWSA's include all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.
Quaternary	The younger of the two geologic periods of the Cainozoic era consisting of the Pleistocene and Holocene (recent) epochs and comprises all geologic time from the end of the Tertiary to and including the present

Recharge	Water infiltrating to replenish an aquifer.
Recharge area	An area through which rainfall or surface water will infiltrate (percolates) into the ground to replenish groundwater or recharge an aquifer. An unconfined aquifer is recharged by direct rainfall throughout its distribution. A confined aquifer is recharged in specific areas where the geological unit containing the aquifer is exposed at the surface.
Reservoir	A reservoir, dam, tank, pond or lake that forms part of any public water supply works.
Run-off	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority of private company and supplied via a distribution network to customers for urban, industrial or irrigation use.
Storage reservoir	A major reservoir of water created in a river valley by building a dam.
Stormwater	Rainwater which has run off the ground surface, roads, paved areas etc. and is usually carried away by drains.
Swan Coastal Plain	The physiographic province comprising land between the Darling Scarp / Whicher Scarp and the coast, which consists of Cainozoic sediments.
Tamala Limestone	The name Tamala Limestone consists of a coarse to medium-grained calcarenite composed largely of skeletal fragments (mainly foraminifers and molluscs), and containing variable amounts of quartz sand. The formation, which contains large-scale cross-bedding, palaeo-soil horizons and calcified root structures, was deposited as coastal sand dunes (lime-sand eolianite).
TCU	True colour units (a measure of degree of colour in water)
TDS	Total dissolved salts, a measurement of ions in solution, such as salts in water.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.

Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	The physical, chemical and biological measures of water.
Water Reserve	An area proclaimed under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater. A wellhead protection zone (WHPZ) is usually declared around wellheads in drinking water areas to protect the water source from contamination.
WESTPLAN HAZMAT	Western Australian Plan for Hazardous Materials.

References

Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & Australian and New Zealand Environment and Conservation Council (ANZECC) 1996, *Draft Rural Land Uses and Water Quality – A Community Resource Document*, ARMCANZ & ANZECC, Canberra.

Appleyard, S. J., 1989, *Augusta Town Water Supply – Decreasing yield of the Cape Leeuwin Spring*, Western Australia Geological Survey, Hydrogeology Report 1989/20 (unpublished).

Baddock, L. J., 1995, *Geology and Hydrogeology of the Scott Coastal Plain, Perth Basin*, Western Australia Geological Survey, Record 1995/7.

Commander, D. P., 1972, *Groundwater prospects in the Perth Basin North East of Augusta*, Western Australia Geological Survey, Hydrology Report No. 951 (unpublished).

Department of Conservation and Land Management, 1989, *Leeuwin Naturaliste National Park Management Plan1989-1999*, Management Plan No. 13, February, 1989, Department of Conservation and Land Management, Como, WA.

Department of Health, 2006, *Use of Herbicides in Water Catchment Areas*, Circular No: PSC 88, August 2006, Department of Health, Perth.

Department of Water Various dates, Water Quality Protection Notes – *Various titles*, Department of Water, Perth, available <www.water.wa.gov.au > Water Quality > Publications > Water Quality Protection Notes.

Geldreich E.E., 1996, *Pathogenic Agents in Freshwater Resources*, Hydrological Processes, Volume 10, pp 315-333, 1996.

Government of Western Australia 1909, *Metropolitan Water Supply Sewerage and Drainage Act*, Reprinted under the Reprints Act 1984 as at 17 February 2006, available <http://www.slp.wa.gov.au/statutes/swans.nsf>.

Government of Western Australia 1947, *Country Areas Water Supply Act*, reprinted under the Reprints Act 1984 as at 7 April 2006, available <http://www.slp.wa.gov.au/statutes/swans.nsf>.

National Health and Medical Research Council & ARMCANZ, 2004, *National Water Quality Management Strategy: Australian Drinking Water Guidelines*, NHMRC & ARMCANZ, Canberra, available <www7.health.gov.au/nhmrc/publications/synopses/eh19syn.htm>

National Minimum Bore Specifications Committee 2003, *Minimum construction requirements for water bores in Australia,* 2nd edition, Land and Water

Biodiversity Committee, Queensland, available <http://portal.water.wa.gov.au/portal/page/portal/LicensingWaterIndustryServices/Licensing/Publications/Content/MCRWBA.pdf>

Playford, P. E., 2005, *Wester Australia: Water Policy in Climate Uncertainty*, Australian Academy of Technical Science and Engineering, Parkerville, Victoria.

Water and Rivers Commission, 2000, *Statewide Policy No.2 – Pesticide Use in Public Drinking Water Source Areas*, Water and Rivers Commission, Perth, available <www.water.wa.gov.au> > Policies > Statewide Policies.

Water and Rivers Commission, 2003, *Statewide Policy No.13 – Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*, Water and Rivers Commission, Perth, available <www.water.wa.gov.au> > Policies > Statewide Policies.

Water Corporation, 1998, *Augusta Water Source Review,* Report No. A4-519, Infrastructure Planning Branch, Planning and Development Division, Water Corporation, Perth (unpublished).

Water Corporation, 2002, *Augusta Water Resource Management Operation Strategy,* Infrastructure Planning Branch, Planning and Development Division, Water Corporation, Perth (unpublished).

Water Corporation, 2005, *Augusta Water Source Review 2004,* Infrastructure Planning Branch, Planning and Development Division, Water Corporation, Perth (unpublished).

Water Corporation, 2006, *SG097 Source Protection Operations Manual*, Infrastructure Planning Branch, Planning and Development Division, Water Corporation, Perth (unpublished).Water Corporation, 2007, *Annual Statement to Water and Rivers Commission*, Water Corporation, Perth (unpublished).

Western Australian Planning Commission 1997, *State Planning Strategy*, State Government of Western Australia, Perth, available <www.wapc.wa.gov.au/Publications/52.aspx>.

Western Australian Planning Commission 2003, Statement of Planning Policy No. 2.7 – *Public Drinking Water Source Policy*, Government Gazette WA, 10 June 2003, pp. 2077-82, Government of Western Australia, Perth, available <www.wapc.wa.gov.au/Publications/149.aspx>.

Western Australian Planning Commission 2006, State Planning Policy No. 2.9 – *Water Resources*, Government Gazette WA, 19 December 2006, pp. 5707-22 Government of Western Australia, Perth, available <http://www.wapc.wa.gov.au/Publications/1281.aspx>.

Wharton, P. H., 1981, *Groundwater prospects at Augusta*, Western Australia Geological Survey, Hydrogeology Report No. 2356, (unpublished).

World Health Organisation 1996, *Guidelines for Drinking-Water Quality – Volume 2 – Health Criteria and Other Supporting Information*, 2nd edn, World Health Organisation, Geneva, available <www.who.int/water_sanitation_health/dwq/en/2edvol2p1.pdf>.

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