



Government of **Western Australia**  
Department of **Water**



*Looking after all our water needs*



# Arrowsmith groundwater area subarea reference sheets

Plan companion for the Arrowsmith groundwater  
area allocation plan

Department of Water

August 2009

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August 2009

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ISBN 978-1-921675-15-7 (online)

**Acknowledgements**

The Department of Water would like to acknowledge the following for their contribution to this publication: Rebecca Palandri, Tasnim Sandooyea, Kylie Benton, Fleur Coaker, Katherine Bozanich, Natalie Lauritsen, Lazarus Leonhard and Adam Maskew.

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# 1 Introduction

## 1.1 Purpose of the plan

The *Arrowsmith groundwater area allocation plan* provides the State government's direction on how Arrowsmith groundwater resources will be allocated and managed, now and in the future, under the current *Rights in Water Irrigation Act 1914*.

The department prepared the plan to provide clear direction to organisations, industry, individuals and licensing officers about the current water availability and management responsibilities in the developing the Arrowsmith groundwater area. The plan replaces *Managing the water resources of Arrowsmith groundwater area WA – Interim sub-regional allocation strategy* (WRC 2002b). We used the most up-to-date information that we had available to develop the plan.

## 1.2 Purpose of the subarea reference sheets

The subarea reference sheets are designed to assist with licensing of groundwater in the plan area (Figure 1) by providing local subarea-based information and guidance on the licensing process. The reference sheets will help to inform prospective licence applicants of their local area requirements for water use in a specific subarea and provide general information to assist in the application process.

## 1.3 Licensing information and the plan

The *Arrowsmith groundwater area allocation plan* contains the specific licensing policies and rules that apply to all subareas and must be used in conjunction with this document in any licence assessment process or new application.

The licensing information detailed in this document follows standard statewide protocols and processes used across all plans. For further information please visit the department's website.

Applicants should be aware of the licensing policies and local area rules that may apply to them before submitting their groundwater licence application to the department.

Licensing forms for licence applications can be found on the Department of Water's website: <[www.water.wa.gov.au](http://www.water.wa.gov.au)> Doing business with us > Water licensing > Licensing publications and forms > or by contacting our Mid West regional office in Geraldton on 08 9965 7400.



Figure 1 The plan area

## 1.4 How to use the subarea reference sheets

The reference sheets provide background information on a particular groundwater subarea (Figure 2). Each subarea has different issues associated with licensing and water management. The reference sheets provide summarised information on the subarea including:

- proclamation, water use and water management issues
- allocation limits and water availability
- hydrogeology
- ecological, social, cultural and recreational sites of significance that were considered in the assessment process for groundwater licensing.

For the full technical detail please see the *Arrowsmith groundwater area allocation plan* for a complete reference and recommended reading list or visit our website <[www.water.wa.gov.au](http://www.water.wa.gov.au)>.

For a licence application to be assessed it should be consistent with, and meet the requirements of, the *Arrowsmith groundwater area allocation plan* and the *Rights in Water and Irrigation Act, 1914*. These reference sheets provide basic information that can be used in a clause 7 (2) licence assessment process under the Act (see Appendix A and Table A1). The information contained in the reference sheets must also be used in conjunction with the following information:

- the objectives for water management described in the *Arrowsmith groundwater area allocation plan* (Chapter 2 of the plan)
- the policies and rules listed in the *Arrowsmith groundwater area allocation plan* (Section 4.1–4.2 of the plan)
- State and Commonwealth legislation relating to water and its use (Appendix B)
- licensing process (Appendix A), unless otherwise stated in the plan
- statewide policies, guidance and allocation notes (Appendix A)
- *Allocation limit review for the Arrowsmith and Jurien groundwater areas* (DoW 2009).

There are also numerous documents produced by the department and other government agencies that provide information on a range of water management issues that can be used as reference material for licence applications and in the assessment process. The most relevant of these are listed in Appendix B.

Appendix C provides a list of useful departmental websites to access for additional information linked to components of the water management process and used in the licence assessment process. Any licence application should be consistent with other departmental plans and other government agencies plans or strategies where applicable.

Please note that all data presented have specified dates of collection and interpretation. New and updated information should be collected and used where appropriate. All technical and supporting documents are available on the department's website <[www.water.wa.gov.au/allocationplanning](http://www.water.wa.gov.au/allocationplanning)>.

## 1.5 Water information data requests

The Department of Water monitors water levels and water quality in its monitoring bore network, storing the data on our water information network (WIN). This information is up-to-date and available upon request using the data request form found here: <[www.water.wa.gov.au](http://www.water.wa.gov.au)> Tools >Monitoring and data> or by contacting the department's regional office in Geraldton. The form is electronic and can be emailed or posted to us.



Figure 2 Subarea boundaries

## 2 Subarea reference sheets

We undertake a clause 7 (2) assessment under the provisions of the *Rights in Water and Irrigation Act 1914* to assess a licence application. In conducting this assessment we consider the impacts from the abstraction of the water and its use on ecological, cultural, social and economic factors.

Important sites and values that we consider have been listed in the subarea reference sheets. These are not the full list of values or sites, but the most relevant to water management for a particular subarea that we consider for all groundwater licence applications. Some of the sections of the subarea reference sheets are discussed below.

### *Ecological*

When we assess a licence application, we consider nearby groundwater-dependent ecosystems (GDE). A map of potential groundwater-dependent ecosystems in the Northern Perth Basin is in Rutherford, Roy and Johnson (2005) which is available on our website. Alternatively, you can view the map by clicking on the following link.

[http://portal.water.wa.gov.au/portal/page/portal/WaterManagement/Publications/HydrogeologicalRecordsSeries/Content/HG11\\_MAP.pdf](http://portal.water.wa.gov.au/portal/page/portal/WaterManagement/Publications/HydrogeologicalRecordsSeries/Content/HG11_MAP.pdf)

Many groundwater-dependent ecosystems contain or are linked to:

- declared rare flora
- declared rare fauna
- threatened ecological communities
- environmental protection policy wetlands
- Australian national conservation areas
- Ramsar wetlands
- numerous water courses and their associated pools, bed and banks.

These sites are listed in the subarea reference sheets to highlight their presence. The level of knowledge on these sites may be limited and as such, licensees may be requested to undertake investigation work, if it has not previously been carried out, in order to prove that the proposed drawdown will not adversely affect these sites.

### *Cultural*

The claimant groups listed and any reference to Aboriginal sites of significance (listed heritage sites) have been extracted from the Department of Indigenous Affairs database. The information only refers to those claims that have been determined and the sites are listed on the permanent register. The listed sites in the subarea reference sheets are directly related to water management and a full search is always undertaken during a licence assessment to ensure that the proposed impacts

are acceptable. Applicants may be required to undertake work associated with Aboriginal heritage if a site is likely to be disturbed.

### *Social*

The major social water use values considered are public and private drinking water (including domestic, stock and garden use) and recreational sites. The localities in each subarea are listed to help licensees find out which subarea they are located in. Although there are many different types of recreational sites related to water, only those which are known to be groundwater-dependent are listed.

### *Economic*

The economic aspects of water management are covered by the sections on licensed water use, allocation and water availability. This includes accounting for existing use and exempt use in determining the allocation limits and assessing any new licence applications.

## 2.1 Allanooka

Allanooka																				
Subarea description																				
<b>Area</b>	541 km <sup>2</sup>																			
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)																			
<b>Shire</b>	Shires of Irwin and Mingenew																			
<b>Rainfall</b>	500 mm <sup>1</sup>																			
<b>Licensed water use (as at January 2009)</b>																				
<table border="1" style="display: none;"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Public water supply</td> <td>99.17%</td> </tr> <tr> <td>Domestic, stock and garden</td> <td>0.41%</td> </tr> <tr> <td>General agriculture</td> <td>0.31%</td> </tr> <tr> <td>Service sector</td> <td>0.11%</td> </tr> <tr> <td>Horticulture</td> <td>0.00%</td> </tr> <tr> <td>Irrigated pasture</td> <td>0.00%</td> </tr> <tr> <td>Mining and industry</td> <td>0.00%</td> </tr> <tr> <td>Viticulture</td> <td>0.00%</td> </tr> </tbody> </table>		Sector	Percentage	Public water supply	99.17%	Domestic, stock and garden	0.41%	General agriculture	0.31%	Service sector	0.11%	Horticulture	0.00%	Irrigated pasture	0.00%	Mining and industry	0.00%	Viticulture	0.00%	<p><b>Total licensed entitlements:</b> 12 100 500 kL/yr</p> <p><b>Aquifer sourced:</b> Yarragadee: 12 100 500 kL/yr</p>
Sector	Percentage																			
Public water supply	99.17%																			
Domestic, stock and garden	0.41%																			
General agriculture	0.31%																			
Service sector	0.11%																			
Horticulture	0.00%																			
Irrigated pasture	0.00%																			
Mining and industry	0.00%																			
Viticulture	0.00%																			
<b>Issues for water management</b>																				
<p>The Yarragadee is the only aquifer present capable of producing large volumes of fresh water. There is a thin layer of surficial sediments present but it is unlikely that any water can be abstracted for use other than stock water and domestic supply.</p>																				
Allocation and water availability																				
Aquifer	Allocation limit kL/yr	Available water																		
Surficial	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing these aquifers <sup>2</sup> .																		
Yarragadee	28 800 000	Contact the Geraldton office for up-to-date availability.																		
Cattamarra	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing these aquifers <sup>2</sup> .																		
Hydrogeology																				
Aquifer	Description																			
Surficial	Surficial sediments are present across the whole subarea as a thin veneer forming a shallow localised colluvial and alluvial lens over the underlying formations.																			
Yarragadee	The Yarragadee aquifer is a major freshwater resource capable of supplying bore yields of > 5 000 kL/day. The aquifer is composed of interbedded sand, sandstone, siltstone and shale. Sand content in the formation decreases with depth and varies in thickness across the aquifer. It is overlain by thin surficial deposits and is unconfined throughout the Arrowsmith region.																			

<b>Allanooka</b>	
	The aquifer extends to 200 m below ground level and discharges into the Irwin River.
Cattamarra	The Cattamarra formation is present at depth underlying the Yarragadee formation. The Cattamarra is separated from the overlying Yarragadee formation by the Cadda formation. Water in the Cattamarra is saline at depth. Due to the depth of the formation the Cattamarra aquifer does not have an allocation limit.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Irwin River and its tributary Hunt Gully.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Several sites are registered, with the majority associated with the main stem of the river and with road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people and Mullewa-Wadjari people are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji Aboriginal Land and Sea council for more information.</p> <p><i>Aboriginal heritage sites:</i> Allanooka swamp, Irwin and Lockier rivers as historical and mythological sites.</p>	
<b>Social</b>	
<p><i>Towns and localities:</i> Allanooka, Lockier, Milo, Moorriary, Mount Horner, Yardarino, Yarragadee, and localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction.</p> <p><i>Public water supply:</i> The towns of Geraldton, Dongara and Port Denison, although outside the subarea, are supplied with scheme water from the Yarragadee aquifer by the Water Corporation. There is a water source protection plan<sup>3</sup> and protection zone around the areas of abstraction.</p> <p><i>Recreational sites:</i> Irwin River.</p>	

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.
- 3 *Allanooka and Dongara–Port Denison water reserves water source protection plan – Geraldton and Dongara–Port Denison town water supply*, WRC 2002a.

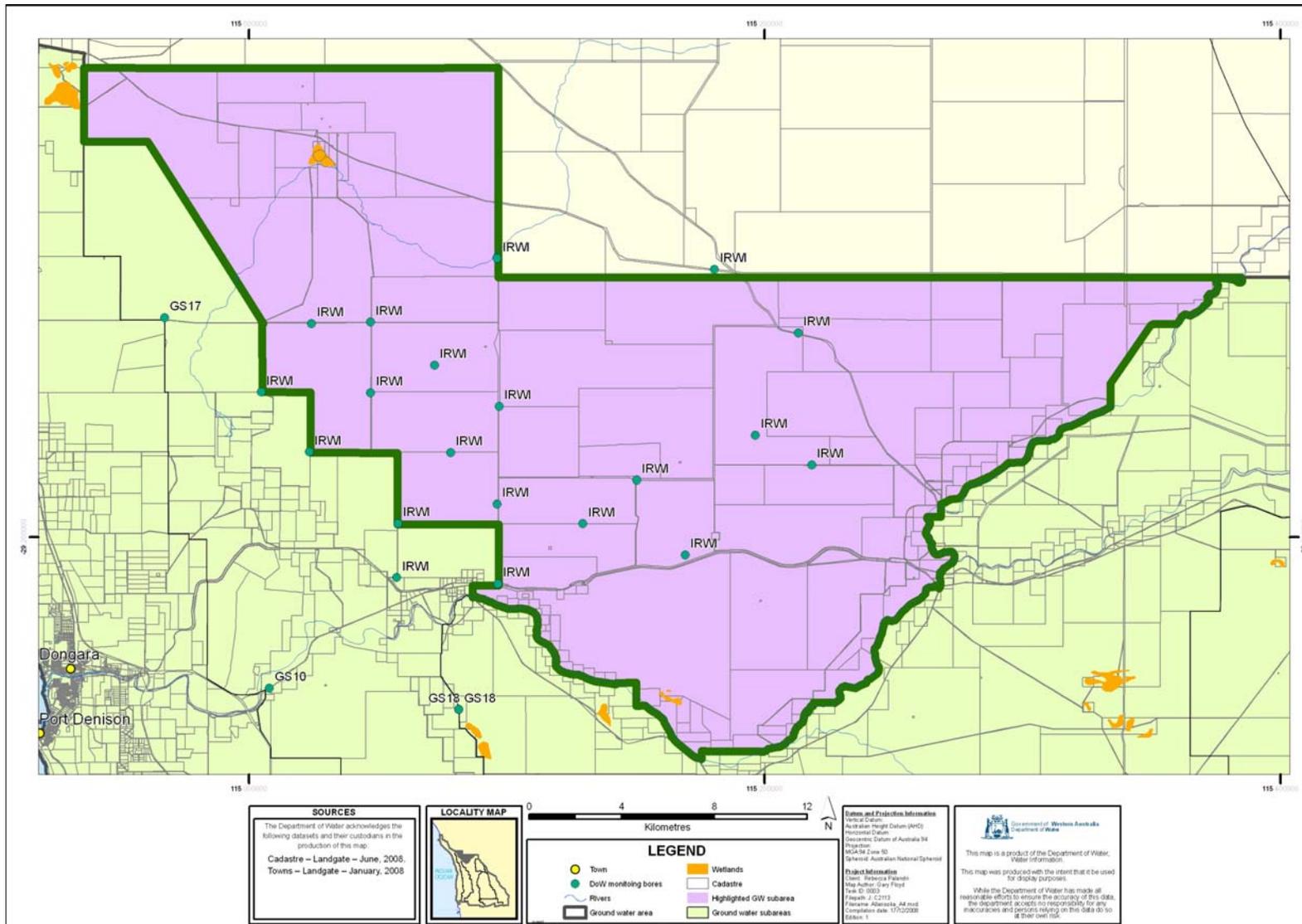
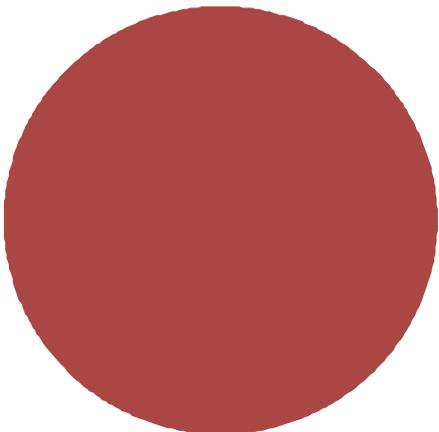


Figure 3 Allanooka subarea

## 2.2 Darling

Darling		
Subarea description		
<b>Area</b>	1536 km <sup>2</sup>	
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)	
<b>Shire</b>	Shires of Three Springs, Carnamah and Coorow	
<b>Rainfall</b>	400 mm <sup>1</sup>	
<b>Licensed water use (as at January 2009)</b>		
 <p style="text-align: center;">100.00%</p>	<ul style="list-style-type: none"> <li><span style="color: yellow;">■</span> Domestic, stock and garden</li> <li><span style="color: #800000;">■</span> General agriculture</li> <li><span style="color: #6aa84f;">■</span> Horticulture</li> <li><span style="color: #4169e1;">■</span> Irrigated pasture</li> <li><span style="color: #a9a9a9;">■</span> Mining and industry</li> <li><span style="color: #ffa500;">■</span> Public water supply</li> <li><span style="color: #4682b4;">■</span> Service sector</li> <li><span style="color: #c08080;">■</span> Viticulture</li> </ul>	<p><b>Total licensed entitlements:</b> 5000 kL/yr</p> <p><b>Aquifer sourced:</b> surficial: 5000 kL/yr</p> <p><b>Use:</b> General agriculture (100%) – intensive stock watering only</p>
<b>Issues for water management</b>		
<p>The nature and location of the aquifers in this subarea may restrict their accessibility and water availability. There is limited monitoring of the groundwater resources and comprehensive hydrogeological investigations have not been undertaken in this area.</p> <p>There is a fractured rock aquifer system present in this subarea which has localised availability with variable supply and quality, depending upon bedrock fractures and faults.</p>		
Allocation and water availability		
Aquifer	Allocation limit kL/yr	Available water
Surficial	2 500 000	Contact the Geraldton office for up-to-date availability.
Cattamarra	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing these aquifers <sup>2</sup> .
Eneabba	N/A	
Lesueur	1 400 000	
Parmelia	N/A	
Otorowiri	N/A	
Yarragadee	N/A	
Hydrogeology		
Aquifer	Description	
Surficial	East of the Gingin Scarp the surficial formation forms a shallow localised colluvial and alluvial lens over the underlying formations.	

<b>Darling</b>	
	The aquifer ranges from saturated to unsaturated across the subarea. The aquifer only provides low supply, has variable water quality and is often brackish.
Eneabba, Lesueur, Cattamarra, and Yarragadee	The formations are only present in the southern portion of the subarea. The formations are upwardly faulted into a near vertical position with limited connectivity. Local recharge from downward infiltration from rainfall.
Parmelia	The formation is only present in the southern portion of the subarea. The formation is overlain by surficial deposits and ranges from semi-confined to confined. The aquifer is located in the Parmelia Sand Member and is generally fresh. The aquifer is composed of interbedded sand, clay and silt.
Otorowiri	The Otorowiri Siltstone Member is a distinct unit within the Parmelia formation. It is a localised confining member overlain by the sandier, upper member of the Parmelia formation. The member acts as an aquiclude between the Parmelia and the Yarragadee aquifers.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Yarra Yarra Lakes; the Coonderoo River and its tributary Gunyidi North; Yarramonger and Marchagee rivers and the headwaters of the Arrowsmith River; Petan and Salt creeks.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority associated with the nature reserves and road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people and Yued group are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji or South West Aboriginal Land and Sea councils for more information.</p> <p><i>Aboriginal heritage sites:</i> the only registered sites relating to water are the Yarra Yarra lakes and Bimara (lodged as heritage sites, yet to be determined).</p>	
<b>Social</b>	
<p><i>Towns and localities:</i> Arrino, Carnamah, Coorow, Eganu, Gunyidi, Kadathinni, and Marchagee localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction.</p> <p>The towns of Arrino, Bunjil, Caron, Latham, Morawa, and Perenjori (Arrowsmith water reserve <sup>3</sup>), and the town of Three Springs (Dookanooka water reserve <sup>4</sup>) are supplied with scheme water from the Parmelia aquifer in the Tathra subarea by the Water Corporation. There are water source protection plans <sup>3, 4</sup> and protection zones around the areas of abstraction.</p> <p><i>National parks, reserves and state forest:</i> Yarra Yarra Lakes nature reserve and conservation park, Watheroo National Park, Pinjarrega, Sweetman, Kadathinni, Marchagee and Capamauro nature reserves.</p> <p><i>Recreational sites:</i> Yarra Yarra Lakes.</p>	

1 Bureau of Meteorology long-term average. See < [www.bom.gov.au](http://www.bom.gov.au) > for more information.

2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.

3 *Arrowsmith water reserve drinking water source protection plan – Morawa, Arrino, Perenjori, Caron, Bunjil and Latham town water supply, DoW 2007c.*

4 *Dookanooka drinking water source protection plan – Three Springs town water supply, DoW 2007d.*

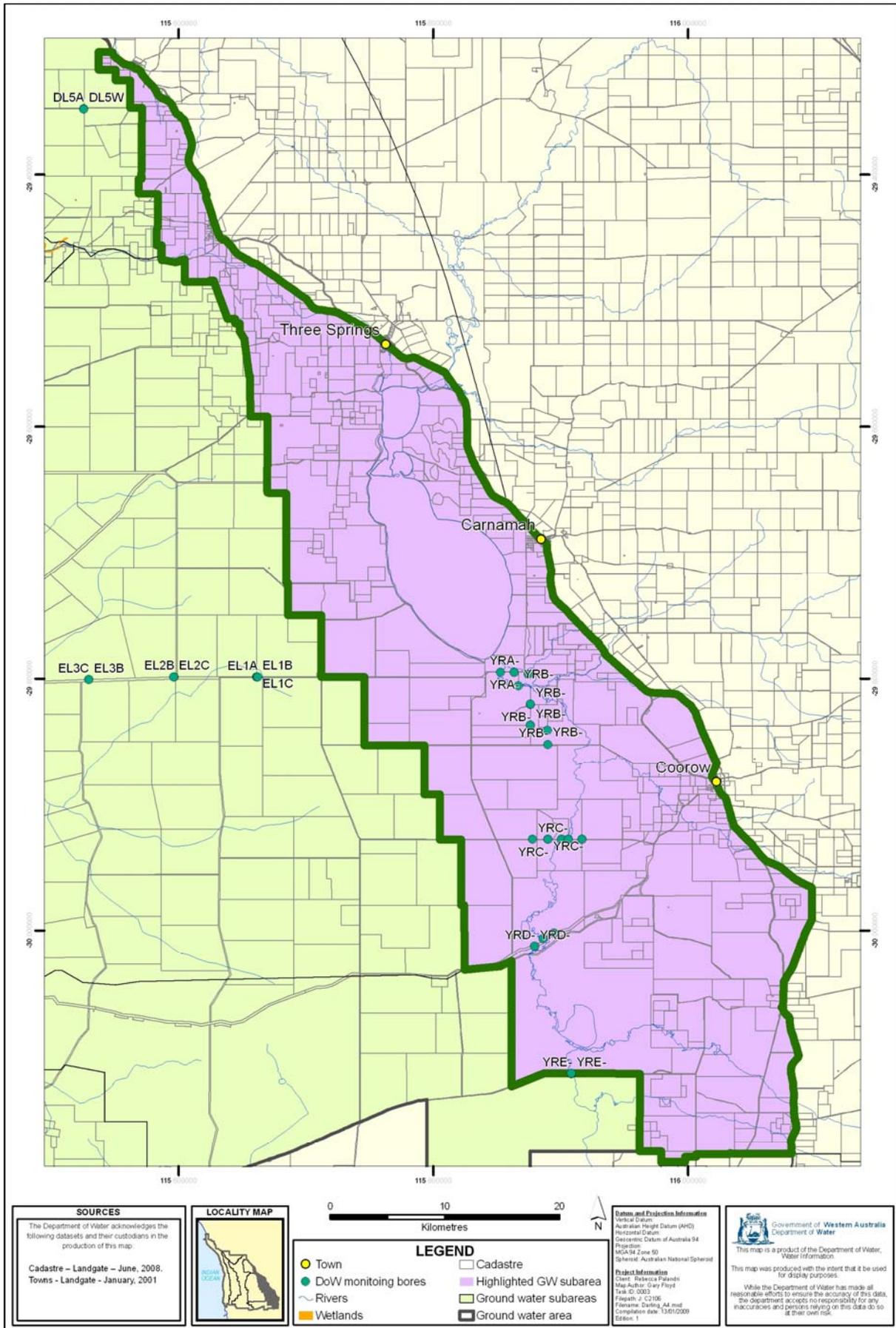


Figure 4 Darling subarea

## 2.3 Dongara

<b>Dongara</b>																			
<b>Subarea description</b>																			
<b>Area</b>	1723 km <sup>2</sup>																		
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)																		
<b>Shire</b>	City of Geraldton-Greenough and Shires of Irwin, Coorow and Carnamah																		
<b>Rainfall</b>	550 mm <sup>1</sup>																		
<b>Licensed water use (as at January 2009)</b>																			
<table border="1"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Domestic, stock and garden</td> <td>0.54%</td> </tr> <tr> <td>General agriculture</td> <td>1.02%</td> </tr> <tr> <td>Horticulture</td> <td>14.70%</td> </tr> <tr> <td>Irrigated pasture</td> <td>3.39%</td> </tr> <tr> <td>Mining and industry</td> <td>28.80%</td> </tr> <tr> <td>Public water supply</td> <td>0.21%</td> </tr> <tr> <td>Service sector</td> <td>49.43%</td> </tr> <tr> <td>Viticulture</td> <td>1.91%</td> </tr> </tbody> </table>	Sector	Percentage	Domestic, stock and garden	0.54%	General agriculture	1.02%	Horticulture	14.70%	Irrigated pasture	3.39%	Mining and industry	28.80%	Public water supply	0.21%	Service sector	49.43%	Viticulture	1.91%	<p><b>Total licensed entitlements:</b> 4 813 646 kL/yr</p> <p><b>Aquifer sourced:</b> Superficial: 3 802 151 kL/yr Yarragadee: 548 445 kL/yr Cattamarra: 5000 kL/yr</p>
Sector	Percentage																		
Domestic, stock and garden	0.54%																		
General agriculture	1.02%																		
Horticulture	14.70%																		
Irrigated pasture	3.39%																		
Mining and industry	28.80%																		
Public water supply	0.21%																		
Service sector	49.43%																		
Viticulture	1.91%																		
<b>Issues for water management</b>																			
<p>The nature and location of the aquifers in this subarea may restrict their accessibility and availability. Cave systems exist extensively throughout the Tamala limestone formation (part of the Superficial aquifer) so licences may not be granted if they have the potential to impact on these areas. A salt water interface extends inland over 8 km from the coast between Cliff head and Dongara. The salinity of the groundwater near the Arrowsmith River is ~1700 mg/L TDS.</p>																			
<b>Allocation and water availability</b>																			
<b>Aquifer</b>	<b>Allocation limit kL/yr</b>	<b>Available water</b>																	
Superficial	8 000 000	Contact the Geraldton office for up-to-date availability.																	
Yarragadee	4 500 000	Contact the Geraldton office for up-to-date availability.																	
Cattamarra	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .																	
<b>Hydrogeology</b>																			
<b>Aquifer</b>	<b>Description</b>																		
Superficial	<p>The Superficial formations occur along the coast west of the Gingin Scarp. They consist of sand, silt, clay and limestone. The average thickness of the aquifer is 20 m, though it increases up to 40 m near the scarp. Depth to the watertable ranges from 2–15 m below ground. It is recharged by rainfall and surface runoff through flood plains. Upward leakage from underlying formations is known to occur. The aquifer discharges to the ocean where a seawater interface exists (ranging from the coastline to 8 km inland). Water quality is generally brackish to saline close to the coast, with some areas fresh towards the scarp.</p>																		

<b>Dongara</b>	
Yarragadee	The Yarragadee aquifer is a major freshwater resource capable of supplying bore yields of > 5 000 kL/day. The formation underlies the Superficial aquifer from north of Cliff Head to about 25 km north of Port Denison and the coastal zone north and south of Geraldton. It is composed of interbedded sand, sandstone, siltstone and shale. Sand content in the formation decreases with depth and varies in width.
Cattamarra	The Cattamarra aquifer is present west of the Beagle and Peron Fault systems, generally south of Cliff Head to approximately 7 km north of Coolimba. It is a minor aquifer with the ability to produce moderate to large bore yields, with water quality generally brackish. The aquifer ranges from semi-confined to confined, with some areas of outcrop along fault lines. It is overlain by the Superficial formation and consists mostly of sandstone with interbedded siltstone, claystone, shale and coal.
Eneabba	The Eneabba formation is only present as an up-faulted horizontal formation west of the Beagle Fault system, underlying a small portion within the southern extent of the Dongara subarea. The Eneabba formation, due to its vertical position, will be in restricted or in limited contact with the Cattamarra located immediately north of this formation. As a result it is not part of the allocation limits for this subarea.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Chapman, Irwin, Greenough and Arrowsmith rivers. Wetlands include Leeman Lagoon and White Lake.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority being associated with Beekeepers nature reserve, Lesueur National Park and road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people, Yued group, Arnold Frank and Mullewa-Wadjari people are all registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji or South West Aboriginal Land and Sea councils for more information.</p> <p><i>Aboriginal heritage sites:</i> Greenough River well, Chapman River, Irwin River, Wondalo springs, Wunneroo cave and Greenough River.</p>	
<b>Social</b>	
<p><i>Towns and localities:</i> Arrowsmith, Bonniefield, Bookara, Bootenal, Cape Burney, Dongara, Eneabba, Georgina, Green Head, Greenough, Leeman, Moonyoonooka, Mount Adams, Mount Hill, Port Denison, South Greenough, Springfield, Yardarino, Walkaway, and several localities around the town of Geraldton are within this subarea. In these locations water supply for domestic purposes comes from rainwater tanks and exempt groundwater abstraction. Dongara–Port Denison, Geraldton, Greenhead and Leeman are supplied with scheme water by the Water Corporation from the Yarragadee aquifer in the Allanooka subarea. This area is covered by a water source protection plan<sup>3</sup>.</p> <p><i>National parks, reserves and state forest:</i> Beekeepers nature reserve and Lesueur National Park.</p> <p><i>Recreational sites:</i> Beekeepers nature reserve, Lesueur National Park, Wunneroo cave, Utakarra Pinnacles and rivers across the subarea.</p>	

1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.

2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.

3 *Allanooka and Dongara–Port Denison water reserves water source protection plan – Geraldton and Dongara–Port Denison town water supply*, WRC 2002a.

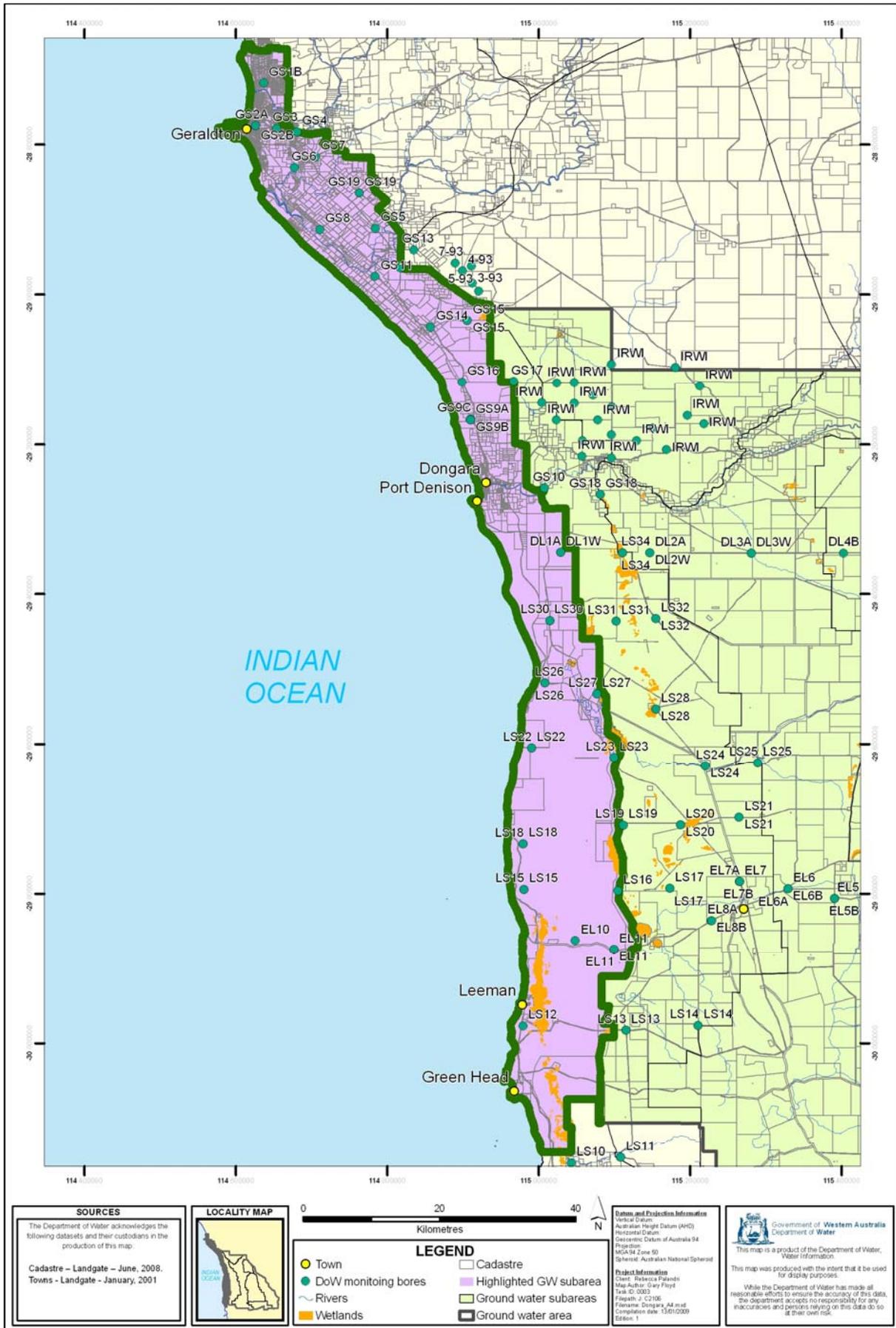


Figure 5 Dongara subarea

## 2.4 Eneabba Plains

Eneabba Plains																				
Subarea description																				
<b>Area</b>	1510 km <sup>2</sup>																			
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)																			
<b>Shire</b>	Shires of Irwin, Carnamah and Coorow																			
<b>Rainfall</b>	500 mm <sup>1</sup>																			
<b>Licensed water use (as at January 2009)</b>																				
<table border="1" style="display: none;"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Domestic, stock and garden</td> <td>0.21%</td> </tr> <tr> <td>General agriculture</td> <td>0.28%</td> </tr> <tr> <td>Horticulture</td> <td>3.81%</td> </tr> <tr> <td>Irrigated pasture</td> <td>23.45%</td> </tr> <tr> <td>Mining and industry</td> <td>65.34%</td> </tr> <tr> <td>Public water supply</td> <td>6.92%</td> </tr> <tr> <td>Service sector</td> <td>0.00%</td> </tr> <tr> <td>Viticulture</td> <td>0.21%</td> </tr> </tbody> </table>	Sector	Percentage	Domestic, stock and garden	0.21%	General agriculture	0.28%	Horticulture	3.81%	Irrigated pasture	23.45%	Mining and industry	65.34%	Public water supply	6.92%	Service sector	0.00%	Viticulture	0.21%	<ul style="list-style-type: none"> <li><span style="color: yellow;">■</span> Domestic, stock and garden</li> <li><span style="color: red;">■</span> General agriculture</li> <li><span style="color: green;">■</span> Horticulture</li> <li><span style="color: purple;">■</span> Irrigated pasture</li> <li><span style="color: grey;">■</span> Mining and industry</li> <li><span style="color: orange;">■</span> Public water supply</li> <li><span style="color: blue;">■</span> Service sector</li> <li><span style="color: pink;">■</span> Viticulture</li> </ul>	<p><b>Total licensed entitlements:</b> 18 360 581 kL/yr</p> <p><b>Aquifer sourced:</b>            Eneabba: 1 400 000 kL/yr            Lesueur: 470 000 kL/yr            Superficial: 227 190 kL/yr            surficial: 37 440 kL/yr            Yarragadee: 16 198 151 kL/yr</p>
Sector	Percentage																			
Domestic, stock and garden	0.21%																			
General agriculture	0.28%																			
Horticulture	3.81%																			
Irrigated pasture	23.45%																			
Mining and industry	65.34%																			
Public water supply	6.92%																			
Service sector	0.00%																			
Viticulture	0.21%																			
<b>Issues for water management</b>																				
<p>The nature and location of the aquifers in this subarea may restrict their accessibility and availability. Public water supply needs are likely to increase in the future as the population of coastal towns expands.</p>																				
Allocation and water availability																				
Aquifer	Allocation limit kL/yr	Available water																		
Superficial	14 000 000	Contact the Geraldton office for up-to-date availability.																		
Surficial	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .																		
Lesueur	1 800 000	Contact the Geraldton office for up-to-date availability.																		
Yarragadee	22 500 000																			
Cattamarra	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .																		
Eneabba	2 000 000	Contact the Geraldton office for up-to-date availability.																		
Hydrogeology																				
Aquifer	Description																			
Superficial	<p>The Superficial aquifer, east of the Peron Fault towards the base of the Gingin Scarp (Eneabba Scarp), is thin and discontinuous with large unsaturated areas. It is generally composed of sand, silt, clay and limestone. The average thickness of the aquifer is 20 m, though it increases up to 40 m near the scarp.</p>																			

<b>Eneabba Plains</b>	
	<p>Depth to the watertable ranges from 2–15 m below ground. It is recharged by rainfall and surface runoff through the flood plains.</p> <p>Upward leakage from underlying formations is known to occur. Water quality is generally brackish to saline close to the coast, with some areas fresh towards the scarp.</p>
Surficial	<p>The surficial formation forms a shallow localised colluvial and alluvial lens over the underlying formations. The aquifer ranges from saturated to unsaturated across the subarea. Composed of sand, silt and clay. Water quality ranges from fresh to brackish.</p>
Yarragadee	<p>The Yarragadee aquifer underlies the Eneabba Plains east and north of the Warradarge and Peron Fault systems, which includes the majority of the subarea — with the exception of the extreme southern extent south-west of Eneabba. It is overlain by thin surficial deposits and is generally unconfined in this subarea. It is generally composed of interbedded sand, sandstone, siltstone and shale.</p>
Lesueur	<p>Present underlying the southern extent of the Eneabba Plain. The aquifer ranges from unconfined to confined depending upon the overlying formation (Superficial formations on the coastal plain and the Eneabba formation inland) and where it outcrops. However for most of this subarea it is confined by thick shale and siltstone beds. It is composed mostly of sandstone and siltstone.</p>
Eneabba	<p>Present underlying the southern extent of the Eneabba Plain. The formation lies conformably between the Lesueur and the Cattamarra. It ranges from semi-confined to confined depending upon the overlying formation. Composed of sandstone interbedded with multicoloured siltstone and clay. Minor grey shale and thin coal seams are present.</p> <p>The aquifer is in hydraulic continuity with the Lesueur aquifer. It is recharged by rainfall and surface runoff in outcrop areas, with local recharge from the overlying Cattamarra formation. Water quality ranges from fresh to brackish, with most areas being between 1000 and 3000 mg/L TDS.</p>
Cattamarra	<p>Underlies a segment of the southern extent of the Eneabba Plain, generally west of the Warradarge and Peron Faults. It is a minor aquifer with the ability to produce moderate to large bore yields. However, the water is generally brackish.</p> <p>The formation is overlain by the Superficial, Eneabba and Lesueur formations. It is composed predominantly of sandstone with interbedded siltstone, claystone, shale and coal. The aquifer locally discharges to the gaining streams of Bindoon and Erindoon creeks on the Eneabba Plain.</p>
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Include the Irwin and Arrowsmith rivers, Hunt and Stockyard gullies (ends in White Lake), Eneabba (ends in Lake Logue), Erindoon and Bindoon creeks (ends in Lake Indoon), and the Australian national conservation area wetland – Lake Logue and Indoon system.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority being associated with the Lesueur National Park and several nature reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people, Yued group, Arnold Frank and Mullewa-Wadjari people are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji or South West Aboriginal Land and Sea councils for more information.</p> <p><i>Aboriginal heritage sites:</i> The Irwin River Waugal sites and Wunneroo cave.</p>	

## Eneabba Plains

### Social

*Towns and localities:* Arrowsmith, Eneabba, Mount Adams, Warradarge and Yardarino localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction. The town of Eneabba is supplied with scheme water from the Yarragadee aquifer by the Water Corporation. There is a water source protection plan<sup>3</sup> and protection zone around the area of abstraction.

*National parks, reserves and state forest:* Lake Logue, Stockyard Gully, Beekeepers, South Eneabba and Yandanogo nature reserves, Lesueur National Park, Lake Indoon wildlife sanctuary.

*Recreational sites:* Lake Logue, Lesueur National Park and Wunneroo cave.

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.
- 3 *Eneabba water reserve drinking water source protection plan – Eneabba town water supply*, DoW 2008a.

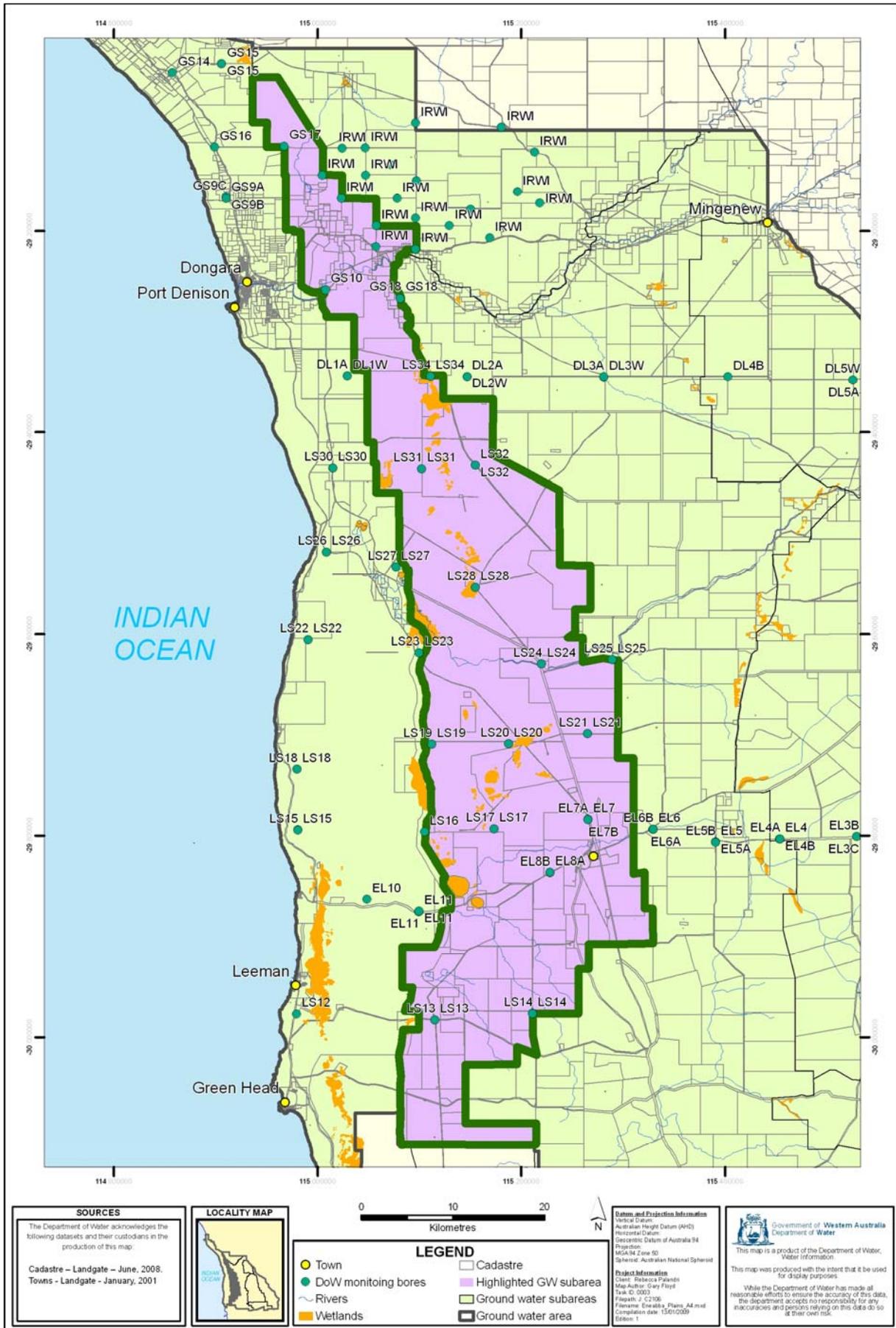


Figure 6 Eneabba Plains subarea

## 2.5 Mingenew

<b>Mingenew</b>																				
<b>Subarea description</b>																				
<b>Area</b>	450 km <sup>2</sup>																			
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)																			
<b>Shire</b>	Shires of Twin Hills and Mingenew																			
<b>Rainfall</b>	450 mm <sup>1</sup>																			
<b>Licensed water use (as at January 2009)</b>																				
<table border="1"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Public water supply</td> <td>84.46%</td> </tr> <tr> <td>Service sector</td> <td>13.90%</td> </tr> <tr> <td>Domestic, stock and garden</td> <td>1.64%</td> </tr> <tr> <td>General agriculture</td> <td></td> </tr> <tr> <td>Horticulture</td> <td></td> </tr> <tr> <td>Irrigated pasture</td> <td></td> </tr> <tr> <td>Mining and industry</td> <td></td> </tr> <tr> <td>Viticulture</td> <td></td> </tr> </tbody> </table>		Sector	Percentage	Public water supply	84.46%	Service sector	13.90%	Domestic, stock and garden	1.64%	General agriculture		Horticulture		Irrigated pasture		Mining and industry		Viticulture		<p><b>Total licensed entitlements:</b> 852 500 kL/yr</p> <p><b>Aquifer sourced:</b> Parmelia: 852 500 kL/yr</p>
Sector	Percentage																			
Public water supply	84.46%																			
Service sector	13.90%																			
Domestic, stock and garden	1.64%																			
General agriculture																				
Horticulture																				
Irrigated pasture																				
Mining and industry																				
Viticulture																				
<b>Issues for water management</b>																				
The nature and location of the aquifers in this subarea may restrict their accessibility and availability. There is limited monitoring of the groundwater resources and comprehensive hydrogeological investigations have not been undertaken in this area.																				
<b>Allocation and water availability</b>																				
<b>Aquifer</b>	<b>Allocation limit kL/yr</b>	<b>Available water</b>																		
Parmelia	8 200 000	Contact the Geraldton office for up-to-date availability.																		
Otorowiri	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .																		
<b>Hydrogeology</b>																				
<b>Aquifer</b>	<b>Description</b>																			
Parmelia	<p>The Parmelia formation overlies the Yarragadee formation east of the Dandaragan Scarp. It contains three members – the overlying, shaley, silty Carnac Member; the underlying, sandier Parmelia Sand Member; and the Otorowiri Siltstone Member. The formation is overlain by surficial deposits and ranges from semi-confined to confined.</p> <p>The aquifer is composed of interbedded sand, clay and silt, with the sandier portions averaging 30 m thick. The aquifer is located in the Parmelia Sand Member and is generally fresh and capable of supplying bore yields of up to 5000 kL/day.</p>																			
Otorowiri	<p>The Otorowiri Siltstone Member is a distinct unit within the Parmelia formation. It is a localised confining member overlain by the sandier, upper member of the Parmelia formation.</p>																			

<b>Mingenew</b>	
	The member acts as an aquiclude between the Parmelia and the Yarragadee aquifers. Limited ability to provide groundwater through abstraction.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<i>Wetlands and waterways:</i> Headwaters of Sand Plain Creek. <i>Threatened ecological communities and declared rare flora sites:</i> Several sites are registered, with the majority being associated with the nature reserves and road reserves in the subarea.	
<b>Culture</b>	
<i>Native title claimant:</i> The Amangu people and Mullewa-Wadjari people are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji Aboriginal Land and Sea council for more information.	
<b>Social</b>	
<i>Towns and localities:</i> Arrino, Arrowsmith East, Bundanoon, Mingenev and Mooriary localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction. The town of Mingenev is supplied with scheme water from Parmelia aquifer by the Water Corporation. There is a water source protection plan <sup>3</sup> and protection zone around the area of abstraction.	

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.
- 3 *Mingenev water reserve water source protection plan – Mingenev town water supply*, WRC 2001.

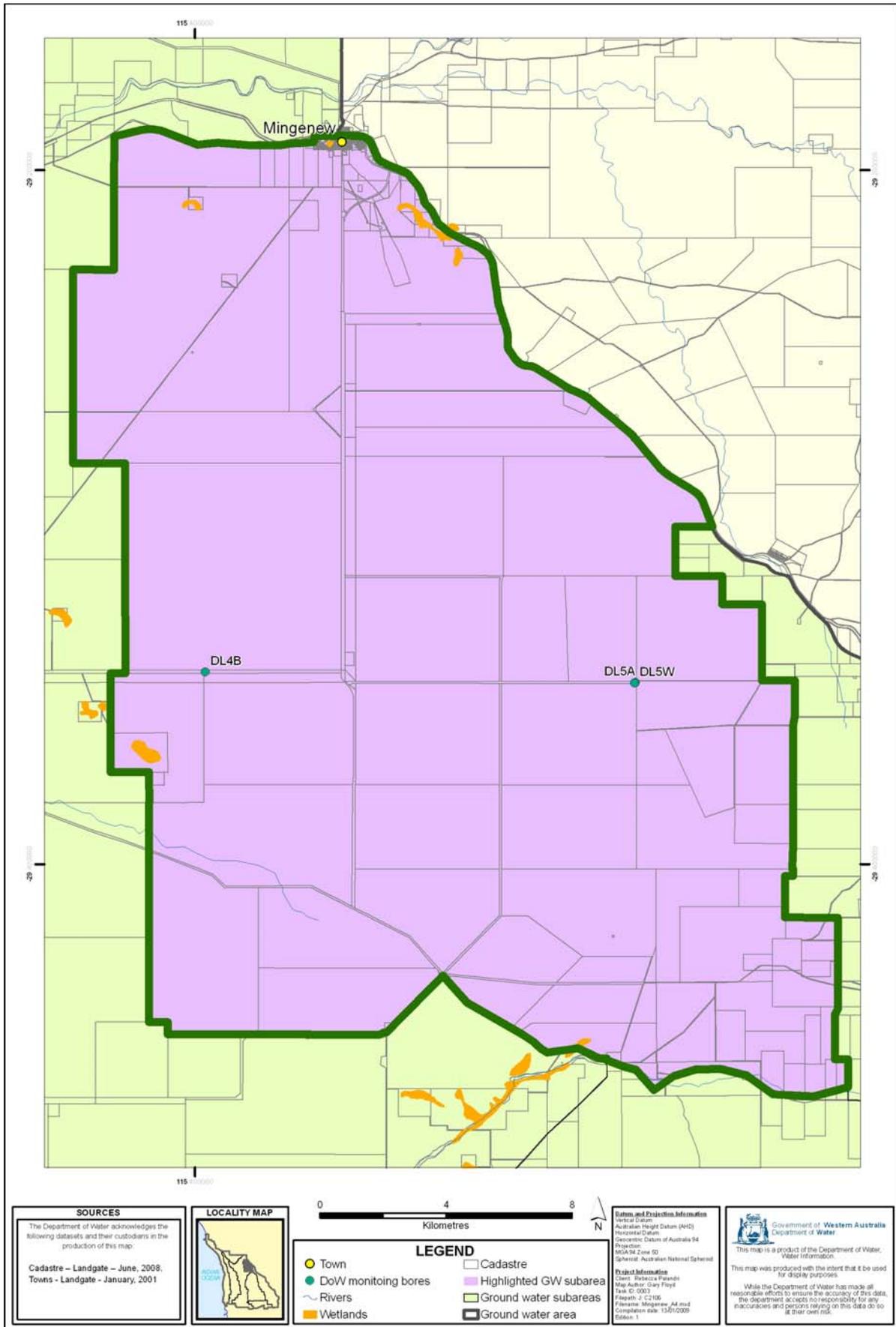


Figure 7 Mingenew subarea

## 2.6 Morrison

<b>Morrison</b>		
<b>Subarea description</b>		
<b>Area</b>	592 km <sup>2</sup>	
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)	
<b>Shire</b>	Shire of Coorow	
<b>Rainfall</b>	450 mm <sup>1</sup>	
<b>Licensed water use (as at January 2009)</b>	No licensed water use. Exempt stock and domestic use only.	
<b>Issues for water management</b>		
The nature and location of the aquifers in this subarea may restrict their accessibility and availability. There is limited monitoring of the groundwater resources and comprehensive hydrogeological investigations have not been undertaken in this area.		
<b>Allocation and water availability</b>		
<b>Aquifer</b>	<b>Allocation limit kL/yr</b>	<b>Available water</b>
Surficial	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .
Parmelia	4 000 000	
Otorowiri	N/A	
Yarragadee	1 000 000	
<b>Hydrogeology</b>		
<b>Aquifer</b>	<b>Description</b>	
Surficial	The surficial formation forms a shallow localised colluvial and alluvial lens over the underlying formations. Aquifer ranges from saturated to unsaturated across the subarea. It is composed of sand, silt and clay. Water quality ranges from fresh to brackish.	
Parmelia	The Parmelia formation overlies the Yarragadee formation east of the Dandaragan Scarp. It contains three members – the overlying, shaley, silty Carnac Member; underlying, sandier Parmelia Sand Member; and the Otorowiri Siltstone Member. The formation is overlain by surficial deposits and ranges from semi-confined to confined.  The aquifer is located in the Parmelia Sand Member and is generally fresh and capable of supplying bore yields of up to 5000 kL/day. The aquifer is composed of interbedded sand, clay and silt, with the sandier portions averaging 30 m thick.	
Otorowiri	The Otorowiri Siltstone Member is a distinct unit within the Parmelia formation. It is a localised confining member overlain by the sandier, upper member of the Parmelia formation. The member acts as an aquiclude between the Parmelia and the Yarragadee aquifers. It has a limited ability to provide groundwater.	
Yarragadee	The aquifer is present west of the Darling and Abrolhos Faults and east of the Dandaragan Scarp. The aquifer is generally composed of interbedded sand, sandstone, siltstone and shale. Sand content in the formation decreases with depth and varies in thickness across the aquifer.	

<b>Morrison</b>	
	It is the major aquifer underlying the Otorowiri Siltstone. Defined by the Dandaragan Scarp to the west and the Urella Fault in the east. Where the Otorowiri formation overlies the Yarragadee aquifer the potentiometric head is up to 25 m above the base of the formation.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Dewar Creek and the eastern branch of the Warradarge Creek.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority being associated with the Alexander Morrison National Park and road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Yued group are the registered claimants over this subarea but the claim is yet to be determined. Contact the South West Aboriginal Land and Sea council for more information.</p>	
<b>Social</b>	
<p><i>Towns and localities:</i> Eganu and Warradarge localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction.</p> <p><i>National parks, reserves and state forest:</i> Alexander Morrison National Park and Pinjarrega nature reserve.</p>	

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.

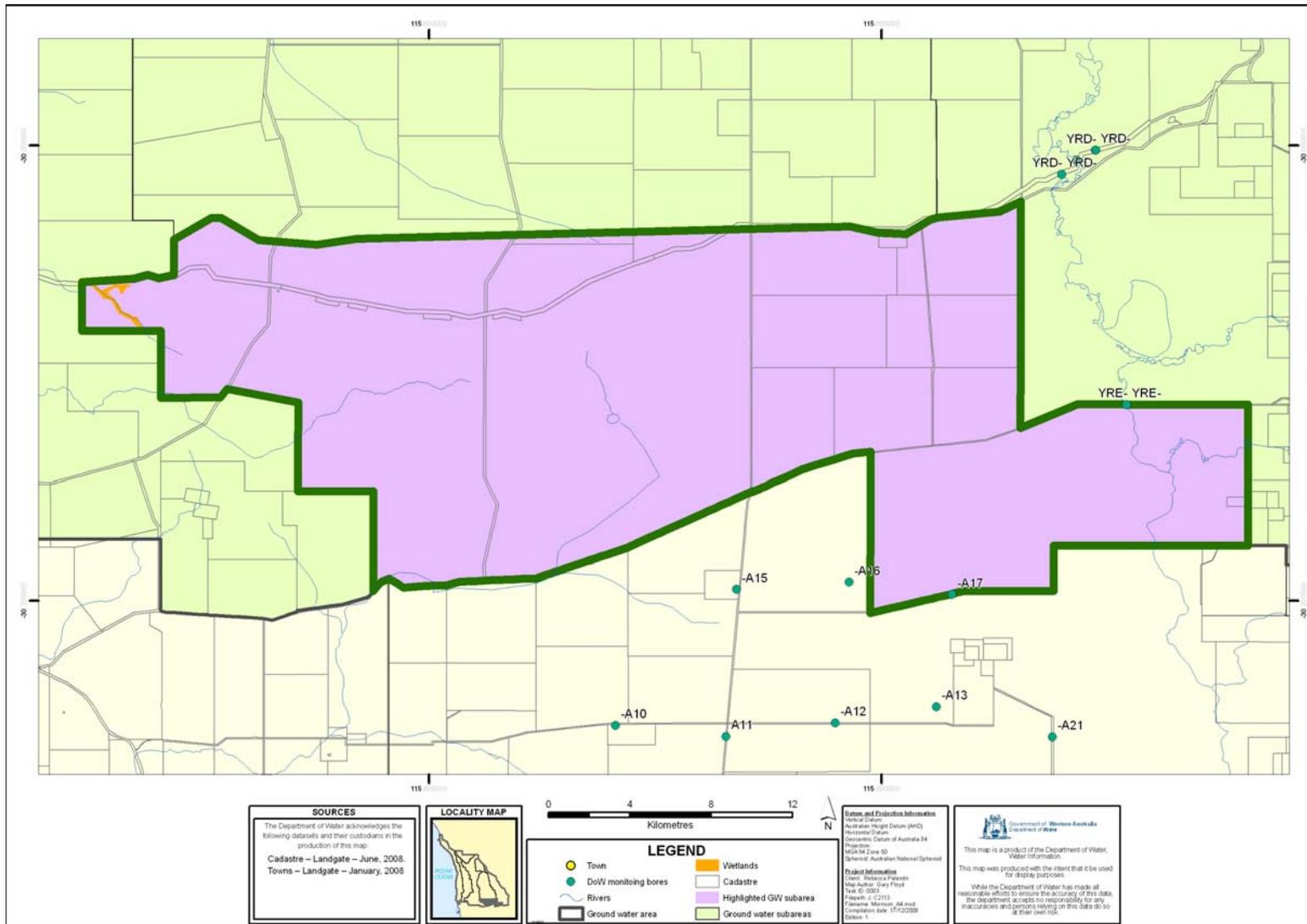


Figure 8 Morrison subarea

## 2.7 Tathra

<b>Tathra</b>														
<b>Subarea description</b>														
<b>Area</b>	1679 km <sup>2</sup>													
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)													
<b>Shire</b>	Shires of Three Springs, Carnamah and Coorow													
<b>Rainfall</b>	450 mm <sup>1</sup>													
<b>Licensed water use (as at January 2009)</b>														
<table border="1"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Horticulture</td> <td>56.88%</td> </tr> <tr> <td>Irrigated pasture</td> <td>34.84%</td> </tr> <tr> <td>Viticulture</td> <td>4.77%</td> </tr> <tr> <td>Public water supply</td> <td>3.51%</td> </tr> <tr> <td>Domestic, stock and garden</td> <td>0.01%</td> </tr> </tbody> </table>		Sector	Percentage	Horticulture	56.88%	Irrigated pasture	34.84%	Viticulture	4.77%	Public water supply	3.51%	Domestic, stock and garden	0.01%	<p><b>Total licensed entitlements:</b> 13 145 530 kL/yr</p> <p><b>Aquifer sourced:</b> Parmelia: 13 143 230 kL/yr surficial: 2500 kL/yr</p>
Sector	Percentage													
Horticulture	56.88%													
Irrigated pasture	34.84%													
Viticulture	4.77%													
Public water supply	3.51%													
Domestic, stock and garden	0.01%													
<b>Issues for water management</b>														
The nature and location of the aquifers in this subarea may restrict their accessibility and availability. There is limited monitoring of the groundwater resources and comprehensive hydrogeological investigations have not been undertaken in this area.														
<b>Allocation and water availability</b>														
<b>Aquifer</b>	<b>Allocation limit kL/yr</b>	<b>Available water</b>												
Surficial	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing these aquifers <sup>2</sup> .												
Eneabba	N/A													
Lesueur	N/A													
Cattamarra	N/A													
Otorowiri	N/A													
Parmelia	33 400 000	Contact the Geraldton office for up-to-date availability.												
Yarragadee	700 000	Restricted by the location of the aquifer. Investigations may be required before accessing this aquifer <sup>2</sup> .												
<b>Hydrogeology</b>														
<b>Aquifer</b>	<b>Description</b>													
Surficial	The surficial formation forms a shallow localised colluvial and alluvial lens over the underlying formations. The aquifer ranges from saturated to unsaturated across the subarea. Composed of sand, silt and clay.													

<b>Tathra</b>	
	Water quality ranges from fresh to brackish. The aquifer is in hydraulic connection with upper portion of the underlying unconfined Parmelia Aquifer. It is difficult to differentiate from the totally weathered upper portion of the underlying Parmelia formation.
Lesueur	Major aquifer containing large volumes of fresh groundwater. The aquifer ranges from unconfined to confined depending upon overlying formation and where it outcrops. However for most of this subarea it is confined by thick shale and siltstone beds. Comprised of sandstone and siltstone.
Eneabba	The formation lies conformably between the Lesueur and the Cattamarra. It ranges from semi-confined to confined depending upon the overlying formation. Comprised of sandstone interbedded with multicoloured siltstone and clay. Minor grey shale and thin coal seams are present. The aquifer is in hydraulic continuity with the Lesueur aquifer. Recharged by rainfall and surface runoff in outcrop areas, with local recharge from the overlying formation. Water quality ranges from fresh to brackish, with most areas 1000–3000 mg/L TDS.
Cattamarra	The Cattamarra is a minor aquifer with the ability to produce moderate to large bore yields. However water quality is generally brackish. The aquifer ranges from semi-confined to confined with some areas of outcrop along fault lines. The formation is overlain by the surficial, Eneabba and Lesueur formations. It is composed predominantly of sandstone with interbedded siltstone, claystone, shale and coal.
Parmelia	The Parmelia formation overlies the Yarragadee formation east of the Dandaragan Scarp. It contains three members – the overlying, shaley, silty Carnac Member; underlying, sandier Parmelia Sand Member; and the Otorowiri Siltstone Member. It is semi-confined to confined at depth depending upon formation characteristics. The aquifer is composed of interbedded sand, clay and silt, with the sandier portions averaging 30 m thick. It is unconfined at top of the formation where the totally weathered portion is difficult to distinguish from sediments of the surficial formation.
Otorowiri	The Otorowiri Siltstone Member is a distinct unit within the Parmelia formation. It is a localised confining member overlain by the sandier, upper member of the Parmelia formation. The member acts as an aquiclude between the Parmelia and the Yarragadee aquifers. Limited ability to provide groundwater through abstraction.
Yarragadee	The aquifer is present across the subarea with the exception of the north eastern edge, which includes the Mullingarra Inlier. It is defined by the Dandaragan Scarp to the west and the Urella Fault in the east. It is composed of interbedded sand, sandstone, siltstone and shale. Sand content in the formation decreases with depth and varies in thickness across the aquifer. It is overlain by the Parmelia and Otorowiri aquifers.
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Warradarge Creek and the Arrowsmith River (northern boundary of the subarea).</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority being associated with the nature reserves and road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people and Yued group are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji or South West Aboriginal Land and Sea councils for more information.</p>	

## Tathra

### Social

*Towns and localities:* Arrino, Carnamah, Eganu, Eneabba, Kadathinni and Warradarge localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction. The Water Corporation supplies drinking water to various towns from the Parmelia aquifer (see subarea reference sheet Darling for more information). There are water source protection plans<sup>3,4</sup> and protection zones around the area of abstraction.

*National parks, reserves and state forest:* Dookanooka, Wilson and Wotto nature reserves and Tathra National Park.

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.
- 3 *Arrowsmith water reserve drinking water source protection plan – Morawa, Arrino, Perenjori, Caron, Bunjil and Latham town water supply*, DoW 2007b.
- 4 *Dookanooka drinking water source protection plan – Three Springs town water supply*, DoW 2007d.

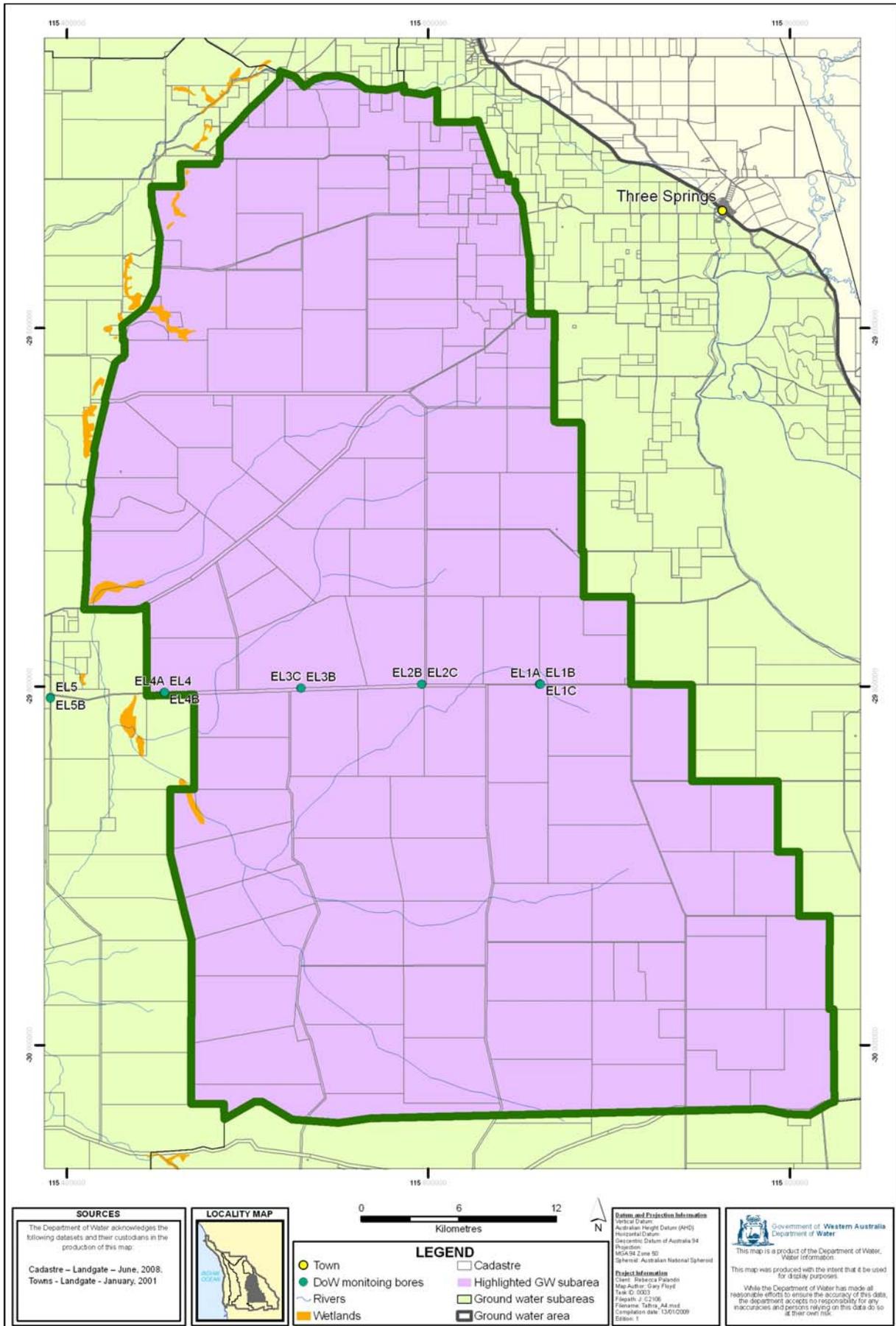


Figure 9 Tathra subarea

## 2.8 Twin Hills

<b>Twin Hills</b>																			
<b>Subarea description</b>																			
<b>Area</b>	2316 km <sup>2</sup>																		
<b>Proclamation</b>	Arrowsmith groundwater area 1989 (variation in 1990)																		
<b>Shire</b>	Shires of Mingenew, Three Springs, Irwin, Carnamah and Coorow																		
<b>Rainfall</b>	450 mm <sup>1</sup>																		
<b>Licensed water use (as at January 2009)</b>																			
<table border="1"> <caption>Licensed water use by sector (as at January 2009)</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Domestic, stock and garden</td> <td>0.25%</td> </tr> <tr> <td>General agriculture</td> <td>2.58%</td> </tr> <tr> <td>Horticulture</td> <td>0.68%</td> </tr> <tr> <td>Irrigated pasture</td> <td>42.22%</td> </tr> <tr> <td>Mining and industry</td> <td>54.28%</td> </tr> <tr> <td>Public water supply</td> <td></td> </tr> <tr> <td>Service sector</td> <td></td> </tr> <tr> <td>Viticulture</td> <td></td> </tr> </tbody> </table>	Sector	Percentage	Domestic, stock and garden	0.25%	General agriculture	2.58%	Horticulture	0.68%	Irrigated pasture	42.22%	Mining and industry	54.28%	Public water supply		Service sector		Viticulture		<p><b>Total licensed entitlements:</b> 7 338 250 kL/yr</p> <p><b>Aquifer sourced:</b> Yarragadee: 7 338 250 kL/yr</p>
Sector	Percentage																		
Domestic, stock and garden	0.25%																		
General agriculture	2.58%																		
Horticulture	0.68%																		
Irrigated pasture	42.22%																		
Mining and industry	54.28%																		
Public water supply																			
Service sector																			
Viticulture																			
<b>Issues for water management</b>																			
<p>The nature and location of the aquifers in this subarea may restrict their accessibility and availability. There is limited monitoring of the groundwater resources and comprehensive hydrogeological investigations have not been undertaken in this area. There is a thin layer of surficial sediments present but it is unlikely that any water can be abstracted for use other than stock water and domestic supply.</p>																			
<b>Allocation and water availability</b>																			
<b>Aquifer</b>	<b>Allocation limit kL/yr</b>	<b>Available water</b>																	
Surficial	N/A	Restricted by the location of the aquifer. Investigations may be required before accessing these aquifers <sup>2</sup> .																	
Eneabba	N/A																		
Lesueur	N/A																		
Cattamarra	500 000																		
Otorowiri	N/A																		
Parmelia	3 400 000	Contact the Geraldton office for up-to-date availability.																	
Yarragadee	48 800 000																		
<b>Hydrogeology</b>																			
<b>Aquifer</b>	<b>Description</b>																		
Surficial	The surficial formation forms a shallow localised colluvial and alluvial lens over the underlying formations.																		

<b>Twin Hills</b>	
Eneabba	<p>Present underlying a small area in the south-south-western area of the subarea. The formation lies conformably between the Lesueur and the Cattamarra formations. It ranges from semi-confined to confined depending upon the overlying formation. Comprised of sandstone interbedded with multicoloured siltstone and clay. Minor grey shale and thin coal seams are present.</p> <p>The aquifer is in hydraulic continuity with the Lesueur aquifer. It is recharged by rainfall and surface runoff in outcrop areas, with local recharge from the overlying Cattamarra formation. Water quality ranges from fresh to brackish, with most areas being between 1000 and 3000 mg/L TDS.</p>
Lesueur	Major aquifer containing large volumes of fresh groundwater. The aquifer is confined in most areas by thick shale and siltstone beds associated with the Eneabba formation. It is generally composed of sandstone and siltstone.
Cattamarra	Minor aquifer with the ability to produce moderate to large bore yields. However water quality is generally brackish. The aquifer ranges from semi-confined to confined with some areas of outcrop along fault lines. The formation is overlain by the Superficial, Eneabba and Lesueur formations. Composed predominantly of sandstone with interbedded siltstone, claystone, shale and coal.
Parmelia	<p>The Parmelia formation overlies the Yarragadee formation east of the Dandaragan Scarp. It contains three members – the overlying, shaley, silty Carnac Member; underlying, sandier Parmelia Sand Member; and the Otorowiri Siltstone Member. The formation is overlain by surficial deposits and ranges from semi-confined to confined.</p> <p>The aquifer is located in the Parmelia Sand Member and is generally fresh and capable of supplying bore yields of up to 5000 kL/day. The aquifer is composed of interbedded sand, clay and silt, with the sandier portions averaging 30 m thick.</p>
Otorowiri	The Otorowiri Siltstone Member is a distinct unit within the Parmelia formation. It is a localised confining member overlain by the sandier, upper member of the Parmelia formation. The member acts as an aquiclude between the Parmelia and the Yarragadee aquifers. It has only a limited ability to provide groundwater through abstraction.
Yarragadee	<p>The Yarragadee formation consists of interbedded, grey to white, fine to coarse grained sandstone, siltstone and claystone with minor conglomerate and coal. Sand content in the formation decreases with depth and varies in thickness across the aquifer.</p> <p>It is overlain by the Parmelia and Otorowiri aquifers. It underlies the majority of the subarea with the exception of the extreme south-south-western area, west of the Warradarge Fault.</p>
<b>Considerations for water use include, but are not limited to, the following</b>	
<b>Ecology</b>	
<p><i>Wetlands and waterways:</i> Sand Plain, Donkey and Warradarge creeks. Irwin, Lockier and Arrowsmith rivers.</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Numerous sites are registered, with the majority being associated with the nature reserves and road reserves in the subarea.</p>	
<b>Culture</b>	
<p><i>Native title claimant:</i> The Amangu people, Yued group, Arnold Frank and Mullewa-Wadjari people are registered claimants over this subarea but claims have yet to be determined. Contact the Yamatji or South West Aboriginal Land and Sea councils for more information.</p> <p><i>Aboriginal heritage sites:</i> the Lockier and Irwin rivers Waugal sites.</p>	

## Twin Hills

### Social

*Towns and localities:* Arrino, Arrowsmith East, Eganu, Eneabba, Lockier, Mooriary, Milo, Mount Adams, Warradarge and Yarragadee, localities are within this subarea. Water supply for domestic purposes is from rainwater tanks and exempt groundwater abstraction.

*National parks, reserves and state forest:* Depot Hill, Mingenew, South Eneabba, White Gums and Wilson nature reserves and the Lesueur National Park.

- 1 Bureau of Meteorology long-term average. See <[www.bom.gov.au](http://www.bom.gov.au)> for more information.
- 2 Investigations may include, but are not limited to, exploratory drilling, geophysical logs, pump tests, hydrogeological reporting and/or local groundwater modelling depending upon the volume and type of aquifer being accessed. See section 4.1 of the plan for more information.

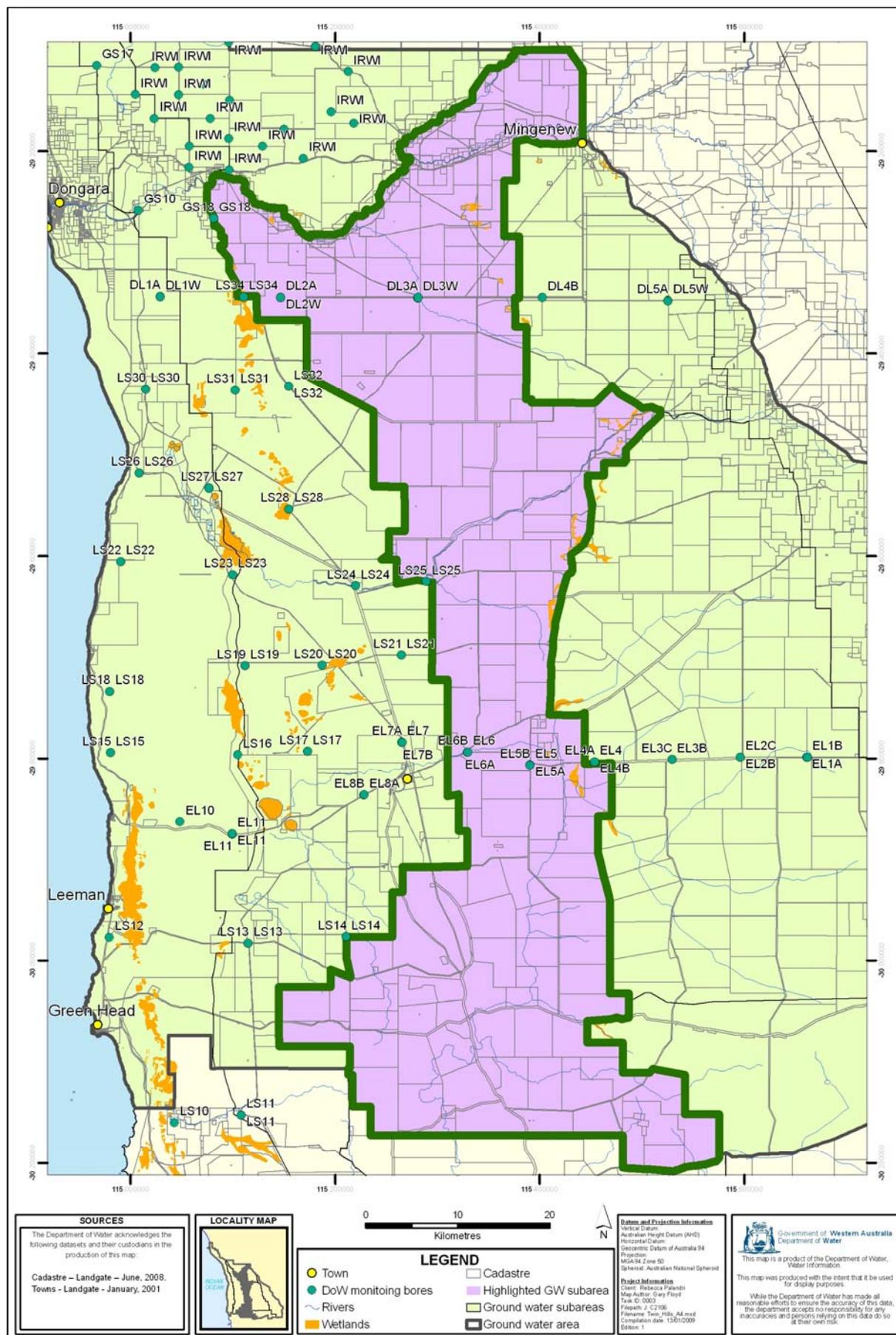


Figure 10 Twin Hills subarea

# Appendices

## Appendix A Statewide licensing policies and process

Policy name	Brief description
<i>Statewide policy no. 2 – Pesticide use in public drinking water source area</i>	Provides the department's position on the use of pesticides within proclaimed public drinking water source areas.
<i>Statewide policy no. 3 – Policy statement on water sharing</i>	Provides guidance on the overall policy approach to sharing water between competing users.
<i>Statewide policy no. 5 – Environmental water provisions policy for Western Australia</i>	Outlines the department's approach on ensuring that the water needs of the environment are addressed in water allocation decision-making.
<i>Statewide policy no. 6 – Transferable (tradeable) water entitlements for Western Australia</i>	Provides guidance on the transfer and trade of water licences.
<i>Statewide policy no. 8 – Giving an undertaking to grant a licence or a permit under the Rights In Water and Irrigation Act 1914</i>	Defines the circumstances under which the department will give undertakings for the granting of licences to take water, the approval of agreements with respect to water entitlements, permits to interfere with a water course or licences to construct a well.
<i>Statewide policy no. 9 – Water licensing – staged developments</i>	Describes the licensing policy and process used for developments and land uses with a prolonged establishment phase, where water requirements will alter significantly during the life of the project.
<i>Statewide policy no. 10 – Use of operating strategies in the water licensing process</i>	Provides guidance on the structure of operating strategies and on the circumstances and purposes under which they are requested.
<i>Statewide policy no. 11 – Management of unused licensed water entitlements</i>	Outlines how to manage licence allocations to ensure that reducing unused allocations to a minimum effectively uses the water resources.
<i>Draft statewide policy no. 14 – Managing unlicensed groundwater use</i>	Provides the department's position on managing groundwater taken by unlicensed users.
<i>Statewide policy no. 16 – Water conservation and efficiency plans</i>	Provides direction on preparing water conservation and efficiency plans required by water users as part of the water licensing process.
<i>Statewide policy no. 17 – Timely submissions of required further information</i>	Describes the department's policy on the timeframes for submission of further information that is required in the licence assessment process.
<i>Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence.</i>	Provides guidance on when hydrogeological assessments and groundwater monitoring reports are required and the information that they should contain.
<i>Strategic policy 5.03 – Metering the take of water</i>	Provides metering of groundwater and surface water guidelines and policy for the state.

Note: All statewide policies are available on the department's website <[www.water.wa.gov.au](http://www.water.wa.gov.au)> Managing our water > Statewide policies>.

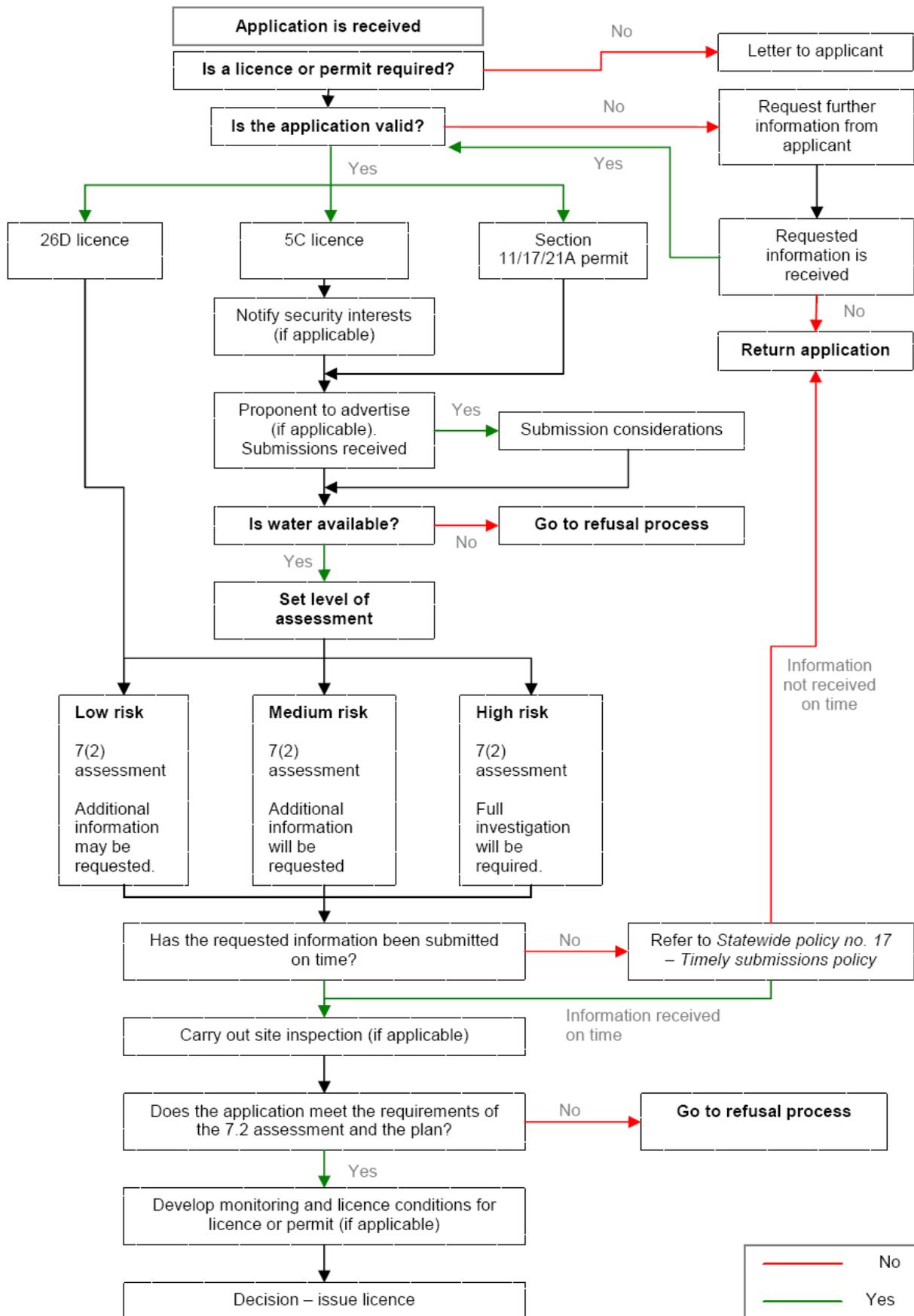


Figure A1 Standard licensing process flowchart

## 7(2) assessments and groundwater licensing

The Department of Water assesses individual licence applications to construct a bore (26D) and to take water (5C licence) under Schedule 1, Division 2, clause 7(2) of the *Rights in Water and Irrigation Act, 1914*. The level of assessment will vary depending on the level of risk to the environment and existing users.

Table 1 provides a brief summary of the clause 7 (2) assessment process with regard to a groundwater licence application (5C and 26D) and what the department considers against each of the requirements under clause 7 (2).

**Table A1 Clause 7(2) assessment process for groundwater licensing**

Relevant consideration under clause 7(2)		What the department considers
7(2)(a)	<p><b>Public interest</b></p> <p>Does the proposal have any economic, social or recreational benefits to the public?</p> <p>This is assessed from a regional or state-wide point of view.</p>	<ul style="list-style-type: none"> <li>• social benefit (including water for community parks and gardens)</li> <li>• recreational benefit (including aesthetics of a natural system, camping, fishing)</li> <li>• economic benefit (including regional development, prospective employment)</li> <li>• advertising of proposals under <i>Rights in Water and Irrigation Act, 1914</i> which provides information to assess public interest</li> </ul>
<p><b>Sustainability assessment</b></p> <p>A sustainability assessment considers economic, social and ecological factors together and attempts to satisfy as many factors as possible, with minimal trade-offs, applying the principles below:</p> <ul style="list-style-type: none"> <li>• long-term economic health</li> <li>• equity and human rights</li> <li>• biodiversity and ecological integrity.</li> </ul>		
7(2)(b)	<p><b>Ecologically sustainable</b></p>	<ul style="list-style-type: none"> <li>• water availability</li> <li>• requirements of relevant allocation plan</li> <li>• hydrogeological assessment</li> <li>• impact on any ecologically significant sites</li> <li>• an assessment is made on the requirements to protect the ecology:                             <ul style="list-style-type: none"> <li>– monitoring as part of the licensing conditions</li> <li>– an operating strategy</li> <li>– nutrient impact or irrigation development assessment</li> <li>– a water conservation/efficiency plan</li> <li>– a water quality assessment</li> </ul> </li> <li>• clearing approval requirements</li> <li>• land capability assessment</li> </ul>

Relevant consideration under clause 7(2)	What the department considers
<p><b>7(2)(c) Environmentally acceptable</b> Can the economic, social and ecological considerations be satisfied? If not, are the impacts acceptable?</p> <p><b>Economic</b> Long-term economic health Recognise needs of current and future demand</p> <p><b>Social</b> Equity and human rights</p> <p><b>Ecological</b> Biodiversity and ecological integrity</p>	<ul style="list-style-type: none"> <li>• any economic values identified through allocation planning</li> <li>• categorisation of economic status: public–commercial or non-commercial, or private–commercial or non-commercial</li> <li>• economic benefit to local, regional or state market</li> <li>• any social and recreational values identified through allocation planning: <ul style="list-style-type: none"> <li>– cultural and heritage considerations:</li> <li>– Aboriginal sites of significance</li> <li>– Native title claims</li> </ul> </li> <li>• Australian heritage listings</li> <li>• social and recreational benefits or liabilities (including fishing)</li> <li>• findings of the 7(2) (b) assessments</li> </ul>
<p><b>7(2)(d) May prejudice other current and future needs for water</b> The regional view</p>	<ul style="list-style-type: none"> <li>• hydrogeological assessment – effects on current and future needs for water and possible environmental impacts on surrounding areas</li> </ul>
<p><b>7(2)(e) Detrimental effect on another person</b> The local view</p>	<ul style="list-style-type: none"> <li>• need for advertising process</li> <li>• need for an operating strategy</li> <li>• hydrogeological assessment (impact on existing use)</li> </ul>
<p><b>7(2)(f) Could be provided for by another source</b> Assessment considers alternative options and sources</p>	<ul style="list-style-type: none"> <li>• most appropriate resource – hydrogeological assessment and water availability</li> <li>• availability of other sources such as surface water, recycled water, scheme water</li> <li>• most economically viable source</li> </ul>
<p><b>7(2)(g) Are in keeping with:</b> <b>(i) Local practices</b> Local practices and planning requirements</p>	<ul style="list-style-type: none"> <li>• local government authority approval and/or compatible with current land use zoning</li> <li>• application has other relevant government approvals including: <ul style="list-style-type: none"> <li>– Department of Agriculture and Food</li> <li>– Department of Mines and Petroleum</li> <li>– Department of State Development</li> <li>– Department for Planning and Infrastructure</li> <li>– Western Australian Planning Commission</li> </ul> </li> </ul>

Relevant consideration under clause 7(2)		What the department considers
		<ul style="list-style-type: none"> <li>- Department of Environment and Conservation.</li> <li>• common practice within the local area</li> </ul>
7(2)(g) cont.	(ii) Relevant local by-law	<ul style="list-style-type: none"> <li>• by-laws under <i>Rights in Water and Irrigation Act, 1914</i> or <i>Environmental Protection Act 1986</i> – there are none at present in the Arrowsmith groundwater area</li> </ul>
	(iii) Plan approved under Part III Division 3d Subdivision 2	<ul style="list-style-type: none"> <li>• meets the requirements of the plan approved under Part III Division 3d Subdivision 2 (statutory)</li> </ul>
	(iv) Relevant previous decisions of the department	<ul style="list-style-type: none"> <li>• departmental policies and plans</li> <li>• previous licensing decisions where relevant</li> </ul>
7(2)(h)	Are consistent with: (i) Land use planning Instruments	<ul style="list-style-type: none"> <li>• application is consistent with Environmental Protection (Clearing of Native Vegetation) Regulations 2004</li> <li>• local government approval</li> <li>• Western Australian Planning Commission approval</li> <li>• other relevant planning and scheme text.</li> </ul>
	(ii) The requirements and policies of other government agencies  Issue of a licence cannot pre-empt approvals under the <i>Native Title Act 1993</i> and Part V of the <i>Environmental Protection Act, 1986</i> .	<ul style="list-style-type: none"> <li>• department refers proposal to other government departments, where appropriate</li> </ul>
	(iii) Any inter-governmental agreement or arrangement	<ul style="list-style-type: none"> <li>• related inter-governmental agreements or arrangements (such as State Development Acts)</li> </ul>

## Appendix B Other plans and strategies to be considered

Plan	Consideration	Agency
<i>State water plan</i>	Strategic direction	DoW
<i>Better managing the urban water cycle – the urban drainage initiative</i>	Urban water drainage and management for better urban design.	DoW
<i>Better urban water management</i>	Urban water management for public services and urban design	Department of Planning
<i>Allanooka and Dongara-Denison water reserves water source protection plan: Geraldton and Dongara-Port Denison town water supplies</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Arrowsmith Water Reserve drinking water source protection plan: Morawa, Arrino, Perenjori, Caron, Bunjil and Latham town water supplies</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Dathagnoorara Drinking Water Source Protection Plan: Carnamah and Coorow town water supplies</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Dookanooka drinking water source protection plan: Three Springs town water supply</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Eneabba Water Reserve drinking water source protection plan: Eneabba town water supply</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Mingenew Water Reserve water source protection plan: Mingeneew town water supply</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Mount Peron Water Reserve and Leeman (Midway) Water Reserve drinking water source protection plan : Leeman and Green Head town water supply</i>	Manages land and water use activities in this area to ensure safe drinking water quality	DoW
<i>Northern Geraldton District Structure Plan (Draft)</i>	Provides the land use planning structure for managing land development in the Northern Geraldton district.	Department of Planning

## **Major legislation relating to water resource management in the Mid West Gascoyne**

### Commonwealth legislation:

- *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999*
- *National Water Commission Act 2004*
- *Natural Heritage Trust Act of Australia 1997*
- *National Environmental Protection Council Act 1994*
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *World Heritage Properties Conservation Act 1995.*

### State legislation:

- *Conservation and Land Management Act 1984*
- *Native Title (State Provisions) Act 1999*
- *Aboriginal Heritage Act 1972*
- *Country Areas Water Supply Act 1947*
- *Environmental Protection Act 1986, amendment 1998*
- *Environmental Protection Regulations 1987*
- *Heritage of Western Australia Act 1990*
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909 (including by-laws)*
- *National Trust of Australia (WA) Act 1964*
- *Rights in Water and Irrigation Act 1914, Regulations 2000*
- *Water Agencies (Powers) Act 1984*
- *Soil and Land Conservation Act 1945, Regulations 1992*
- *Town Planning and Development Act 1928*
- *Planning and Development Act 2005*
- *Water and Rivers Commission Act 1995*
- *Waterways Conservation Act 1976*
- *Western Australian Planning Commission Act 1985*
- *Wildlife Conservation Act 1950, Regulations 1970*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Contaminated Sites Act 2003.*

## Appendix C Useful information and websites for other government departments

Government department	Website	Contact for more information on:
<b>Department of Environment and Conservation</b>	< <a href="http://www.dec.wa.gov.au">www.dec.wa.gov.au</a> >	Acid sulfate soils and contaminated sites. Vegetation clearing and declared rare flora, fauna and threatened ecological sites. Environmental protection policy wetlands. National Park management.
<b>Environmental Protection Authority</b>	< <a href="http://www.epa.wa.gov.au">www.epa.wa.gov.au</a> >	EPA approvals and processes
<b>Department of Environment, Water, Heritage and the Arts</b>	< <a href="http://www.environment.gov.au">www.environment.gov.au</a> >	Information and approvals under the <i>Environmental Protection and Biodiversity Conservation Act 1999</i>
<b>Department of Agriculture and Food</b>	< <a href="http://www.dafwa.wa.gov.au">www.dafwa.wa.gov.au</a> >	Best management practices and information on agriculture and food
<b>Bureau of Meteorology</b>	< <a href="http://www.bom.wa.gov.au">www.bom.wa.gov.au</a> >	Rainfall, evaporation and climate related information
<b>Department of Mines and Petroleum</b>	< <a href="http://www.dmp.wa.gov.au">www.dmp.wa.gov.au</a> >	Mining tenements, best-management practices and approvals
<b>Geological Survey of Western Australia</b>		Geological survey maps and reports
<b>Department of State Development</b>	< <a href="http://www.dsd.wa.gov.au">www.dsd.wa.gov.au</a> >	State agreement Acts and state developments
<b>Department of Planning</b>	< <a href="http://www.planning.wa.gov.au">www.planning.wa.gov.au</a> >	Cadastral information, land planning information and development approvals
<b>Department of Fisheries</b>	< <a href="http://www.fish.wa.gov.au">www.fish.wa.gov.au</a> >	Aquaculture
<b>Forest Products Commission</b>	< <a href="http://www.fpc.wa.gov.au">www.fpc.wa.gov.au</a> >	Plantations
<b>Department of Indigenous Affairs</b>	< <a href="http://www.dia.wa.gov.au">www.dia.wa.gov.au</a> >	Aboriginal heritage sites
<b>Office of Native Title</b>	< <a href="http://www.nativetitle.wa.gov.au">www.nativetitle.wa.gov.au</a> >	Native title determination
<b>Heritage Council of Western Australia</b>	< <a href="http://www.heritage.wa.gov.au">www.heritage.wa.gov.au</a> >	Heritage sites
<b>Landgate</b>	< <a href="http://www.landgate.wa.gov.au">www.landgate.wa.gov.au</a> >	Public mapping information for government agencies

## Glossary

<b>abstraction</b>	The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality.
<b>allocation limit</b>	Annual volume of water set aside for use from a water resource. In the Arrowsmith groundwater area a resource is a given aquifer within a particular subarea.
<b>aquifer</b>	A geological formation or group of formations capable of receiving, storing and transmitting water.
<b>artesian aquifer</b>	A confined aquifer in which the hydraulic pressure will cause water to rise in a bore or spring above the land surface. If the pressure is insufficient to cause the well to flow at the surface, it is called a sub-artesian aquifer.
<b>artesian bore</b>	A bore, including all associated works, from which water flows, or has flowed, naturally to the surface.
<b>base flow</b>	The component of streamflow supplied by groundwater discharge.
<b>bore</b>	An opening in the ground, normally vertical hole drilled in soil or rock, made or used to obtain access to underground water. This is equivalent to the description of a 'well' in the <i>Rights In Water and Irrigation Act 1914</i> .
<b>confined aquifer</b>	An aquifer lying between confining layers of low permeability strata (such as clay, coal or rock) so that the water in the aquifer cannot easily flow vertically.
<b>dewatering</b>	Removing underground water to facilitate construction or other activity. It is often used as a safety measure in mining below the watertable or as a preliminary step to development in an area.
<b>discharge</b>	The water that moves from the groundwater to the ground surface or above, such as a spring. This includes water that seeps to the ground surface, evaporation from soil, and water extracted from groundwater by plants (evapotranspiration) or engineering works (groundwater pumping).
<b>domestic bore</b>	A bore used for providing the household and household garden watering requirements.
<b>drawdown</b>	The lowering of a watertable resulting from the removal of water from an aquifer or reduction in hydraulic pressure.
<b>ecological water requirements</b>	The water regime required to maintain ecological values of water-dependent ecosystems at a low level of risk.
<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, cultural and economic impacts. They may meet in part or in full the ecological water requirements.
<b>first-in first-served</b>	A process by which groundwater entitlements are allocated consistent with the order in which licence applications are received by the Department of Water.
<b>groundwater</b>	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. Also see aquifer, confined and unconfined aquifer.
<b>groundwater area</b>	An area proclaimed under the <i>Rights in water and irrigation act 1914</i> for the purposes of licensing and managing water use.

<b>groundwater-dependent ecosystem</b>	An ecosystem that is dependent on groundwater for its existence and health.
<b>hydrogeology</b>	The hydrological and geological science concerned with the occurrence, distribution, quality and movement of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
<b>licence</b>	A formal authorisation which entitles the licence holder to 'take' water from a watercourse, wetland or underground source for a specified quantity and period of time.
<b>m AHD</b>	Australian Height Datum – height in metres above mean sea level at Fremantle + 0.026 m.
<b>non-artesian well</b>	A well, including all associated works, from which water does not flow, or has not flowed, naturally to the surface but has to be raised, or has been raised, by pumping or other artificial means.
<b>precautionary principle</b>	Taking a cautious approach to development and environmental management decisions when information is uncertain, unreliable or inadequate.
<b>public water supply reserve</b>	Reservation of a volume of water, from the allocation limit, to supply drinking water for human consumption.
<b>purchaser</b>	A person receiving a trade is referred to as the purchaser. Any person permitted by the <i>Rights in Water and Irrigation Act 1914</i> to hold a water licence is potentially able to purchase a licensed entitlement.
<b>recharge</b>	Water that infiltrates into the soil to replenish an aquifer.
<b>salinity</b>	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved solids (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
<b>social value</b>	A particular in situ quality, attribute or use that is important for public benefit, welfare, physical and spiritual state or health.
<b>stock bore</b>	A bore that provides drinking water for stock.
<b>subarea</b>	A smaller area determined by the Department of Water within a proclaimed area used for water allocation planning and management purposes, the boundaries of which are primarily defined by the location of the water resource.
<b>surface water</b>	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
<b>sustainability</b>	Meeting the needs of current and future generations through integration of environmental protection, social advancement and economic prosperity.
<b>sustainable groundwater yield</b>	The amount of water that can be abstracted/extracted over time from a water resource while maintaining the ecological values (including assets, functions and processes).
<b>throughflow</b>	The flow of water within an aquifer.
<b>trade</b>	Sale of part or all of a licensed entitlement, by a licensee (vendor) to a second party (purchaser). This involves moving the point of abstraction from one property to another.

<b>transfer</b>	A transfer is a change in ownership of the water licence associated with the sale of the property to which the licence applies. There is no change in the location of the abstraction. Licences can be transferred without recompense.
<b>transpiration</b>	The water taken up by plants, normally measured in millimetres.
<b>unconfined aquifer</b>	Is the aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater within the aquifer is called the watertable. An aquifer containing water with no upper non-porous material to limit its volume or to exert pressure.
<b>unconformity</b>	A discontinuity in rock sequence indicating interruption of sedimentation, commonly accompanied by erosion of rocks below the break or the interface between such strata.
<b>vendor</b>	A licence holder wishing to trade a water entitlement is referred to as the vendor. Any person permitted by the <i>Rights in Water and Irrigation Act 1914</i> to hold a water licence is potentially able to sell a licensed entitlement.
<b>water use efficiency</b>	Increasing water supply efficiency and water demand efficiency to minimise the taking and use of water.
<b>water entitlement</b>	The quantity of water that a person is entitled to take on an annual basis in accordance with the <i>Rights in Water and Irrigation Act 1914</i> and a licence.
<b>water reserve</b>	An area proclaimed under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> or <i>Country Areas Water Supply Act 1947</i> to allow the protection and use of water on or under the land for public water supplies.
<b>watertable</b>	The saturated level of the unconfined groundwater. Wetlands in low-lying areas are often seasonal or permanent surface expressions of the watertable.
<b>well</b>	An opening in the ground made or used to obtain access to underground water. This includes soaks, wells, bores and excavations.
<b>wetland</b>	An area that is permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static. (Taken from Ramsar Convention definition)
<b>yield</b>	The volume of water that may be drawn from a well or water supply system.

## Volumes of water

One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 Megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 Gigalitre	(GL)

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## Shortened forms

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AHD	Australian height datum
ANZECC	Australian and New Zealand Environmental Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid sulfate soils
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DoW	Department of Water
DPC	Department of the Premier and Cabinet
EPA	Environmental Protection Authority
EWR	Ecological water requirements
GDE	Groundwater-dependent ecosystems
IOCI	Indian Ocean Climate Initiative
NACC	Northern Agricultural Catchments Council
PASS	Potential acid sulfate soils
PWS	Public water supply
TDS	Total dissolved solids
WAPC	Western Australian Planning Commission
WC	Water Corporation
WRC	Water and Rivers Commission

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