



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

# Environmental management of groundwater from the Gnangara and Jandakot mounds

Annual compliance report to the Office of the Environmental Protection Authority  
July 2012 to June 2013

February 2014

*Looking after all our water needs*



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Department of Water

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# 1 Introduction

This report describes the Department of Water's compliance with ministerial conditions and commitments for the Gnangara and Jandakot groundwater mounds for the period 1 July 2012 to 30 June 2013. These conditions and commitments, including water level criteria, are stated in *Ministerial Statement No. 819* (Government of Western Australia 2009a) for Gnangara and *Ministerial Statement No. 688* (Government of Western Australia 2005) for Jandakot. This report also outlines the environmental monitoring, management actions, research initiatives and consultation the department undertakes to manage the groundwater resources of the Gnangara and Jandakot systems in a sustainable manner.

*Ministerial statement No. 819* sets environmental water provisions in the form of water level criteria at 30 sites across the Gnangara Mound – 14 wetland sites and 16 terrestrial phreatophytic vegetation sites (Figure 1). *Ministerial statement No. 688* sets water level criteria at 23 sites across the Jandakot Mound – 10 wetland sites, nine terrestrial phreatophytic vegetation sites and four rare flora sites across the Jandakot, Perth and Cockburn groundwater areas (Figure 2).

Ministerial conditions and commitments were established (in 1986 for Gnangara and 1992 for Jandakot) to manage the development of groundwater abstraction for public water supply and the expected growth in private licensed use. The conditions and commitments have been revised several times to remove sites where the environmental values identified for protection have since been lost due to causes other than abstraction. These causes include the drying climate, land clearing and disturbance related to changing land use. The most recent revision (2008) for Gnangara removed seven sites and amended the water level criteria at three sites. For Jandakot, the most recent revision (2005) removed 15 sites and amended the water level criteria at five sites. Increased rainfall variability and reduced recharge to groundwater associated with the drying climate in the south-west of Western Australia continues to contribute to non-compliance with water level criteria.

The department aims to manage abstraction from the Gnangara and Jandakot groundwater systems to meet water level criteria and to minimise environmental impacts associated with abstraction. Water allocation limits and licensing of groundwater abstraction are the main mechanisms the department uses to manage groundwater resources. We set allocation limits by considering recharge estimates, environmental objectives and benefits of groundwater use and set limits for each aquifer by subarea. Allocation limits guide water availability for individual licensing. The department also guides the appropriate use of unlicensed, domestic garden bores.

This report presents the totals of licensed water entitlements from the groundwater areas that influence Ministerial sites on the Gnangara and Jandakot mounds, focusing on entitlements from the Superficial aquifer. See tables 1, 2 and 4 for the Gnangara Mound and tables 1, 3 and 5 for the Jandakot Mound.

In the 2012–13 period, the number of sites non-compliant with absolute minimum or peak water level criteria increased by one for Gnangara and remained unchanged for Jandakot (Table 1).

**Table 1** *Rainfall, water use from the Superficial aquifer and number of sites non-compliant with absolute minimum and/or peak water level criteria for 2012–13 against 2011–12*

	<b>Gnangara Mound (Superficial aquifer)</b>		<b>Jandakot Mound (Superficial aquifer)</b>	
	<b>2011–12</b>	<b>2012–13</b>	<b>2011–12</b>	<b>2012–13</b>
Rainfall <sup>1</sup>	838.0 mm	584.8 mm	882.2 mm	667.6 mm
Public water supply entitlements <sup>2</sup>	41.96 GL	31.52 GL	2.80 GL	3.04 GL
Private licensed entitlements and commitments	113.18 GL	110.56 GL	35.28 GL	34.94 GL
Estimated garden bore use <sup>3</sup>	30.00 GL	30.00 GL	1.00 GL	1.00 GL
Non-compliance <sup>4</sup>	16/30	17/30	5/23	5/23

<sup>1</sup> Rainfall figures are for the months July to June, corresponding with the reporting period. Gnangara figures are taken from Perth Airport (BOM station no. 9021) and Jandakot figures from Jandakot Airport (BOM station no. 9172).

<sup>2</sup> Public water supply figures are comprised of water licensed to the Water Corporation as part of Perth's public water supply and water licensed for the Woodridge town water supply. Prior to 2012–13 we only reported on water licensed to Water Corporation.

<sup>3</sup> Garden bore use is estimated using data collected through surveys, data from the Australian Bureau of Statistics and records of household use from the Water Corporation. The figure for the Jandakot Mound is for the Jandakot groundwater areas only.

<sup>4</sup> The number of sites non-compliant with absolute summer minimum or absolute minimum spring peak water level criteria (sites can be non-compliant with both water level criteria, but are counted only once in the table). For full details of compliance see Table 6 and Appendix A for Gnangara and Table 7 and Appendix C for Jandakot.

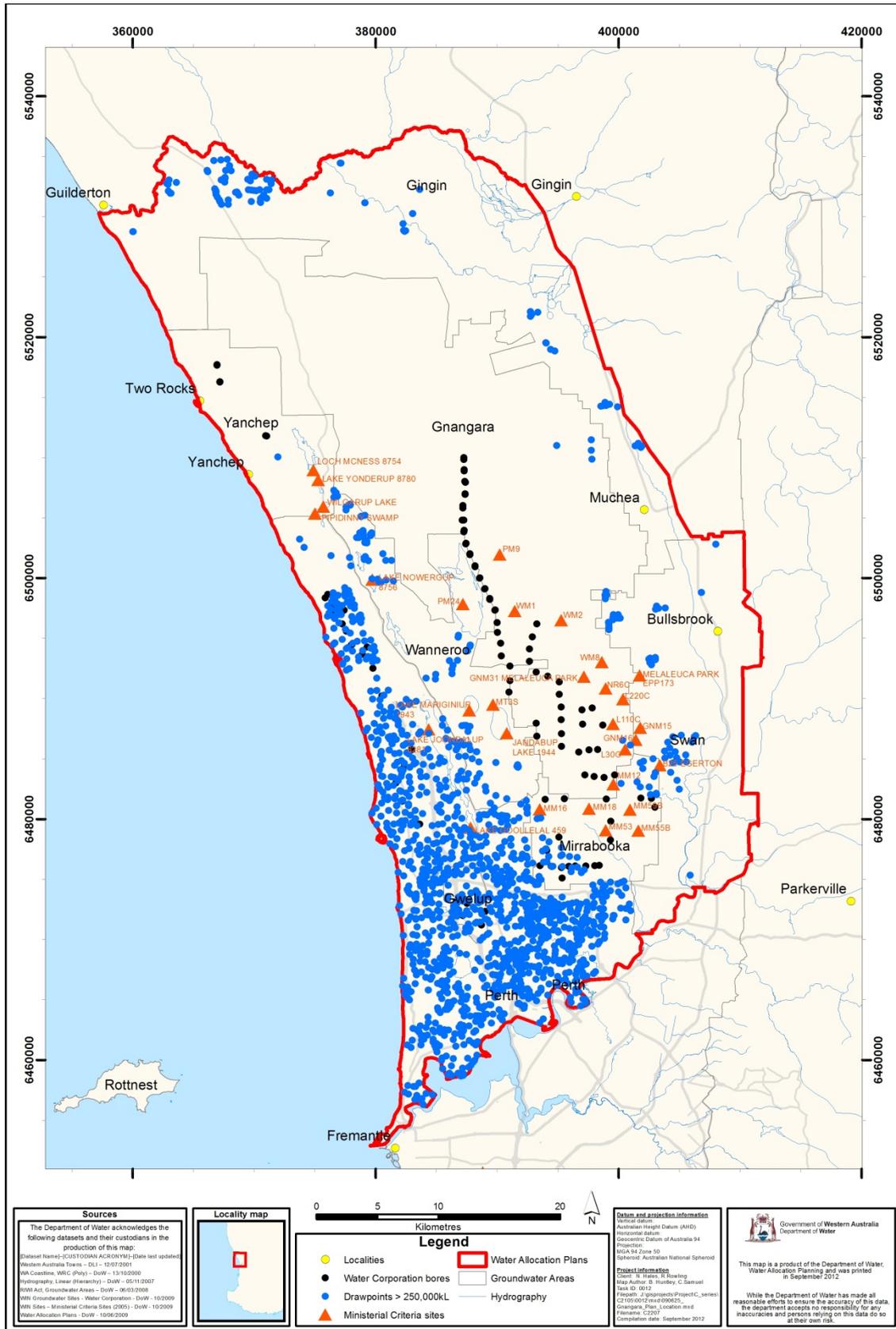


Figure 1 Gngangara groundwater system – location of Ministerial sites, public water supply production bores and private licensed entitlements over 250 000 kL from the Superficial aquifer



## 2 Groundwater systems

### 2.1 The Gnangara groundwater system

The Gnangara groundwater system provides water for public open space, horticulture, industry and gardens, and is a vital component of Perth's public water supply. The system comprises four main aquifers:

- the shallow unconfined Superficial (water table) aquifer known as the Gnangara Mound
- the shallow, semi-confined Mirrabooka aquifer
- the deeper, partially-confined Leederville aquifer
- and the deeper, mostly-confined Yarragadee aquifer.

Groundwater levels across the Gnangara Mound have generally declined over the last thirty years due to a combination of:

- the drying climate (less rainfall and recharge)
- pine plantations limiting recharge
- impacts from abstraction for public water supply, private licensed use and unlicensed garden bores.

Environmental impacts from abstraction and reduced recharge occur where ecosystems depend on direct connection to the Superficial aquifer. Impacts can occur from abstraction within the Superficial aquifer itself and through abstraction from deeper aquifers where they are directly or indirectly connected to the Superficial aquifer.

### 2.2 The Jandakot groundwater system

The Jandakot groundwater system provides water for public open space, horticulture, industry and gardens, and contributes to Perth's public water supply. The system comprises three main aquifers:

- the shallow unconfined Superficial (water table) aquifer known as the Jandakot Mound
- the deeper, mostly confined Leederville aquifer
- and the deeper, mostly confined Yarragadee aquifer.

Groundwater levels across the Jandakot Mound have also declined over the last 30 years, but at a slower rate than seen in the Gnangara Mound. This is due to a combination of factors including:

- the Jandakot Mound receives more rainfall than the Gnangara Mound
- abstraction pressure on the Jandakot Mound is less than on the Gnangara Mound
- large parts of the Jandakot Mound are now urbanised, which has increased recharge.

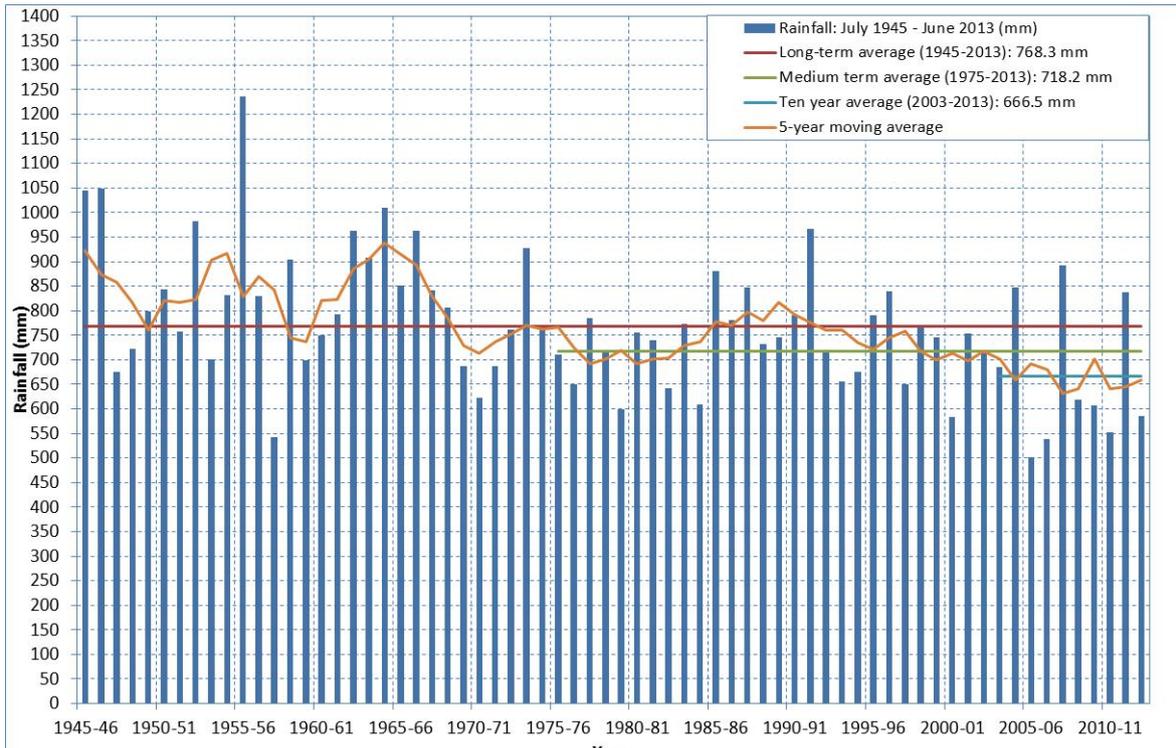
Most of the Jandakot Mound is separated from the deeper Leederville aquifer by a confining layer of Kardinya shale that extends under all the Ministerial sites except Lake Forrestdale. These relatively impermeable shales limit the potential for inter-aquifer impacts of abstraction across most of the mound. The disconnection created by the shales means abstraction from the Superficial aquifer has a greater impact on wetlands on the Jandakot Mound than abstraction from the deep aquifers.

### 3 Rainfall and recharge

Groundwater levels of the Superficial aquifer depend on recharge from rainfall. Across the south-west of Western Australia there has been a general trend of declining annual rainfall since the mid 1970s. A CSIRO investigation of climate change (Bates et al. 2010), along with relevant global climate change models, predict a continuation of rainfall reduction in the south-west of Western Australia.

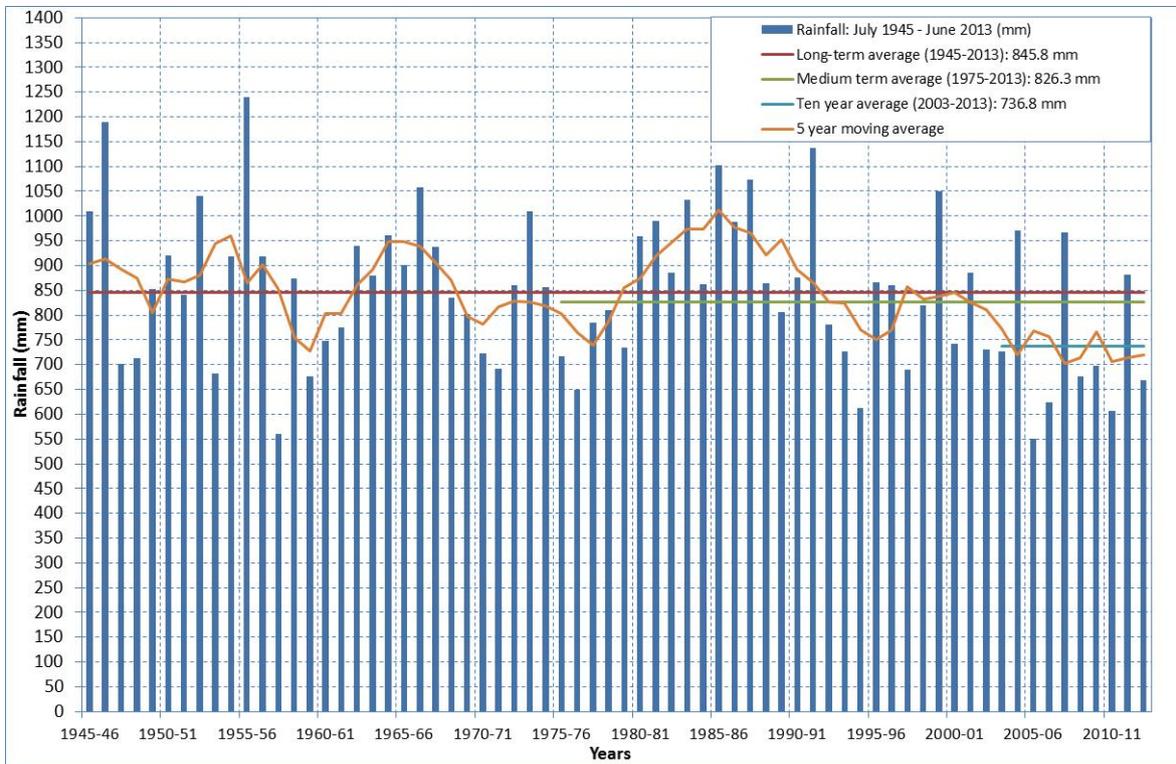
Comparison of medium term (post July 1975) and ten-year average rainfall (post July 2003) for the Perth Airport station shows further declines since the 1970s (Figure 3). Over the 2012–13 reporting period, rainfall at Perth Airport (584.8 mm) and Jandakot Airport (667.6 mm) was well below the long term and more recent averages (figures 3 and 4).

In 2012, the wet season rainfall between May and September was the second lowest on record. This led to the second lowest inflow into Water Corporation's reservoirs ever recorded.



Note: Data sourced from the Bureau of Meteorology.

Figure 3 Annual and average rainfall over time, by water year for Perth Airport (BOM site 9021)



Note: Data sourced from the Bureau of Meteorology.

Figure 4 Annual and average rainfall over time, by water year for Jandakot Airport (BOM site 9172)

## 4 Groundwater use

### 4.1 Public water supply

The Department of Water licenses the Water Corporation to take groundwater from the Gngangara and Jandakot groundwater systems for Perth's public water supply. Abstraction from these systems forms an important component of the Integrated Water Supply Scheme (IWSS). Within the Gngangara system, there is also a small volume of groundwater licensed for the Woodridge town water supply. This volume does not form part of the IWSS. Licensed entitlements for public water supply are from all of the aquifers in the groundwater systems.

For the Gngangara groundwater system, licence entitlements for public water supply from the Superficial aquifer are within the Gngangara, Gwelup, Mirrabooka, Perth, Yanchep and Gingin groundwater areas (Figure 1). For the Jandakot groundwater system, licensed entitlements for public supply from the Superficial aquifer are from the Jandakot groundwater area only (Figure 2).

The volumes of groundwater licensed over the 2012–13 reporting period for the IWSS (public water supply) from all aquifers are shown in tables 2 and 3. The volumes licensed from the Gngangara and Jandakot systems, include:

- 120 GL for annual public water supply requirements (licence allows an average of 120 GL/yr to be taken during 2012–13 to 2016–17)
- 19 GL from temporary, short term licences approved for 2012–13 (due to a shortage of supply from other sources)
- 1.3 GL licensed as part of a groundwater replenishment trial.

The overall volume licensed for public supply in 2012–13 was reduced by about 20 GL compared to the previous year. Tables 4 and 5 show licensed entitlements for public supply from the Superficial aquifer by groundwater subarea. The volume licensed for public supply from the Superficial aquifer was reduced by about 10 GL compared to the previous year.

### 4.2 Private licensed use

Most of the groundwater licensed from the Superficial aquifer is to private users. Groundwater from the Superficial aquifer is used for horticulture, public open space, industry, gardens, institution grounds and recreation grounds.

Over the reporting period, private licensed entitlements from all aquifers in the Gngangara groundwater system remained relatively steady (Table 2). Table 4 shows volumes of private licensed entitlements from the Superficial aquifer over the reporting period by groundwater subarea.

Over the reporting period, private licensed entitlements from the Superficial aquifer in the Jandakot groundwater system also remained relatively stable (Table 3). Table 5 shows volumes of private licensed entitlements from subareas with Ministerial criteria sites, or subareas that may impact on them.

### 4.3 Garden bore use

Groundwater is also abstracted from the Superficial aquifer through domestic garden bores that do not require a licence. The department has estimated garden bore use using data collected through surveys, data from the Australian Bureau of Statistics and household use data from the Water Corporation (Table 2).

*Table 2 Public water supply, private use and estimated garden bore use from all aquifers in the Gngangara groundwater system for 2011–12 and 2012–13*

Aquifer	Public water supply entitlements <sup>1</sup> GL		Private licensed entitlements and commitments GL		Estimated garden bore use GL	
	2011–12	2012–13	2011–12	2012–13	2011–12	2012–13
Superficial	41.96	31.52	113.18	110.56	30.00	30.00
Mirrabooka	4.22	2.65	2.21	2.24		
Leederville	48.85	<sup>2</sup> 43.08	11.49	11.13		
Yarragadee	52.28	51.79	0.68	0.68		
<b>TOTAL</b>	<b>147.31</b>	<b>129.04</b>	<b>127.76</b>	<b>124.61</b>	<b>30.00</b>	<b>30.00</b>

<sup>1</sup> From 2012–13 onwards public water supply figures include both the groundwater licensed to Water Corporation as part of the Integrated Water Supply Scheme and groundwater licensed for the Woodridge town water supply (0.13 GL from the Superficial aquifer and 0.03 GL from the Leederville aquifer).

<sup>2</sup> A total of 1.3 GL is licensed as part of the groundwater replenishment scheme.

*Table 3 Totals of licensed entitlements from all aquifers within the Jandakot groundwater subareas with or that impact on Ministerial criteria sites*

Aquifer	Public water supply entitlements GL		Private licensed entitlements and commitments GL	
	2011–12	2012–13	2011–12	2012–13
Superficial	2.80	3.05	35.95	34.94
Leederville	8.25	7.45	0.00	0.00
Yarragadee	0.66	0.93	0.00	0.00
<b>TOTAL</b>	<b>11.71</b>	<b>11.43</b>	<b>35.95</b>	<b>34.94</b>

Table 4 Licensed entitlements for public water supply and private use from the Superficial aquifer in the Gnangara groundwater areas

Groundwater area	Subarea	Ministerial site present	Allocation limit GL/yr <sup>1,2</sup>		Public water supply licensed entitlements <sup>4</sup> GL			Private licensed entitlements and commitments <sup>6</sup> GL	
			2007	2011	2011-12	2012-13 <sup>7</sup>	Future water reserve <sup>5</sup>	2011-12	2012-13
Gingin <sup>1,5,7</sup>	Beermullah Plain South	No	3.00	2.70				3.60	3.13
	Deepwater Lagoon South	No	3.50	3.50				3.46	3.38
	Guilderton South	No	11.00	9.92		0.13		11.09	9.98
	Lake Mungala	No	3.40	3.16				3.39	2.90
<b>Total for Gingin Groundwater area</b>			<b>20.90</b>	<b>19.29</b>	<b>0.00</b>	<b>0.13</b>	<b>Yes</b>	<b>21.55</b>	<b>19.30</b>
Gnangara <sup>5</sup>	Reserve	Yes	9.00	8.83	1.30	0.17		1.22	1.22
	Wanneroo Wellfield	Yes	12.00	11.85	8.04	5.92		0.50	0.50
<b>Total for Gnangara Groundwater area</b>			<b>21.00</b>	<b>20.68</b>	<b>9.34</b>	<b>6.09</b>	<b>Yes</b>	<b>1.72</b>	<b>1.72</b>
Gwelup <sup>1,5</sup>	Gwelup	No	7.95	7.85	5.08	2.65		1.45	1.11
<b>Total for Gwelup Groundwater area</b>			<b>7.95</b>	<b>7.85</b>	<b>5.08</b>	<b>2.65</b>	<b>Yes</b>	<b>1.45</b>	<b>1.11</b>
Mirrabooka <sup>5</sup>	Ballajura	No	6.00	5.90	1.95	1.94		1.12	0.91
	Beechboro	No	1.00	0.90				0.27	0.25
	Henley Brook	No	1.60	1.57	0.44	0.55		0.33	0.27
	Improvement Plan 8	No	5.50	5.48	2.00	1.45		0.19	0.14
	Landsdale	Yes	1.40	1.40				0.90	0.75
	Plantation	No	0.60	0.60				0.45	0.40
	State Forest	No	1.00	0.90				1.04	1.07
	Whiteman Park	Yes	1.00	0.99	0.25	0.15		0.52	0.54
<b>Total for Mirrabooka Groundwater area</b>			<b>18.10</b>	<b>17.75</b>	<b>4.64</b>	<b>4.09</b>	<b>Yes</b>	<b>4.83</b>	<b>4.33</b>
Perth <sup>5</sup>	City of Bayswater	No	2.30	2.30				1.68	1.72
	City of Fremantle North	No	0.70	0.70				0.04	0.04
	City of Nedlands	No	2.30	2.30				2.35	2.35
	City of Perth	No	1.50	1.50				3.26	3.26
	City of Stirling	No	11.15	11.15	3.43	3.08		7.85	7.76
	City of Subiaco	No	1.00	1.00				1.30	1.12
	Eglington	No	15.45	15.45				1.77	2.02
	Quinns	No	24.65	24.65	15.32	11.75		2.86	2.84
	Shire of Peppermint Grove	No	0.10	0.10				0.08	0.08
	Shire of Swan North	No	1.00	0.90				0.61	0.53
	Town of Bassendean	No	0.50	0.45				0.37	0.34
	Town of Cambridge	No	3.50	3.50				2.43	2.43
	Town of Claremont	No	0.70	0.70				0.70	0.70
	Town of Cottesloe	No	0.30	0.30				0.25	0.25
	Town of Mosman Park	No	0.50	0.50				0.48	0.48
	Town of Vincent	No	1.00	1.00				1.17	1.82
Whitfords	Yes	22.43	21.54	2.87	2.51		9.32	9.27	
<b>Total for Perth Groundwater area</b>			<b>89.08</b>	<b>88.04</b>	<b>21.61</b>	<b>17.34</b>	<b>Yes</b>	<b>36.53</b>	<b>37.03</b>
Swan	Bandy Spring	No	0.35	0.35				0.33	0.33
	Central Swan	No	1.00	0.92				1.34	1.31
	Cockman Bluff	No	1.50	1.35				1.16	1.18
	East Swan	No	0.75	0.68				1.01	1.08
	Neaves	No	2.00	1.80				3.43	3.43
	North Swan	Yes	2.00	1.83				2.91	2.91
	Radar	No	2.00	1.80				2.27	2.27
	South Swan	No	4.00	3.62				3.84	3.74
<b>Total for Swan Groundwater area</b>			<b>13.60</b>	<b>12.35</b>	<b>0.00</b>	<b>0.00</b>	<b>No</b>	<b>16.36</b>	<b>16.24</b>
Wanneroo	Adams	Yes	1.00	0.91				1.12	1.11
	Carabooda	No	6.40	5.76				7.80	8.01
	Carramar	No	1.70	1.55				1.50	1.49
	Jandabup	No	0.20	0.18				0.18	0.18
	Joondalup	No	1.50	1.35				0.87	0.87
	Lake Gnangara	No	7.50	7.50				7.15	7.15
	Mariginiup	Yes	4.00	3.61				4.26	4.25
	Neerabup	No	2.65	2.39				2.56	2.56
	Nowergup	Yes	2.00	1.80				2.77	2.77
Pinjar	Yes	0.50	0.45				0.70	0.62	
<b>Total for Swan Groundwater area</b>			<b>27.45</b>	<b>25.51</b>	<b>0.00</b>	<b>0.00</b>	<b>No</b>	<b>28.90</b>	<b>29.01</b>
Yanchep <sup>5</sup>	Yanchep	Yes	10.87	10.87	1.30	1.22		1.83	1.81
<b>Total for Yanchep Groundwater area</b>			<b>10.87</b>	<b>10.87</b>	<b>1.30</b>	<b>1.22</b>	<b>Yes</b>	<b>1.83</b>	<b>1.81</b>
<b>Total for Gnangara Groundwater areas</b>			<b>208.95</b>	<b>202.33</b>	<b>41.96</b>	<b>31.52</b>		<b>113.18</b>	<b>110.56</b>

**Table 5 Licensed entitlements for public water supply and private use from the Superficial aquifer within the Jandakot subareas with or that impact on Ministerial sites**

Groundwater area	Subarea	Ministerial criteria site present	Allocation limit GL/yr	Public water supply licensed entitlements <sup>4</sup> GL			Private licensed entitlements and commitments <sup>6</sup> GL		
				2011–12	2012–13	Future Water Reserve <sup>5</sup>	Quota set by EPA <sup>8</sup>	2011–12	2012–13
Jandakot <sup>3</sup>	Airport <sup>5</sup>	Yes	4.29	0.64	0.70	Yes	1.40	0.63	0.25
	Banjup <sup>5</sup>	Yes	3.61	0.42	0.43	Yes	1.80	0.71	0.36
	Canning Vale <sup>5</sup>	No	1.35	0.45	0.32	Yes	0.60	0.11	0.06
	Forrestdale <sup>5</sup>	Yes	2.01	0.08	0.30	Yes	1.67	0.98	0.70
	Mandogalup	No	3.00				3.00	1.88	1.17
	Oakford	Yes	1.37				1.37	0.24	0.83
	South Lakes	No	1.25				1.25	0.46	0.29
	Success <sup>5</sup>	Yes	4.30	1.22	1.30	Yes	2.25	1.05	0.84
	Wandi	No	1.20				1.20	0.47	0.27
Wright	No	0.96				0.96	0.79	0.87	
<b>Total for Jandakot Groundwater area</b>			<b>23.34</b>	<b>2.80</b>	<b>3.05</b>		<b>15.50</b>	<b>7.30</b>	<b>5.65</b>
Perth <sup>1</sup>	City of Armadale	Yes	4.00					3.05	2.92
	City of Canning	No	3.50					2.25	2.48
	City of Cockburn	Yes	1.00					0.48	0.48
	City of Gosnells	No	5.50					3.22	3.24
	City of Melville	No	5.50					4.18	4.17
<b>Total for Perth Groundwater areas</b>			<b>19.50</b>	<b>0.00</b>	<b>0.00</b>			<b>13.19</b>	<b>13.30</b>
Cockburn	Kogalup	Yes	11.46					9.86	10.36
	Thompsons	Yes	8.70					5.60	5.63
<b>Total for Cockburn Groundwater areas</b>			<b>20.16</b>	<b>0.00</b>	<b>0.00</b>			<b>15.46</b>	<b>15.99</b>
<b>Total for Jandakot subareas that affect Ministerial criteria sites</b>			<b>63.00</b>	<b>2.80</b>	<b>3.05</b>			<b>35.95</b>	<b>34.94</b>

**Footnotes for tables 4 and 5.**

**NOTE:** In 2011–12 there were minor administrative changes to how the department accounted for water licensed for public water supply. This report only presents licensed entitlement data rather than the combined abstraction estimate and licensed entitlement data presented in previous compliance reports. Similarly, there were minor administrative changes in how we account for a small group of private licences, which was part of the streamlining of legislation. Therefore, some of the figures presented will differ slightly to those presented in compliance reports prior to 2011–12.

<sup>1</sup> Allocation limits for the Gnangara groundwater areas were reviewed in 2007 and finalised in the *Gnangara groundwater areas allocation plan* (DoW 2009a). As part of this review, subarea boundaries in the Gingin groundwater area (GWA) were amended. Additionally, the Gwelup subarea (for the Superficial aquifer) was moved from the Perth GWA to the Gwelup GWA. This allocation limit review also included subareas within the Perth groundwater area located to the south of the Swan River.

<sup>2</sup> Allocation limits for the Gnangara groundwater areas were reviewed again in 2011 to account for reduced rainfall and recharge (also see section 6.2.2).

<sup>3</sup> Allocation limits for the Jandakot groundwater areas are currently being reviewed (see section 6.2.4)

<sup>4</sup> Public water supply information is from both the Water Resourcing Licensing System and annual reports submitted to the Department of Water by the Water Corporation as a condition of their licence. For consistency with all other department corporate reporting the data presented in this table shows annual licensed entitlements sourced from the Water Resourcing Licensing System.

<sup>5</sup> For subareas containing groundwater reserved for future public water supply, the reserve volumes are NOT included in the licensed entitlement figures presented.

<sup>6</sup> The source of private licensed entitlement and commitments data is the department's Water Resourcing Licensing System (2011–12 report run on 1 July 2012, 2012–13 report run on 1 July 2013). There have been minor administrative changes to accounting for a small group of private licences as part of the streamlining of legislation. Therefore, some of the figures presented will differ slightly to those presented in compliance reports prior to 2011–12. Commitments include conditional approvals and development commitments.

<sup>7</sup> Prior to the 2012–13 reporting period we have not reported on the small volume of water in the Gingin groundwater area that is licensed for public water supply. This water is not part of the Integrated Water Supply Scheme (IWSS) that supplies Perth but is for Woodridge town water supply.

<sup>8</sup> The quota for private licensed allocation was set in accordance with the Environmental Management Program by the EPA in 1992. Since then the South Lakes subarea has been expanded to include the Yangebup subarea.

Up to date figures on water availability are available from the Swan Avon Regional office.

1 GL = 1 000 000 kL.

Figures have been rounded to two decimal places.

## 5 Compliance

Appendices A to D (the ‘audit tables’) detail the conditions and commitments that the Department of Water is required to comply with on the Gngangara and Jandakot mounds (*Ministerial Statement Nos. 819 and 688* respectively). The Office of the Environmental Protection Authority (OEPA) and the then Department of Environment and Conservation have previously cleared some of the conditions and commitments in the statements and therefore we no longer report against them.

### 5.1 Compliance with water level criteria

*Ministerial Statement No. 819* sets water level criteria at 30 sites across the Gngangara Mound (Figure 1). There are 14 wetland sites and 16 terrestrial phreatophytic vegetation sites. *Ministerial statement No. 688* sets water level criteria at 23 sites across the Jandakot Mound (Figure 2). There are 10 wetland sites, nine terrestrial phreatophytic vegetation monitoring sites and four rare flora sites. Phreatophytic vegetation is vegetation that uses groundwater to meet at least part of its water needs.

Some sites have more than one water level criterion and can be non-compliant with multiple criteria. Water level criteria include:

- preferred minimum water levels
- absolute minimum water levels
- peak water levels
- water levels allowed between preferred minimum and absolute minimum at a rate of two in six years to replicate natural drying cycles (referred to as other water level criteria)
- rate of decline and timing of drying (referred to as other water level criteria).

As of June 2013, water levels at a number of sites were still declining and the minimum water level had not been reached. For these sites the minimum water level recorded for 2013 was in June. For Gngangara, there was one additional site (Melaleuca Park Dampland 78) non-compliant with the absolute minimum water level, which is arguably the most ecologically significant criterion.

A summary of non-compliant sites on Gngangara and Jandakot can be found in Table 6 and Table 7. It shows the trend over the last three years.

We describe the management and mitigation being undertaken in response to non-compliances in the following section (Section 6). Details for individual sites can be found in the ‘audit tables’ in Appendix A and Appendix C.

Table 6 Summary of sites across the Gnangara Mound that are non-compliant with Ministerial water level criteria

Year	Compliance <sup>1</sup>						
	Absolute minimum water level criteria			Peak water level criteria		Other water level criterion	
	Wetlands	Terrestrial vegetation	Total non-compliant	Wetlands	Total non-compliant	Wetlands	Total non-compliant
2010–11	Loch McNess Lake Yonderup Lake Jandabup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173	MM16 MM53 MM55B MM59B PM9 WM1 WM8	14/30 <sup>2</sup>	Lake Mariginiup Lake Nowergup Lake Wilgarup Pipidinny Swamp	4/5	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 186	4/8
2011–12	Loch McNess Lake Yonderup Lake Jandabup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173	MM53 MM55B MM59B PM9 WM1 WM2 WM8	14/30	Lake Mariginiup Lake Nowergup Lake Wilgarup Pipidinny Swamp	4/5	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 186	4/8
2012–13	Loch McNess Lake Yonderup Lake Jandabup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173 Melaleuca Park Dampland 78	MM53 MM55B MM59B PM9 WM1 WM2 WM8	15/30	Lake Mariginiup Lake Nowergup Lake Wilgarup Pipidinny Swamp	4/5	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 186	4/8

<sup>1</sup> Sites can be non-compliant with both absolute summer minimum water level and peak water level criteria. Also see Appendix A.

<sup>2</sup> There have been issues with water levels recorded from the staff gauge at Pipidinny Swamp (see Appendix A). This site was incorrectly reported as compliant with the absolute minimum water level criteria in the 2010–11 compliance report. The department has notified the OEPA of these errors and the correct figure for the number of non-compliant sites is used in this table.

Table 7 Summary of sites across the Jandakot Mound that are non-compliant with Ministerial water level criteria

Year	Compliance					
	Absolute minimum water level criteria			Other water level criterion		
	Wetlands	Terrestrial and rare flora vegetation	Total non-compliant	Wetlands	Terrestrial and rare flora vegetation	Total non-compliant
2010–11	North Lake Bibra Lake Lake Forrestdale Lake Banganup Shirley Balla Swamp	JM14 JM19	7/23	North Lake Bibra Lake Thomsons Lake Lake Forrestdale Shirley Balla Swamp Beenyup Road Swamp	JM7 JM8 JM45 JE17C	10/12
2011–12	North Lake Bibra Lake Lake Forrestdale Lake Banganup Shirley Balla Swamp		5/23	Bibra Lake Thomsons Lake Lake Forrestdale Shirley Balla Swamp		4/12
2012–13	North Lake Bibra Lake Lake Forrestdale Lake Banganup Shirley Balla Swamp		5/23	Bibra Lake Thomsons Lake Lake Forrestdale Shirley Balla Swamp		4/12



## 6 Environmental monitoring, management actions, research initiatives and consultation

### 6.1 Environmental monitoring

The department engages expert environmental consultants to carry out an environmental monitoring program in line with the commitments in *Ministerial Statement No. 819* for Gngangara and *Ministerial Statement No. 688* for Jandakot. The monitoring program was reviewed in 2009 (see Appendix D) to improve the cost effectiveness and efficiency of the program. The program includes monitoring of:

- wetland and terrestrial vegetation
- wetland aquatic macroinvertebrates and water quality
- cave and spring macroinvertebrates and water quality
- wetland frogs.

Ecological condition is affected by a number of factors that influence water levels, including abstraction. Condition is also affected by other factors such as fire and disturbance related to changing land use. The department uses environmental monitoring information to continually check the link between water levels and ecological outcomes. We also use the information to manage abstraction at priority locations, where it is identified that reduced abstraction can have a positive effect on ecological condition.

#### 6.1.1 Gngangara

##### *Wetland vegetation*

Vegetation was monitored at 10 wetlands in 2012–13 (Wilson et al. 2013). The monitoring highlighted a number of wetlands of concern, where declines in ecological condition in relation to falling groundwater levels were observed. These wetlands included Lake Nowergup, Loch McNess, Lake Yonderup, Lake Wilgarup and Lake Mariginiup (Wilson et al. 2013). Water levels at these sites were non-compliant with water level criteria.

##### *Wetland aquatic macroinvertebrates and water quality*

Macroinvertebrates and water quality were monitored at 10 wetlands in 2012–13. Monitoring occurred in spring to coincide with peak water levels (Judd and Horwitz 2013).

Family richness at Lake Gngangara and Lake Mariginiup was the lowest since monitoring begun. Richness was also low at Melaleuca Park EPP173, Lake Jandabup and Lake Nowergup. Richness increased from the previous year at Lake Goollelal and Lake Joondalup, and Loch McNess was relatively high compared to historical levels (Judd and Horwitz 2013).

Wetland nutrient concentrations were similar to the previous year and within historical ranges. A pH of less than 4 was recorded at Lake Gngangara, Lake Mariginiup and Melaleuca Park EPP173. The low pH recorded at Lake Gngangara and Lake Mariginiup may have resulted from the exposure of sulphidic sediments (Judd and Horwitz 2013).

#### *Cave and spring macroinvertebrates and water quality*

Macroinvertebrates and water quality were monitored in nine caves in the Yanchep area and three springs in the Lexia/Bullsbrook area in 2012–13 (Knott et al. 2013). Monitoring occurred in spring (September/October) to coincide with peak water levels.

Water levels in the Yanchep caves continued to decline to the point where most of the caves were dry and could not be sampled. In the two caves with enough water to be sampled, water quality was similar to previous years. The low water levels in these two caves resulted in low macroinvertebrate species richness. The root mat (a threatened ecological community) (TEC) is no longer evident in accessible caves, though may still exist in undiscovered or inaccessible parts of caves.

Flows at Gaston Road and Sue's springs were reduced compared to previous years. At the time of monitoring, Egerton Spring had ceased to flow despite water levels at the site being compliant with the water level criteria. Measured pH was relatively low at all sites and especially low at Gaston Road Spring. Water quality conditions at Egerton Spring reflected a lack of flow, with low dissolved oxygen recorded.

Macroinvertebrate species richness at Gaston Road and Sue's springs was the highest recorded since monitoring commenced. Richness at Egerton Spring had declined from previous years, possibly due to a lack of flow.

#### *Wetland frogs*

Frog populations were monitored at sites across the Gngangara Mound. Trapping was done at five sites in spring and aural surveys of calling males were done in spring and autumn at the same sites, and at other sites identified through the draft Gngangara Sustainability Strategy (Government of Western Australia 2009b).

Generally, the numbers of frogs trapped and calling was considered to be low compared to previous years. Annual variations in the numbers of frogs calling and captured is related to changes in rainfall, water levels and the annual inundation of wetlands (Everard and Bamford 2013).

## 6.1.2 Jandakot

### *Wetland vegetation*

Vegetation was monitored at six wetland sites in 2012–13 (Wilson et al. 2013). The monitoring highlighted that Shirley Balla Swamp, where declines in canopy condition and tree deaths were recorded, was the main wetland of concern. Water levels at Shirley Balla Swamp have been non-compliant with the absolute minimum criteria since 1997–98 (Wilson et al. 2013).

Declines in canopy condition were also recorded at North Lake, The Spectacles and Beenyup Road Swamp. Tree deaths were also observed at Lake Forrestdale, Banganup Lake and North Lake. Improved canopy condition was recorded at Thomsons Lake and Banganup Lake (Wilson et al. 2013).

### *Wetland aquatic macroinvertebrates and water quality*

Six wetlands were monitored for macroinvertebrate family richness and assemblages and water quality in 2012–13 (Strehlow et al. 2013). Monitoring coincided with peak water levels.

Species richness was below average at Lake Forrestdale and The Spectacles and above average at Lake Yangebup, Thomsons Lake and Kogolup Lake.

Water quality was similar to previous years, except for low pH recorded at Thomsons Lake. Nutrient levels were generally lower or within normal ranges, however most exceeded ANZECC/ARMCANZ (2001) trigger values (Strehlow et al. 2013).

## 6.2 Management actions

The department's primary approach to non-compliance is to manage abstraction more stringently in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites.

Since a number of sites are non-compliant with a number of Ministerial criteria across the Gngangara and Jandakot mounds, we are implementing strategies to reduce abstraction to a sustainable level and to reduce the environmental risks associated with abstraction.

For Gngangara, these strategies are outlined in the *Gngangara groundwater allocation plan (2009)*, which were evaluated as part of the *Gngangara groundwater areas allocation plan – evaluation statement (2009–2011)* and will be refined through the review and update of the allocation plan, scheduled for release in 2016.

### 6.2.1 Gngangara groundwater areas allocation plan

The *Gngangara groundwater areas allocation plan* was released in November 2009 (DoW 2009a). It describes how the department manages groundwater allocation from the Gngangara groundwater system. The objectives of the plan are to:

- 1 Reduce the total volume of water abstracted from the Gngangara system towards a level that better reflects the current recharge from rainfall.
- 2 Optimise the use of water through water use efficiency and demand management measures.

- 3 Protect groundwater-dependent ecosystems from direct impacts associated with abstraction.
- 4 Protect the quality of groundwater for public and self-supply from impacts associated with abstraction and land use.
- 5 Adapt management of the water resource based on the results of monitoring programs and the condition of the resource.

The allocation plan was an important step in updating our groundwater management in the context of high demand for groundwater and a drying climate. The plan improved how the Gnangara system is managed by capping increases in groundwater allocations, setting management actions to reduce the impacts of abstraction and providing a basis to meet growth in demand through efficiency gains and new supply options.

Private allocations from developed areas were essentially capped. At the same time, a staged reduction of public water supply abstraction, with provisions for exceptional circumstances, was initiated.

#### 6.2.2 Gnangara groundwater areas allocation plan - evaluation statement 2009-2011

As part of our adaptive management approach we evaluated the *2009 Gnangara allocation plan* and released the *Gnangara groundwater areas allocation plan evaluation statement 2009–2011*. The report states that progress has been made towards achieving the plan's objectives, but that abstraction remains at an unsustainable level, particularly given that the drying climate is predicted to continue.

The evaluation showed that a new plan is needed to take management to the next step, to maintain viable, multi-benefit groundwater resources in the long term.

#### 6.2.3 Updating the 2009 Gnangara areas groundwater allocation plan

Initiating work on the next phase of Gnangara allocation planning is a 2013 business priority for the department. The new allocation plan will focus on the framework and tools to better meet objectives 1 and 3 (see above). This includes a comprehensive assessment of abstraction scenarios using the updated Perth Regional Aquifer Modelling System (PRAMS) version 3.5. A formal consultation process will be initiated in 2014–15, with the replacement allocation plan scheduled for release in 2016.

#### 6.2.4 Jandakot groundwater area allocation limit review

The department is reviewing the allocation limits for the Jandakot groundwater area. The updated allocation limits will be based on recharge predicted under the drying climate and will align with the environmental objectives for the Jandakot Mound in *Ministerial statement 688*. The new limits will reduce the risk of further non-compliances and reduced ecological condition at Ministerial sites.

#### 6.2.5 Managing public water supply allocations

As outlined in the *2009 Gnangara groundwater areas allocation plan*, the addition of the Southern Seawater Desalination Plant to the Integrated Water Supply Scheme

triggered a change in how groundwater for the public water supply is allocated. In line with the plan, from 2012–13, the Water Corporation's groundwater allocation from the Gngangara and Jandakot systems for the Integrated Water Supply Scheme has been reduced from 145 GL to 120 GL (from existing infrastructure). The Water Corporation is committed to achieving an average allocation of 120 GL over the five-year licence period from 2012–13 to 2016–17.

Under the 120 GL average allocation, the licensed volume from the Superficial aquifer has been reduced. Superficial licence entitlements decreased from 42.7 GL to 29.6 GL for the Gngangara groundwater areas and from 3.2 GL to 2.9 GL for the Jandakot groundwater area. These reductions were targeted to environmentally sensitive areas where they would most benefit water levels and ecological condition at Ministerial sites and other significant groundwater-dependent ecosystems. Licence entitlements also reduced from the Leederville (45.3 GL to 42.0 GL) and Yarragadee (50.0 GL to 44.4 GL).

#### *Groundwater replenishment scheme*

The department is working with the Water Corporation to progress their groundwater replenishment scheme at Beenyup Wastewater Treatment Plant. The government now supports the 7 GL per year groundwater replenishment scheme, where treated recycled wastewater is injected back into the Leederville and Yarragadee aquifers. 2012–13 was the first year the Water Corporation has been issued a licence to abstract the first 1.3 GL of groundwater to offset the volume of water injected at Beenyup. The scheme has the potential to deliver up to 28 GL per year by 2022.

#### 6.2.6 Managing private licensed use

Most of the groundwater licensed from the Superficial aquifer now is to private users. Activities to manage private licensed use include on-ground compliance inspections, meter audits and water use surveys. We use this work to check that groundwater use is within licence entitlements and that site activities are authorised.

The department has prioritised its compliance and enforcement activities to consider water level criteria and ecological condition at Ministerial sites. This has included expanding the scope of our *State compliance monitoring plan* to consider conditions and commitments at Ministerial sites, and forms part of the department's work to reduce levels of non-compliance.

There are also other ways the department works to manage the use of groundwater by private licensees:

- The department works with local governments, urban developers and other licensees using large volumes to improve water use efficiency, reduce demand for groundwater, assess water needs for future public open space and assess supply options. All but one of the local government authorities across the Gngangara system are implementing a water conservation strategy. In the north-west urban growth corridor, where water is scarce, the department is working with the City of Wanneroo to apportion available water across the whole corridor and improve water efficiency, so that there will be adequate water for public open space.

- The department continues to work with peak bodies, as well as directly with horticulturalists in the Carabooda and Wanneroo areas, to focus on water use efficiency, compliance with licence conditions and options to reduce total water use in the future.
- The department updated its water trading policy and listed a web-based register of licensees in 2010 to facilitate water trades as a way to optimise water use.

### 6.2.7 Managing garden bore use

The efficient use of water from garden bores reduces demand on scheme water and is an appropriate option in some areas. The department developed a garden bore use guideline in 2011, emphasising water conservation and efficiency, and now has an updated garden bore suitability map online in the Perth Groundwater Atlas (accessed through the department's website). Garden bores are not encouraged in areas where there is a risk of acid sulphate soils, poor water quality or low yields. These areas are identified in the Atlas.

The government updated the 2007 water efficiency measures legislation for garden bores in November 2011 under the Water Agencies (Water Use) By-laws 2010. This restricts their use to three days per week over summer and applies a total use-ban during winter. As a result, we've seen a significant reduction in garden bore water use.

## 6.3 Research initiatives

The department, with research partners, is completing a number of major projects to focus management effort on the areas that will show the most benefit from changes to abstraction. This work is informing the review of allocation limits for the Jandakot groundwater area and will inform the next Gnangara allocation plan.

PRAMS is currently being updated to version 3.5. We will use PRAMS for detailed modelling studies, including modelling of different scenarios to examine interactions between climate, land use and groundwater abstraction. This will support decision making for how we manage the Gnangara and Jandakot groundwater systems.

We are investigating the ongoing sustainability of current abstraction from the Leederville and Yarragadee aquifers and whether additional abstraction from these aquifers could be a viable source option for public water supply.

Outcomes of the Perth shallow groundwater system investigation have been published in reports for Lake Mariginiup, Loch McNess, Lexia Wetlands, Lake Yonderup, Egerton Seepage, Tangletoe Swamp, Lake Muckenburra, Lake Nowergup and Lake Gwelup. These studies have improved our understanding of the interrelationships between wetlands and the Superficial aquifer, and the complex, superimposed impacts of climate change, land use and abstraction. The department is using the outcomes and recommendations to better relate water levels to ecological condition and to manage local abstraction. This will be considered in the next Gnangara allocation plan and the department will consult with the OEPA on amending how the water level criteria are measured at some sites.

The department commissioned Edith Cowan University to develop a model to determine ecological risk to groundwater-dependent vegetation in a drying climate. The model is based on 30 years of ecological and hydrological monitoring data. It will be an important management tool for assessing risk to groundwater-dependent vegetation and the impact of future land uses under different climate and abstraction regimes.

## 6.4 Consultation

The department engages regularly with the community through public seminars, conferences, workshops and community meetings. For example, the department presents annually to the Jandakot Community Consultative Committee. In 2012–13 the department also presented at the Western Australian Wetlands Management Conference and to the Wetlands Coordinating Committee.

As mentioned above, we also work with peak bodies and horticulturalists in the Carabooda and Wanneroo areas on water use efficiency and licensing.

The department also provides advice to local and state government agencies on water supply, including water for public open space, and development proposals (as required) to minimise the impacts on groundwater-dependent ecosystems. For example, the department recently provided a detailed submission on the *Roe Highway Extension - Public Environmental Review* and is providing ongoing advice on this proposal to the OPEA.

The department also uses the *Better urban water management framework* to provide local government authorities and other land development agencies with advice on water management in urban areas to minimise the effects of drainage and stormwater on shallow groundwater in the plan area.



# Appendices



## Appendix A – Water level monitoring results for Ministerial sites on the Gnangara Mound, 2000–2013

Sites non-compliant with water level criteria and other criteria are highlighted in **RED**. See also Table 8 for further information about the circumstances of non-compliance and mitigation actions.

Table 1 Wetland sites

Wetland	AWRC Ref.	Water level criteria (mAHD)				Water level (mAHD)														Comments on compliance in 2012–13
		Spring peak		End of summer minimum			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	
		Pref	Abs	Pref	Abs															
Lake Goollelal	6162517			* 26.2	26.0	max	27.5	27.4	27.4	27.5	27.4	27.6	27.3	27.2	27.4	27.4	27.2	27.1	27.2	<p><u>Compliance:</u> <b>Compliant with absolute summer minimum.</b></p> <p><u>Location:</u> Yanchep linear suite of wetlands. West of the Gnangara Mound crest. Whitfords subarea of the Perth groundwater area.</p>
<b>Loch McNess</b>	6162564				6.95	max	7.10	7.06	7.05	7.05	7.03	7.04	7.02	6.94	6.85	6.80	6.64	6.43	6.40	<p><u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> The lake has been non-compliant since 2002–03. Lake levels have declined rapidly since 2006. The minimum level in 2012–13 was the lowest on record.</p> <p><u>Location:</u> Yanchep linear suite of wetlands. West of the Gnangara Mound crest. Yanchep groundwater area.</p> <p><u>Management and mitigation:</u> As part of the Perth shallow groundwater systems investigation, a shallow bore was installed adjacent to the vegetation monitoring transect on the south-west side of the lake. This bore improves monitoring of groundwater directly related to the monitored vegetation (Searle 2009a). The investigation determined that a groundwater level of 5.27 mAHD measured at bore MCN_SWC (AWRC ref. 61611844) would meet the minimum groundwater requirements of all wetland vegetation on the southern vegetation transect. Levels at MCN_SWC were found to correlate well with levels at bore BH-LM2 (61640108) that was already part of the department's long term monitoring program. The department is using levels at BH-LM2 to better relate groundwater levels to the ecological condition of vegetation at Loch McNess. In 2012–13 levels at the bore continued a declining trend evident since 2006. The minimum groundwater level at the bore did not meet the minimum groundwater requirement of wetland vegetation in 2012–13.</p> <p>Clusters of bores were also installed on the north western and eastern sides of the lake to improve the department's understanding of the lake's hydrogeology. Detailed findings and recommendations from the investigation can be found in DoW 2011a.</p> <p>Building on the work of the shallow groundwater system investigation, the department recently completed an investigation into the cause of rapidly declining levels in Loch McNess. This study improved our understanding of the hydrogeology of the lake and surrounding areas including the caves. The report will be available of the department's website when finalised. In line with recommendations from the report, the department has:</p> <ul style="list-style-type: none"> <li>reduced local abstraction in Yanchep National Park</li> <li>turned off the abstraction bores for the Yanchep caves supplementation trial</li> <li>reduced public supply abstraction from the Leederville aquifer in the Pinjar bore field.</li> </ul> <p>The department is also assessing groundwater allocations along the north-west coastal corridor, considering compliance and ecological condition at the lake.</p>
						min	6.97	6.96	<b>6.90</b>	<b>6.92</b>	<b>6.93</b>	<b>6.91</b>	<b>6.74</b>	<b>6.63</b>	<b>6.61</b>	<b>6.45</b>	<b>6.25</b>	<b>6.17</b>	<b>6.10</b>	

Wetland	AWRC Ref.	Water level criteria (mAHD)				Water level (mAHD)														Comments on compliance in 2012–13	
		Spring peak		End of summer minimum			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13		
		Pref	Abs	Pref	Abs																
Lake Yonderup	6162565				5.9	max	6.0	6.0	5.9	6.0	6.0	5.9	6.0	5.9	5.9	5.9	5.9	5.9	5.9	5.8	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  The lake has been non-compliant since 2007–08. Lake levels have declined since 1998, with the rate of decline increasing since 2006. Lake level fluctuations have increased since 2010. The minimum level in 2012–13 was the lowest on record.</p> <p><u>Location:</u>  Yanchep linear suite of wetlands. West of the Gnangara Mound crest. Yanchep groundwater area.</p> <p><u>Management and mitigation:</u>  Clusters of bores were also installed on the eastern and western sides of the lake. This additional monitoring infrastructure was installed to understand the hydrology of the lake and to better relate groundwater levels to wetland vegetation condition at the transect. The investigation determined that a groundwater level of 5.48 mAHD at bore YDP_SC (AWRC ref. 61611840) would meet the minimum groundwater requirements of all wetland vegetation on the southern vegetation transect. The minimum groundwater level at this bore did not meet the minimum groundwater requirement of wetland vegetation in 2012–13.</p> The department is currently assessing groundwater allocations along the north-west coastal corridor, considering compliance and ecological condition at the lake.
						min	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.6	
Lake Joondalup	6162572 (8281 staff)				* 16.2	max	17.0	17.0	16.9	17.0	16.8	17.1	16.9	16.8	17.0	17.0	16.8	16.8	16.8	16.8	<p><u>Compliance and trends:</u>  <b>Compliant with absolute summer minimum.</b>  <b>Non-compliant with other criterion.</b>  The lake has been non-compliant since 1998–99. Lake levels have been relatively stable since 1998, despite declining rainfall. The minimum level in 2012–13 was higher than the minimum level recorded in the previous two years.</p> The staff gauge dries at approximately 16.0 mAHD and cannot be used to determine compliance with the absolute summer minimum criteria when lake levels fall below this level. The monitoring bore, which is located 100 m up gradient of the lake, may also be inappropriate for determining compliance with criteria levels. <p><u>Location:</u>  Yanchep linear suite of wetlands. West of the Gnangara Mound crest. Whitfords subarea of the Perth groundwater area.</p> <p><u>Management and mitigation:</u>  Analyses conducted as part of the shallow groundwater systems investigation found that groundwater levels at bore JP20C (AWRC ref. 61610629) more closely reflect trends in lake levels than the current criteria bore and that this bore should be used to measure water level criteria.</p> A cluster of bores was installed on the western margin of the lake adjacent to the vegetation monitoring transect as part of the Perth shallow groundwater systems investigation (Bourke 2008). Clusters of bores were also installed on the northern and eastern margins of the lake. This infrastructure was installed to understand the hydrology of the lake and to better relate groundwater levels to wetland vegetation condition at the transect. Analyses conducted as part of the investigation found that groundwater levels at bore JP20C (AWRC ref. 61610629) more closely reflect trends in lake levels than the current criteria bore and that this bore should be used to measure water level criteria. The minimum groundwater level at this bore was 16.64 mAHD in 2012–13, a slight increase from the minimum level in 2011–12. The department will consult with the OEPA as part of the development of the next Gnangara allocation plan on amending the bore used to measure the water level criteria at this site to JP20C.
	61610661 (8281 bore)					min	16.1	16.1	16.0	16.0	16.1	16.4	16.0	16.0	16.2	16.2	16.0	16.0	16.0	16.0	<p><u>Location:</u>  Yanchep linear suite of wetlands. West of the Gnangara Mound crest. Whitfords subarea of the Perth groundwater area.</p> <p><u>Management and mitigation:</u>  Analyses conducted as part of the shallow groundwater systems investigation found that groundwater levels at bore JP20C (AWRC ref. 61610629) more closely reflect trends in lake levels than the current criteria bore and that this bore should be used to measure water level criteria.</p> The minimum groundwater level at this bore was 16.64 mAHD in 2012–13, a slight increase from the minimum level in 2011–12. The department will consult with the OEPA as part of the development of the next Gnangara allocation plan on amending the bore used to measure the water level criteria at this site to JP20C.
						max	18.7	18.6	18.6	18.6	18.5	18.8	18.5	18.5	18.7	18.9	18.7	18.6	18.6	18.6	
						min	17.7	17.9	17.8	17.8	17.8	18.1	17.8	17.9	18.1	18.3	17.9	18.0	18.0	18.0	

Wetland	AWRC Ref.	Water level criteria (mAHD)				Water level (mAHD)														Comments on compliance in 2012–13
		Spring peak		End of summer minimum			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	
		Pref	Abs	Pref	Abs															
Lake Mariginiup	6162577 (1943 staff)	* 42.1	41.5			max	41.9	41.8	41.7	41.8	41.5	41.7	41.4	41.4	41.5	41.5	41.3	41.2	41.1	
						min	41.3	41.3	41.3	41.2	41.3	41.3	41.3	41.2	41.2	41.3	41.1	41.0	41.0	
	max					41.5	41.4	41.3	41.4	41.1	41.3	41.1	41.0	41.3	41.1	40.8	40.9	40.8		
	min					40.5	40.5	40.5	40.4	40.3	40.4	40.0	40.2	40.2	40.2	40.0	40.1	40.1		
61610685 (MS10 bore)																				
Lake Jandabup	6162578 (1944 staff)	* 44.7	44.2		44.3	max	44.9	44.9	44.8	44.9	44.7	45.0	44.6	44.7	44.8	44.8	44.5	44.7	44.6	
						min	44.3	44.3	44.2	44.2	44.3	44.4	44.2	44.1	44.3	44.2	44.1	44.2	44.1	

Wetland	AWRC Ref.	Water level criteria (mAHD)				Water level (mAHD)														Comments on compliance in 2012–13
		Spring peak		End of summer minimum			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	
		Pref	Abs	Pref	Abs															
Lake Nowergup	6162567 (staff)	* 17.0	16.8			max	16.6	17.0	16.6 4/6 yr	16.3 4/6 yr	16.4 4/6 yr	16.7 4/6 yr	16.8 4/6 yr	17.2 4/6 yr	16.5 4/6 yr	16.5 4/6 yr	16.2 4/6 yr	16.1 4/6 yr	16.0 4/6 yr	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute spring minimum peak.</b>            Lake levels have been non-compliant in most years since 1996 despite water levels being artificially maintained by the department since 1989. Lake levels were recorded above the preferred spring peak criteria in 2007–08 for the first time since 2001–02.  <b>Non-compliant with other criterion.</b>  <u>Location:</u>            Yanchep linear suite of wetlands. West of the Gngangara Mound crest. Nowergup subarea of the Wanneroo groundwater area.  <u>Management and mitigation:</u>            Lake Nowergup was included in the Perth shallow groundwater systems investigation. Detailed findings and recommendations can be found in Bourke (2008) and Searle et al. (2010b). The investigation included the development of a local area model. Details on the model developed can be found in SKM (2009a).            Key recommendations relating to the water level criteria and the vegetation monitoring transect included:</p> <ul style="list-style-type: none"> <li>continuing the current managed rise and fall artificial maintenance regime</li> <li>measuring lake levels at the new telemetered site (AWRC ref. 616139) as levels less than 16 mAHD cannot be measured at the current staff gauges</li> <li>using a revised spring peak criteria of 16.2 m AHD, which should be gradually reduced to this level from the 2009 peak of 16.5 mAHD</li> <li>measuring groundwater levels at bore LN2-89 (AWRC ref. 61611247) when relating the watertable to the ecological condition of the vegetation transect.</li> </ul> <p>The department will consult with the OEPA as part of the development of the next Gngangara allocation plan on amending the water level criteria at this site based on the recommendation above and is using bore LN2-89 to better relate groundwater levels to the ecological condition of vegetation at this site. In 2012–13 levels at LN2-89 continued to show a declining trend that has been evident since 2009.            The department is currently assessing groundwater allocations along the north-west coastal corridor, considering compliance and ecological condition at the lake.</p>
						min	15.9	16.0	16.0	16.0	16.0	16.3	16.1	16.5	16.2	16.0	16.0	15.9	16.0	
Lake Wilgarup	6162623 (staff)	6.10	5.65	4.8	4.5	max	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute spring minimum peak.</b>            No surface water has been present in the lake since 1998.  <b>Non-compliant with absolute summer minimum.</b>            Groundwater levels have declined steadily since 1998. Groundwater levels were first non-compliant with the absolute minimum criteria in 2006–07 and have been non-compliant since.  <u>Location:</u>            Yanchep linear suite of wetlands. West of the Gngangara Mound crest. Yanchep groundwater area.  <u>Management and mitigation:</u>            The department is currently assessing groundwater allocations along the north-west coastal corridor, considering compliance and ecological condition at the site.  <u>Ecological values:</u>            The groundwater related ecological values at Lake Wilgarup have also been significantly impacted by fire and acidification, and management objectives for the lake may have been irreversibly compromised.</p>
						min														
	61618500 (bore)					max	5.48	5.38	5.16	5.26	4.99	5.32	4.88	4.77	4.77	4.64	4.47	4.38	4.31	
						min	4.73	4.66	4.53	4.51	4.53	4.62	4.34	4.18	4.08	4.02	3.80	3.84	3.83	



Wetland	AWRC Ref.	Water level criteria (mAHD)				Water level (mAHD)														Comments on compliance in 2012–13
		Spring peak		End of summer minimum			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	
		Pref	Abs	Pref	Abs		min													
						min	49.0	49.1	49.1	49.1	49.0	49.2	48.9	49.1	48.9	48.9	48.6	48.8	48.7	The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.
Melaleuca Park Dampland 78 (GNM31)	61613231			* 65.4	65.1	max	66.5	66.1	66.0	66.1	65.9	66.1	65.9	66.0	66.0	65.9	65.5	65.3	65.2	<u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> 2012–13 was the first year the site was non-compliant with water level criteria. Water levels have declined significantly since 2008 then stabilised and were equal to the absolute summer minimum in 2010–11 and 2011–12. <u>Location:</u> East of the Gnangara Mound crest. Wanneroo Wellfield subarea of the Gnangara groundwater area. <u>Management and mitigation:</u> A cluster of bores were installed adjacent to GNM31 as part of the Perth shallow groundwater systems investigation (Searle 2009a).
						min	65.9	65.8	65.7	65.7	65.5	65.8	65.5	66.0	65.6	65.5	65.1	65.1	64.9	
Egerton Spring (B25)	61618607				39.29	max	39.82	39.66	39.58	39.81	39.83	40.00	39.7	40.03	40.22	40.15	40.01	40.05	40.04	<u>Compliance and trends:</u> <b>Compliant with absolute summer minimum.</b> Water levels have been compliant since 2003. Water levels have risen over the past 10 years, probably in response to increased recharge from runoff due from surrounding urban development. <u>Location:</u> East of the Gnangara Mound crest. North Swan subarea of the Swan groundwater areas.
						min	39.45	39.42	39.26	39.43	39.42	39.69	39.50	39.54	39.72	39.72	39.49	39.70	39.69	

\* Water levels allowed between preferred minimum and absolute minimum at a rate of two in six years to replicate natural drying cycles.

# As of June 2012, water levels were still declining. The minimum water level reported is the minimum water level recorded during the 2011–12 water year.

Table 2 Terrestrial phreatophytic vegetation sites

Groundwater monitoring bore	ARWC Ref.	End of summer absolute minimum (mAHD)	Water levels (mAHD)														Comments on compliance in 2012-13
				2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	
MM16	61610835	38.8	max	40.1	40.0	40.0	40.0	39.8	40.2	39.4	39.4	39.8	39.9	39.4	39.6	39.6	<u>Compliance:</u> <b>Compliant.</b> <u>Location:</u> Boundary of the Improvement Plan 8 and Whiteman Park subareas of the Mirrabooka groundwater area.
			min	38.8	39.1	38.9	38.8	38.8	39.0	<b>38.6</b>	38.8	39.0	39.0	<b>38.6</b>	38.9	39.0	
MM18	61610918	38.6	max	40.4	40.2	39.6	39.8	39.8	40.0	39.4	39.3	40.0	39.8	39.3	39.5	39.6	<u>Compliance:</u> <b>Compliant.</b> <u>Location:</u> Boundary of the Landsdale and Improvement Plan 8 subareas of the Mirrabooka groundwater area.
			min	39.2	39.2	38.7	39.0	38.9	39.1	38.6	38.8	39.0	39.0	38.7	38.9	39.0	
MM53	61610493	33.3	max	34.5	34.3	34.2	34.4	34.3	34.4	33.8	33.9	34.1	33.9	33.3	33.8	33.6	<u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> Water levels have generally declined since 2005. <u>Location:</u> Whiteman Park subarea of the Mirrabooka groundwater area. <u>Management and mitigation:</u> The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.
			min	33.3	33.4	33.3	33.3	<b>33.2</b>	33.3	<b>33.1</b>	<b>33.2</b>	<b>33.1</b>	<b>33.0</b>	<b>32.8</b>	<b>33.0</b>	<b>33.0</b>	
MM55B	61610559	29.5	max	31.1	30.9	30.7	31.1	30.8	30.9	30.3	30.6	31.0	30.8	30.1	30.3	30.3	<u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> Water levels have generally declined since 2008. <u>Location:</u> Whiteman Park subarea of the Mirrabooka groundwater area. <u>Management and mitigation:</u> The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.
			min	29.6	29.6	<b>29.4</b>	29.5	<b>29.4</b>	29.5	<b>29.4</b>	<b>29.4</b>	<b>29.4</b>	<b>29.3</b>	<b>29.0</b>	<b>29.3</b>	<b>29.2</b>	
MM59B	61611025	36.3	max	37.7	37.2	36.8	37.1	36.8	37.0	36.2	36.4	36.8	36.6	36.0	36.1	36.2	<u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> Water levels have declined since 2000. <u>Location:</u> Whiteman Park subarea of the Mirrabooka groundwater area. <u>Management and mitigation:</u> The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.
			min	<b>36.2</b>	<b>36.2</b>	<b>35.9</b>	<b>36.0</b>	<b>35.9</b>	<b>35.8</b>	<b>35.6</b>	<b>35.8</b>	<b>35.8</b>	<b>35.7</b>	<b>35.3</b>	<b>35.5</b>	<b># 35.5</b>	
MT3S	61610745	43.0	max	45.2	45.1	44.9	45.1	44.7	45.4	44.6	44.7	44.9	44.8	44.3	44.4	44.2	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Boundary of the Mariginiup and Jandabup subareas of the Wanneroo groundwater area.
			min	43.2	44.6	44.1	44.1	44.0	44.2	43.7	43.9	44.0	43.9	43.5	43.6	43.5	
NR6C	61610982	58.5	max	60.7	60.2	60.0	60.2	59.8	60.2	59.7	59.7	60.0	60.1	59.9	59.7	59.3	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Wanneroo Wellfield subarea of the Gngangara groundwater area.
			min	59.6	59.5	59.3	59.4	59.3	59.4	59.1	59.1	59.2	59.4	58.9	59.0	58.7	

Groundwater monitoring bore	ARWC Ref.	End of summer absolute minimum (mAHD)	Water levels (mAHD)													Comments on compliance in 2012–13	
				2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12		2012–13
PM9	61610804	56.3	max	57.7	57.3	57.0	57.2	56.8	57.0	56.4	56.3	56.1	55.9	55.9	55.0	54.8	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  Water levels have declined significantly since 1996 and were first non-compliant in 2006–07. In 2012–13 there was no recharge evident at this site and water levels continued to decline.  <u>Location:</u>  Reserve subarea of the Gngangara groundwater area.  <u>Management and mitigation:</u>  The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.</p>
			min	57.1	56.9	56.5	56.5	56.4	56.3	56.0	55.8	55.6	55.4	54.9	54.8	54.4	
PM24	61610697	40.5	max	43.1	42.9	42.6	43.1	43.0	43.1	42.4	42.7	43.0	42.5	42.1	42.4	42.0	<p><u>Compliance:</u>  <b>Compliant with absolute summer minimum.</b>  <u>Location:</u>  Pinjar subarea of the Wanneroo groundwater area.</p>
			min	41.4	41.5	41.4	41.4	41.4	41.4	41.2	41.3	41.2	41.2	41.0	41.1	41.1	
WM1	61610833	55.7	max	56.8	56.2	56.0	56.2	55.9	56.5	55.6	55.6	55.7	55.4	54.8	54.8	54.4	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  Water levels have been non-compliant since 2001–02 and have declined since 2005. In 2012–13 there was little recharge evident at this site and water levels continued to decline.  <u>Location:</u>  Wanneroo Wellfield subarea of the Gngangara groundwater area.  <u>Management and mitigation:</u>  The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.</p>
			min	55.7	55.5	55.3	55.4	55.2	55.4	55.0	55.0	54.9	54.8	54.4	54.3	# 54.1	
WM2	61610908	66.5	max	68.3	67.9	67.7	68.0	67.7	68.2	67.6	67.5	67.6	67.5	66.9	66.8	66.4	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  2011–12 was the first year the site was non-compliant with water level criteria. In 2012–13 there was little recharge evident at this site and water levels continued to decline.  <u>Location:</u>  Wanneroo Wellfield subarea of the Gngangara groundwater area.  <u>Management and mitigation:</u>  The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.</p>
			min	67.5	67.5	67.2	67.3	67.2	67.5	67.1	67.0	66.9	66.9	66.5	66.4	# 66.1	
WM8	61610983	64.8	max	66.2	65.8	65.8	66.0	65.6	66.0	65.5	65.4	65.5	65.4	65.5	64.9	64.7	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  Water levels have declined since 2005 and were non-compliant for the first time in 2010–11. In 2012–13 there was no recharge evident at this site and water levels continued to decline.  <u>Location:</u>  Wanneroo Wellfield subarea of the Gngangara groundwater area.  <u>Management and mitigation:</u>  The department is managing abstraction in environmentally sensitive areas, where it can lead to improved water levels and ecological condition at Ministerial sites. We are also implementing strategies to reduce abstraction to reduce the environmental risks associated with abstraction.</p>
			min	65.6	65.4	65.4	65.5	65.3	65.5	65.1	65.1	65.1	65.1	65.1	64.7	64.7	
MM12	61610989	42	max	45	44	43	44	43	44	43	43	43	43	43	43	43	<p><u>Compliance:</u>  <b>Compliant with absolute summer minimum.</b>  <u>Location:</u>  Wanneroo Wellfield subarea of the Gngangara groundwater area.</p>
			min	43	43	43	43	43	43	42	42	43	43	42	42	43	

Groundwater monitoring bore	ARWC Ref.	End of summer absolute minimum (mAHD)	Water levels (mAHD)													Comments on compliance in 2012–13	
				2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12		2012–13
L30C	61611010	47.2	max	49.2	49.1	48.9	49.2	48.8	49.5	48.4	48.6	48.7	48.9	48.1	48.2	47.8	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Wanneroo Wellfield subarea of the Gngara groundwater area.
			min	48.6	48.5	48.3	48.5	48.3	48.4	48.0	48.0	48.2	48.1	48.0	47.7	47.5	
L110C	61611011	55.7	max	59.0	58.6	58.4	58.6	58.1	58.5	57.8	57.7	57.8					<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> Minimum levels cannot currently be measured at the Ministerial criteria bore as it is blocked. This bore is scheduled for maintenance. <u>Location:</u> Wanneroo Wellfield subarea of the Gngara groundwater area.
			min	58.1	58.0	57.7	57.8	57.6	57.7	57.3	57.2	57.5					
L220C	61611018	52.2	max	54.3	54.2	53.9	54.1	53.8	54.2	53.7	53.7	53.5	53.6	52.8	53.2	52.8	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Wanneroo Wellfield subarea of the Gngara groundwater area.
			min	53.3	53.0	53.0	52.9	52.9	52.8	53.1	52.7	52.6	52.6	52.3	52.4	52.1	

Observed water levels have been rounded to the same number of decimal places as shown in table 1 and 2 on *Ministerial Statement No. 819*.

Note: Water levels are permitted to fall between the preferred and absolute criteria levels. Non-compliances exist when groundwater levels fall below the absolute minimum criteria.

# As of June 2013, water levels were still declining. The minimum water level reported is the minimum water level recorded during the 2010–12 water year.

## Appendix B – Audit table. Environmental conditions, procedures and commitments, Gngangara Mound groundwater resources (including groundwater resources allocation, East Gngangara, City of Swan)

Proponent: Department of Water

Period: 1 July 2009 to 30 June 2013

Text in blue represents Conditions/Proponent Commitments for which the Department of Water seeks 'Clearance' from DEC/EPA.

### Ministerial conditions and procedures

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
<b>819: M 1-1</b>	Implementation	The proponent shall implement the proposals as documented in "Section 46 Review of Environmental Conditions on Management of the Gngangara and Jandakot Mounds – Stage 1 Proposal for Changes to Conditions" (August 2004), as modified and documented in Environmental Protection Authority Bulletin 1155.	Implement proposals given in EPA Bulletin 1155 and <i>Ministerial Statement No. 819</i> .	Compliance report	Minister for the Environment		Overall		<b>Partly compliant.</b> Partly compliant with majority of Ministerial conditions – refer to 'the status' column of this audit table (Appendix B). Further amendments are likely to be proposed in the next Gngangara groundwater areas allocation plan.
<b>819: M 2-1</b>	Proponent commitments	The proponent shall implement the environmental management commitments, as revised in May 2009, and documented in schedule 1 of Statement No. 819, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.	Implement commitments given in Schedule 1 of EPA Bulletin 1324 and <i>Ministerial Statement No. 819</i> .	Compliance report	Minister for the Environment	EPA	Overall		<b>Partly compliant.</b> Compliant with majority of proponent commitments – refer to the 'status' column of this audit table (Appendix B).
<b>819: M 3-1</b>	Proponent nomination & contact details	The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the <i>Environmental Protection Act 1986</i> is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.	Adhere to conditions, procedures and commitments given in EPA Bulletin 1324 and <i>Ministerial Statement No. 819</i> . Maintain responsibility for implementation of proposal.	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details. Compliance report.	Minister for the Environment	EPA	Overall		<b>N/A at this time.</b>
<b>819: M 3-2</b>	Proponent nomination & contact details	If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent and provide a letter with a copy of this statement endorsed by the proposed replacement proponent that the proposal will be carried out in accordance with this statement. Contact details and appropriate documentation on the capability of the proposed replacement proponent to carry out the proposal shall also be provided.	Follow procedure given in 'action'.	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details.	Minister for the Environment		Overall		<b>N/A at this time.</b>
<b>819: M 3-3</b>	Proponent nomination & contact details	The nominated proponent shall notify the Chief Executive Officer of the Department of Environment and Conservation of any change of contact name and address within 60 days of such change.	Follow procedure given in 'action'.	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details.	CEO		Overall	60 days of change	<b>N/A at this time.</b>
<b>819: M 4-1 1</b>	Compliance audit & performance review	The proponent shall prepare an audit program and submit compliance reports to the Chief Executive Officer of the Department of Environment and Conservation which address: 1. evidence of compliance with the conditions and commitments.	Detail in annual/triennial reports. Compliance report will include: 1. evidence of compliance with the conditions and commitments.	Audit program	CEO		Overall	Annually	<b>Compliant.</b> Summarised in the compliance report and the 'status' column of this audit table (Appendix B).

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
<b>819:</b> <b>M 4-1 2</b>	Compliance audit & performance review	The proponent shall prepare an audit program and submit compliance reports to the Chief Executive Officer of the Department of Environment and Conservation which address: 2. the performance of the environmental management plans and programs.	Detail in annual/triennial reports. Compliance report will include: 2. the performance of the environmental management plans and programs.	Compliance report	CEO			Annually	<b>Compliant.</b> Environmental management plans and programs are on-going and include: 1. The final <i>Gnangara groundwater areas allocation plan</i> was released in November 2009 (DoW 2009a). The plan will be evaluated regularly to assess whether objectives are being achieved. The first evaluation statement was recently completed. The statement evaluates the department's management of Gnangara groundwater resources and the extent to which the objectives of the Gnangara plan have been met since its release in November 2009 until December 2011. The evaluation statement is available on the department's website. The draft <i>Gnangara sustainability strategy</i> was released for public comment in July 2009 (Government of Western Australia 2009b). 2. Initiating work on the next phase of the Gnangara allocation planning is a 2013 business priority for the department. The new allocation plan will focus on the framework and tools to better meet the following objectives: <ul style="list-style-type: none"> <li>reduce the total volume of water abstracted from the Gnangara system towards a level that better reflects the current recharge from rainfall</li> <li>protect groundwater-dependent ecosystems from direct impacts associated with abstraction.</li> </ul>
<b>819:</b> <b>M 4-2 1</b>	Compliance audit & performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Chief Executive Officer of the Department of Environment and Conservation, which address: 1. compliance with the conditions.	The performance review will address: 1. compliance with the conditions	Compliance report	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Refer to 819: M 4-1 2. Compliance with conditions can found in the 'status' column of audit tables (Appendix B).
<b>819:</b> <b>M 4-2 2</b>	Compliance audit & performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Chief Executive Officer of the Department of Environment and Conservation, which address: 2. the achievement of environmental objectives set for the proposal.	The performance review will address: 2. the achievement of environmental objectives set for the proposal	Compliance report	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Evidence of achievement of the objectives is given by the 'evidence' & 'status' columns of this audit table (Appendix B).
<b>819:</b> <b>M 4-2 3</b>	Compliance audit & performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Chief Executive Officer of the Department of Environment and Conservation, which address: 3. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed.	The performance review will address: 3. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed.	Compliance report	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Partly Compliant.</b> A series of community forums were held during the development of the draft <i>Gnangara sustainability strategy</i> . The draft <i>Gnangara sustainability strategy</i> was released for public comment in July 2009 (Government of Western Australia 2009b). The final <i>Gnangara groundwater areas allocation plan</i> was released in November 2009. The accompanying <i>Gnangara groundwater areas allocation plan statement of response</i> (DoW 2009b) sets out how we have responded to issues raised by the public in finalising the plan and how we are working towards managing these issues when the plan is implemented. The first Gnangara plan evaluation statement was recently completed. The statement evaluates the department's management of Gnangara groundwater resources and the extent to which the objectives of the Gnangara plan have been met since its release in November 2009 until December 2011. The evaluation statement is available on the department's website.
<b>819:</b> <b>M 4-2 4</b>	Compliance audit & performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Chief Executive Officer of the Department of Environment and Conservation, which address: 4. proposed environmental management over the next three years to comply with conditions and environmental objectives set for the proposal.	The performance review will address: 4. proposed environmental management over the next three years to comply with conditions and environmental objectives set for the proposal.	Compliance report	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Section 6.2 describes management actions and research initiatives the department is undertaking to limit impacts of abstraction on groundwater dependent ecosystems.

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: M 4-3	Compliance audit & performance review	The proponent shall make the reports required by condition 4-2 publicly available, to the requirements of the Chief Executive Officer of the Department of Environment and Conservation.	Available on Department of Water's website.	Reports made available on the Department of Water's website.	CEO		Overall	After OEPA acknowledgement letter being received. Department of Water website.	<b>Compliant.</b> The following Gngangara compliance reports have been formally audited or commented on by DEC or the OEPA and can be found on the department's website: <ul style="list-style-type: none"> <li>• 2003–06 triennial (DoW 2007a)</li> <li>• 2006–07 annual (DoW 2008a)</li> <li>• 2006–09 triennial (DoW 2010a).</li> </ul> The following Gngangara compliance reports that haven't been formally audited or commented on can also be found on the department's website: <ul style="list-style-type: none"> <li>• 2007–08 annual (DoW 2009c)</li> <li>• 2009–10 annual (DoW 2010b)</li> <li>• 2010–11 annual (DoW 2011d)</li> <li>• 2009–12 triennial (DoW 2013).</li> </ul>
819: M 4-4	Compliance audit & performance review	The proponent shall report any breach or anticipated breach of the environmental criteria set out in tables 1 and 2 or environmental objectives to the Chief Executive Officer of the Department of Environment and Conservation immediately it becomes evident to the proponent.	Report in regular summaries sent to the Chief Executive Officer of the Environmental Protection Authority.	Letter to the Chief Executive Officer of the Office of the Environmental Protection Authority reporting non compliances with water level and other criteria as required. Compliance report.	CEO		Overall	Immediately as it becomes evident.	<b>Compliant.</b> The department reported regularly to DEC (now the Office of the EPA) on non-compliance with criteria water levels and other criteria.
819: M 5-1	Management of the water resource	The proponent shall base decisions affecting the management of groundwater resources of the Gngangara Mound on the concept of sustainable yield of resources and maintenance of ecological systems in accordance with the objectives of the State Conservation Strategy (1987).	Base decision on the concept of sustainable yield of resources and maintenance of ecological systems in accordance with the State Conservation Strategy (1987). Present relevant material in annual/triennial compliance reports.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> The concept of sustainable yield using PRAMS modelling was applied in the calculation allocation limits for the <i>Gngangara groundwater areas allocation plan</i> (DoW 2009a). This plan provides the basis for water management decisions on the Gngangara Mound. The department recognises that sustainable yield has diminished as recharge has decreased in recent years. Sustainable yields of Gngangara resources will be reassessed as part of an allocation limit review for the next Gngangara groundwater areas allocation plan.
819: M 5-2	Management of the water resource	The proponent shall subject to review, every three years, the basis for groundwater management decisions, including groundwater allocations and licences, and the criteria specified for conservation of the environment and the groundwater resource of the Gngangara Mound, to the requirements of the Environmental Protection Authority on advice of the Department of Environment and Conservation.	Present relevant material in annual/triennial reports. Refer draft groundwater management planning reports to the Office of Environmental Protection Authority, the Department of Environment and Conservation for comment. Make compliance reports publicly available (on the Department of Water's website).	Compliance report. Draft groundwater management documents sent to DEC/EPA for comment. Reports made available on Department of Water's website.	EPA	DEC	Overall	Subject to regular review every three years.	<b>Compliant.</b> The 'basis for groundwater management decisions' are the department's water licensing policies. These policies undergo a regular cycle of review which is detailed in a specific section of the policies (e.g. state-wide policies reviewed every 5 years). The <i>Gngangara groundwater areas allocation plan</i> provides the foundation for water allocation decision-making on the Gngangara Mound. The first Gngangara plan evaluation statement was recently completed. The statement evaluates the department's management of Gngangara groundwater resources and the extent to which the objectives of the Gngangara plan have been met since its release in November 2009 until December 2011. The evaluation statement is available on the department's website. The draft <i>Gngangara sustainability strategy</i> (Government of Western Australia 2009b) indicates the association of other factors (e.g. land uses) with water management decisions on the Gngangara Mound. The following Gngangara compliance reports have been formally audited or commented on by DEC or the OEPA and can be found on the department's website: <ul style="list-style-type: none"> <li>• 2003–06 triennial (DoW 2007a)</li> <li>• 2006–07 annual (DoW 2008a)</li> <li>• 2006–09 triennial (DoW 2010a).</li> </ul> The following Gngangara compliance reports that haven't been formally audited or commented on can also be found on the department's website: <ul style="list-style-type: none"> <li>• 2007–08 annual (DoW 2009c)</li> <li>• 2009–10 annual (DoW 2010b)</li> <li>• 2010–11 annual (DoW 2011d)</li> <li>• 2009–12 triennial (DoW 2013).</li> </ul>

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
<b>819: M 6-1</b>	Groundwater allocation	The proponent shall ensure that the allocation of water to public and private users and the operation of the Pinjar Stages 1, 2 and 3, Wanneroo, Mirrabooka, and Lexia Groundwater Schemes comply with environmental water provisions.	Licensed allocations not to exceed allocation limits for Groundwater Area sub-areas.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> As outlined in the <i>Gnangara groundwater areas allocation plan</i> , the addition of the Southern Seawater Desalination Plant to the Integrated Water Supply Scheme triggered a change in how groundwater for the public water supply is allocated. In line with the plan, from 2012–13, the Water Corporation's baseline groundwater allocation from Gnangara and Jandakot for the Integrated Water Supply Scheme has been reduced from 145 GL to 120 GL (from existing infrastructure). The Water Corporation is committed to achieving an average abstraction of 120 GL over the five year licence period from 2012–13 to 2016–17. The department worked with Water Corporation to distribute abstraction to limit impacts at groundwater dependent ecosystems. Public water supply allocations will be reviewed as part of the development of the next Gnangara groundwater areas allocation plan.
<b>819: M 7-1</b>	Groundwater-dependent ecosystems	The proponent shall ensure that the integrity of all groundwater-dependent ecosystems (GDE) located on the Gnangara Mound that may be impacted as a result of groundwater abstraction are protected, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Comply with EPA Bulletin No. 1324 and Ministerial Statement No. 819. Undertake a monitoring program to measure integrity of GDEs.	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> Section 6.1 and Appendix F describe the department's environmental monitoring program (in line with the commitments in <i>Ministerial Statement No. 819</i> ). Section 6.2 describes management actions and research initiatives the department is undertaking to limit impacts of abstraction on groundwater dependent ecosystems.
<b>819: M 8-1</b>	Groundwater availability	The proponent shall widely publish by the end of October each year the limits on groundwater availability for the Gnangara Mound.	Detail limits on availability on the Department of Water's website.	Allocation limits made available on the Department of Water's website. Current water availability figures can be obtained from Swan Avon regional office or through the department's water register: < <a href="http://www.water.wa.gov.au/ags/WaterRegister">www.water.wa.gov.au/ags/WaterRegister</a> >	Minister for the Environment		Overall	End of October each year	<b>Compliant.</b> Current water availability figures are constantly changing. Up to date figures are available by contacting the Swan Avon regional office or through the department's water register: < <a href="http://www.water.wa.gov.au/ags/WaterRegister">www.water.wa.gov.au/ags/WaterRegister</a> >
<b>819: M 8-2</b>	Groundwater availability	The proponent shall update annually the figures published according to the requirements of condition 8-1, with the emphasis on those areas of high allocation relative to sustainable yield of the groundwater resource so that limits to use and development can be clearly seen by all interested parties. The updated figures shall also be widely published.	Detail limits on availability relative to sustainable yield (allocation limits) published on the Department of Water's website.	Allocation limits made available on the Department of Water's website. Current water availability figures can be obtained from Swan Avon regional office or through the department's water register: < <a href="http://www.water.wa.gov.au/ags/WaterRegister">www.water.wa.gov.au/ags/WaterRegister</a> >	Minister for the Environment		Overall	End of October each year	<b>Compliant.</b> Current water availability figures are constantly changing. Up to date figures are available by contacting the Swan Avon regional office or through the department's water register: < <a href="http://www.water.wa.gov.au/ags/WaterRegister">www.water.wa.gov.au/ags/WaterRegister</a> >
<b>819: M 9-1</b>	Water conservation	The proponent shall actively encourage further reduction in public and private water demand in accordance with the State Water Strategy (2003) and other water conservation initiatives.	Engage in activity that supports water conservation.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> In accordance with the <i>State Water Plan</i> (Department of Premier and Cabinet 2007), and following extensive consultation with the mining and irrigation industries as well as local government, the department developed and implements <i>Operational policy no. 1.2 – 'Policy on water conservation and efficiency plans'</i> (DoW 2009d). The department's Water Recycling and Efficiency Branch undertake projects to reduce water demand and achieve water conservation initiatives. These include implementing <i>Operational policy no. 1.2 – 'Policy on water conservation and efficiency plans'</i> (in particular by local government authorities), implementing the permanent winter sprinkler ban and implementing metering programs. Section 6.2 discusses the department's approach to the allocation of groundwater for public water supply and other initiatives aimed to reduce demand on the Gnangara groundwater resources and increase efficiency.

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: M 10-1 1	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 1. clarification of the relationship between groundwater level and rainfall under conditions of declining long-term rainfall to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 1. clarification of the relationship between groundwater level and rainfall under conditions of declining long-term rainfall.	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> The department is using PRAMS modelling to examine the relationship between rainfall and groundwater levels in a drying climate. A number of scenarios have been run using: short-term, 30-year average and dry climate conditions from 2008 to 2031 to examine the impact of the drying climate on groundwater levels. A new version of PRAMS is currently being calibrated and the datasets that feed into the model updated, including the predicted climate datasets. The model will soon be used for detailed modelling studies, including scenarios examining interactions of climate, land use and public and private allocation (including provision of water to the environment). This work will inform the review of allocation limits that will be undertaken as part of the next Gngangara groundwater areas allocation plan.
819: M 10-1 2	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 2. improvement in the understanding of the relationship between groundwater levels and vegetation, including plantations to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 2. improvement in the understanding of the relationship between groundwater levels and vegetation, including plantations	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> The Perth shallow groundwater system investigations have improved the department's understanding of the interrelationships between wetlands and the Superficial aquifer, and the complex, superimposed impacts of climate change, land use and abstraction. The department is using outcomes and recommendations from the investigations to better relate water levels to ecological condition at groundwater dependent ecosystems. The department commissioned Dr Bea Sommer and Professor Ray Froend of Edith Cowan University to develop a model for determining ecological risk to groundwater dependent vegetation on the Gngangara Mound in a drying climate. The model is based on 30 years of ecological and hydrological monitoring data. It will be an important management tool for assessing the impact of future land and water use scenarios and for revising allocation limits as part of the next phase of planning for the Gngangara groundwater resources. Several projects undertaken as part of the draft <i>Gngangara sustainability strategy</i> address improving the understanding this relationship. They included: <ul style="list-style-type: none"> <li>• fire regimes on the Gngangara Mound – potential for water gain and impacts on biodiversity</li> <li>• options and implications of continuing plantation forestry on the Gngangara Mound</li> <li>• biodiversity values on the Gngangara Mound.</li> </ul> For further information see sections 4.1.2 & 4.1.3 of the draft <i>Gngangara sustainability strategy</i> and the department's website.
819: M 10-1 3	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 3. improvement in the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gngangara Mound to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 3. improvement in the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gngangara Mound	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> PRAMS modelling is being used to improve the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gngangara Mound. Reductions to both public and private abstraction have been modelled to evaluate storage gains in the Superficial aquifer over the next 20 years. These scenarios have informed the management of allocations and licensing. A new version of PRAMS is currently being calibrated and the datasets that feed into the model updated. The model will soon be doing detailed modelling studies, including scenarios examining interactions of climate, land use and public and private allocation (including provision of water to the environment). This work will inform the review of allocation limits that will be undertaken as part of the next Gngangara groundwater areas allocation plan. Perth shallow groundwater system investigations have improved the department's understanding of the interrelationships between wetlands and the Superficial aquifer, and the complex, superimposed impacts of climate change, land use and abstraction. The department is using outcomes and recommendations from the investigations to limit abstraction impact on groundwater dependent ecosystems.

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: M 10-1 4	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 4. clarification of the relationship between groundwater level and wetland water levels and wetland water quality to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 4. clarification of the relationship between groundwater level and wetland water levels and wetland water quality	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> The department has undertaken hydrogeological investigations at a number of sites across the Gngangara Mound as part of the Perth shallow groundwater systems investigation. To date, nine reports have been completed and are available on the department's website. These reports examine relationships between wetland hydrogeology, chemistry and ecosystem function to provide a basis for improved management strategies that limit abstraction impacts. Local area groundwater flow models for the following areas have been constructed and scenario modelling completed: <ul style="list-style-type: none"> <li>East Wanneroo integrated groundwater-lake flow modelling: Predictive scenario modelling to support the draft Gngangara Sustainability Strategy (Bourke 2009)</li> <li>local area model of groundwater flows and lake interactions: Lakes Mariginiup and Jandabup (RPS 2009)</li> <li>development of local area groundwater models – Gngangara Mound, Lake Nowergup (SKM 2009a)</li> <li>development of local area groundwater models – Gngangara Mound, Lexia Wetlands (SKM 2009b)</li> </ul> These reports were used to support the draft <i>Gngangara sustainability strategy</i> . Reports are available on the department's website.
819: M 10-1 5	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 5. improvement in the understanding of the relationship between groundwater level and water levels in the Yanchep caves to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 5. improvement in the understanding of the relationship between groundwater level and water levels in the Yanchep caves	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Partly-compliant.</b> The department's current environmental monitoring program is summarised in Appendix F. The program includes regular monitoring of Yanchep caves and surrounding Superficial aquifer monitoring bores. Monitoring of water quality and invertebrate cave fauna is undertaken annually. Building on the work of the shallow groundwater system investigation, the department recently completed an investigation into the cause of rapidly declining levels in Loch McNess in Yanchep National Park. This study improved our understanding of the hydrogeology of Loch McNess and surrounding areas including the caves. The report is will be available of the department's website when finalised.
819: M 10-1 6	Research & monitoring	The proponent shall participate in and undertake research and monitoring on the Gngangara Mound which includes: 6. improvement in understanding of the conservation value of wetland and other groundwater-dependent ecosystems on the Gngangara Mound to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Environment and Conservation.	Engage in research projects to address this issue, which includes: 6. improvement in understanding of the conservation value of wetland and other groundwater-dependent ecosystems on the Gngangara Mound	Compliance report	Minister for the Environment	EPA/DEC	Overall		<b>Compliant.</b> The conservation value of wetlands issue is a prime responsibility of the DEC. The department undertakes research and monitoring to determine how conservation values are supported by groundwater and how abstraction can be managed to limit impacts on these values.
819: M Procedure 1		Where a condition states "to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority", the Environmental Protection Authority will prepare the written notice to the proponent.	The Environmental Protection Authority to provide written notice to the proponent (Department of Water).		Minister for the Environment		Overall		<b>The Department of Water seeks 'clearance' of this condition.</b> It is not responsibility of Proponent.
819: M Procedure 2		The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice.	The Environmental Protection Authority to seek advice as required.		EPA	Other agencies as required.	Overall		<b>The Department of Water seeks 'clearance' of this condition.</b> It is not responsibility of Proponent.
819: M Procedure 3		Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Chief Executive Officer of the Department of Environment and Conservation.	Department of Water liaises with advisory body as required.	Liaison with advisory body in compliance report.	EPA	Agencies listed as part of compliance reporting.	Overall		<b>Compliant.</b> Refer to commitments: <ul style="list-style-type: none"> <li>2, 4,6,8,21 = CALM/DEC;</li> <li>21 = FPC.</li> </ul> Although specific feedback was not sought on each separate condition, advice on relevant issues were obtained as part of the comprehensive interagency network that formed part of the draft <i>Gngangara Sustainability Strategy</i> . Also, both the DEC and Forest Products Commission made public submissions to the <i>Gngangara groundwater areas water management plan, draft for public comment</i> (DoW 2008b) which dealt with similar issues as the conditions.

## Proponent environmental management conditions

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: P 1	Gnangara Mound allocations	Sustainable use of groundwater from the Gnangara Mound (Superficial aquifer).	Manage public and private groundwater abstraction to meet objectives and Environmental Water Provisions (EWP) criteria presented in tables 1 and 2 ( <i>Ministerial Statement No. 819</i> ).	Meet objectives and Environmental Water Provisions criteria presented in tables 1 and 2 ( <i>Ministerial Statement No. 819</i> ).	Compliance report	Minister for the Environment		Overall		<b>Partly compliant.</b> Refer to the results given in Appendix A – water level monitoring results for Ministerial criteria sites on the Gnangara Mound, 1999–2011. Table 1 (wetlands) and Table 2 (terrestrial phreatophytic vegetation).
819: P 2	Management objectives & Criteria	To provide for ongoing adaptive management	Management objectives, criteria and water allocation limits will be regularly reviewed and amended as information becomes available to provide for ongoing adaptive management.	Regularly review management objectives, criteria and water allocation limits. Best examined in triennial reports, which also review long-term trends (most recent triennial for Gnangara: 2006-09).	Compliance report	Minister for the Environment	DEC	Overall		<b>Compliant.</b> The first Gnangara plan evaluation statement was recently completed. The statement evaluates the department's management of Gnangara groundwater resources and the extent to which the objectives of the Gnangara plan have been met since its release in November 2009 until December 2011. The evaluation statement is available on the department's website. The most recent review of Ministerial conditions and commitments for the Gnangara mound are outlined in the 2007 <i>Review of Ministerial Conditions on the groundwater resources of the Gnangara Mound</i> (DoW 2008b) and confirmed in <i>Ministerial Statement No. 819</i> . Allocation limits of Gnangara resources will be reviewed as part of the development of the next Gnangara groundwater areas allocation plan.
819: P 3	Yanchep caves	To minimise environmental and/or significant impact	Continue to develop catchment strategies to minimise change in hydrological regime within the caves of Yanchep National Park. Monitor water levels and cave fauna.	Interact with state and local agencies to coordinate land and water development activity to promote objective. Incorporate water level and fauna monitoring of caves in Department of Water Gnangara Mound monitoring program.	Compliance report	Minister for the Environment	DEC	Overall		<b>Partly-compliant.</b> Water levels in Yanchep Caves have been declining for a number of years and the majority of caves are now dry. Additionally, we can no longer gain access to a number of the caves above due to safety concerns. This informed the decision to discontinue macroinvertebrate and water quality at Yanchep caves. Monitoring of surrounding Superficial aquifer groundwater bores is ongoing. Building on the work of the shallow groundwater system investigation, the department recently completed an investigation into the cause of rapidly declining levels in Loch McNess in Yanchep National Park. Working with DEC, the department has recently reduced local abstraction in the Yanchep National Park. The department is also re-assessing groundwater allocations along the northwest coastal corridor.
819: P 4	Strategic drainage plans	To minimise environmental and/or significant impact.	Prepare strategic drainage plans for the study area including options for management of higher water levels in lakes Joondalup, Goollelal, Mariginiup, and Jandabup.	Prepare strategic drainage plans for the study area.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> During the reporting period the department finalised the following plan dealing with drainage for the area: <ul style="list-style-type: none"> <li>Swan Urban Growth Corridor drainage and water management plan (DoW 2009e).</li> </ul> See the department's website for more information.
819: P 5 1	Research & investigation program	Improving understanding of: <ul style="list-style-type: none"> <li>groundwater-environmental relationships on the Swan Coastal Plain;</li> <li>the associated management requirements, and</li> <li>potential management techniques.</li> </ul>	Prepare a research and investigation program for submission to the EPA for review and subsequent finalisation of the program to the satisfaction of the EPA. The research and investigation program will be prepared with the objective of improving understanding of: <ul style="list-style-type: none"> <li>groundwater – environmental relationships on the Swan coastal plain;</li> <li>the associated management requirements, and</li> <li>potential management techniques;</li> </ul> and will incorporate all relevant aspects of research and investigation work currently committed to under Ministerial statements 438 and 496.	Prepare a research and investigation program.	Submit research and investigation program to the EPA for approval. Compliance report.	EPA	DEC	Overall	Within four months of a revised statement being issued following the 2004 Stage 1 section 46 review	<b>Compliant.</b> The department, with research partners, is completing a number of major pieces of work to focus management effort on those areas which will show the most benefit from changes to abstraction. This work will inform the next Gnangara allocation plan. <ul style="list-style-type: none"> <li>The Perth regional aquifer modelling system (PRAMS) is currently being updated.</li> <li>Investigations to determine whether additional abstraction from the Leederville and/or Yarragadee aquifers could be a viable source option for public water supply.</li> <li>The Perth shallow groundwater system investigation is complete and reports are being finalised. These studies improved understanding of the interrelationships between wetlands and the Superficial aquifer, and the complex, superimposed impacts of climate change, land use and abstraction.</li> <li>For the next phase of Gnangara allocation planning, a tool developed by Edith Cowan University will be used to assess risk to groundwater dependent vegetation under different water, land use and climate scenarios.</li> </ul> A previous research and investigation program was produced and submitted to the EPA on 21 December 2005. It was detailed in Appendix 7 of Gnangara Triennial report 2003–06 (DoW 2007). The audit of 2003–06 and 2006–07 compliance reports agreed commitment could be 'cleared' upon confirmation from the DEC.
819: P 5 2	Research & investigation program	Administrative	1. Implement the research and investigation program to the satisfaction of the EPA.	Make part of annual Departmental work program.	Compliance report	EPA	DEC	Overall		<b>Compliant.</b> The department uses outcomes from the research and investigation program to develop management strategies based on scientific data that promote the sustainable use of the groundwater resources of the Gnangara system.

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: P 5 3	Research & investigation program	To provide for ongoing up-to-date adaptive management.	2. Review and revise the program every six years (coinciding with triennial reports), to the satisfaction of the EPA.	Incorporate review in Triennial reporting in 6 year intervals.	Triennial compliance report	EPA	DEC	Overall	Every six years (coincide with triennial reports)	<b>Compliant.</b> The department's research and investigation program is constantly evolving. The current program includes: updating the Perth regional aquifer modelling system, investigating the Leederville and Yarragadee aquifers as source options for public water supply and ongoing Perth shallow groundwater system investigations.
819: P 6 1	Environmental monitoring program	To enable evaluation of the environmental impact of groundwater abstraction from the Gngangara Mound (Superficial aquifer).	1. Prepare an environmental monitoring program for submission to the EPA for review and subsequent finalisation of the program to the satisfaction of the EPA. The monitoring program will include: <ul style="list-style-type: none"> <li>• monitoring of groundwater levels in all relevant aquifer systems;</li> <li>• relevant wetland water levels and water quality;</li> <li>• condition of vegetation and fauna associated with groundwater- dependent ecosystems</li> <li>• cave water levels.</li> </ul>	Prepare an environmental monitoring program.	Submit monitoring program to the EPA for approval. Compliance report.	EPA	DEC	Overall	Within four months of a revised statement being issued following the 2004 Stage 1 section 46 review	<b>Compliant.</b> A letter was sent to Director General of the DEC in December 2009, seeking advice and input on amendments to the monitoring program. To date, no response has been received. The monitoring program is set out in Appendix F. The previous environmental monitoring program was produced and submitted to the EPA on 21 December 2005. It was detailed in Appendix 7 of Gngangara triennial report 2003-06 (DoW 2007). The audit of 2006-07 compliance report agreed commitment could be 'cleared' upon confirmation from the DEC. Although technically this requirement has been satisfied (monitoring program prepared), the department does not seek a 'clearance' of this commitment as the program is constantly evolving and modifications are ongoing (with OEPA/DEC approval).
819: P 6 2	Environmental monitoring program	Administrative	2. Implement the approved environmental monitoring plan to the satisfaction of the EPA.	Make part of annual departmental work program.	Compliance report	EPA	DEC	Overall		<b>Compliant.</b> (see P 6 1)
819: P 6 3	Environmental monitoring program	To provide for ongoing up-to-date adaptive management.	3. Review and revise the program every six years (coinciding with triennial reports), to the satisfaction of the EPA.	Incorporate review in Triennial reporting in 6 year intervals.	Triennial compliance report	EPA	DEC	Overall	Every six years (coincide with triennial report)	<b>Compliant.</b> A review of the environmental monitoring program was undertaken in June 2009 in collaboration with the ecologists who undertake the monitoring. A number of amendments were made. A letter was sent to Director General of the DEC in December 2009, seeking advice and input on the amendments. To date, no response has been received. Although stated to be addressed in triennial reports every 6 years, the ecological monitoring program undergoes regular revision as required. Environmental objectives and monitoring will be reviewed as part of the development of the next Gngangara groundwater areas allocation plan.
819: P 7	Development advice	Integrated land and water resource planning for enhanced water resource management.	Continue to provide advice to the City of Wanneroo, the Department for Planning and Infrastructure, DEC and other relevant agencies on the impact of land use on groundwater resources.	Liaise with the City of Wanneroo, the Department for Planning and Infrastructure, DEC and other relevant agencies.	Compliance report	Minister for the Environment	City of Wanneroo, Department for Planning, DEC and other relevant agencies	Overall		<b>Compliant.</b> The department assesses land use proposals with potential water resource issues referred from local and state government agencies. The department is also currently assessing groundwater availability along the northwest coastal corridor, considering compliance and ecological condition at Ministerial criteria sites.
819: P 8	Gngangara inter-agency technical advisory group	Integrated land and water resource planning for enhanced water resource management.	Convene and provide ongoing executive support for an inter-agency technical advisory group for water resources planning and management issues on the Gngangara Mound. The group will consider planning and management issues in the context of recommendations of the Select Committee on Metropolitan Development and Groundwater Supplies.	Provide executive duties for the Gngangara Coordinating Committee. Provide executive duties for the Gngangara Consultative Committee (see P 9).	Compliance report. See P 9.	Minister for the Environment		Overall		<b>Compliant.</b> (See P 9)
819: P 9	Community consultation	Useful forum for information exchange and advice.	Continue to chair and provide support for the Gngangara Consultative Committee as an ongoing forum for information exchange and advice.	Chair and provide support for the Gngangara Consultative Committee.	Compliance report	Minister for the Environment		Overall		<b>Partly-compliant.</b> Although the Gngangara Consultative Committee did not meet during the reporting period, its role was assumed by the Gngangara Coordinating Committee (GCC) that oversaw the Gngangara sustainability strategy. While there is currently no coordinating committee, the department continues to consult with a range of stakeholders on Gngangara as required. There will be focused consultation undertaken as part of the development of the next Gngangara groundwater areas allocation plan.

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
819: P 10	Vegetation protection	Limit environmental impact – tree deaths.	Limit potential for tree deaths around production wells to 100 metres radius for normal (average) climate conditions and within 200 metres to extreme conditions.	Considered in Water Corporation operating strategy.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> Over the summer of 2010–11 widespread signs of water stress were observed, including large numbers of dead or dying eucalypts and banksias. Both phreatophytic species (that are dependant or partially dependant on groundwater) and non-phreatophytic species were affected, suggesting the cause of the deaths is likely to be a combination of groundwater levels falling below rooting depths and a severe lack of soil moisture. Each public water supply bore is assigned a sensitivity classification determined by proximity to environmentally sensitive areas. The department uses these classifications to distribute public supply abstraction to limit impacts at groundwater dependent ecosystem. The department has recently reviewed the classifications of each bore and amended bore quotas to limit the impacts of abstraction on groundwater dependent vegetation.
819: P 11	Lake Nowergup supplementation	Protect environmental values.	Should EWPs in Lake Nowergup not be met by November, artificial supplementation will be used until the EWP is reached.	Operate Lake Nowergup artificial maintenance facility if EWPs not met by end of November until EWP is reached.	Compliance report	Minister for the Environment		Overall		<b>Non-compliant.</b> Supplementation occurs at Lake Nowergup but water levels continue to be non-compliant (see Table 8).
819: P 12	Reporting	Assessment of environmental impact(s) from groundwater abstraction for public water supply.	Require the Water Corporation to submit yearly production plans as part of the operating strategy and to report on compliance with environmental commitments made in the operating strategy.	Water Corporation to submit annual production summary and report on compliance with environmental commitments defined in operating strategy.	Compliance report	Minister for the Environment		Overall		<b>Compliant.</b> Water Corporation submitted bore abstraction plans that the department reviewed to ensure abstraction was distributed to limit impacts on groundwater dependent ecosystems. The Water Corporation also submitted an <i>Integrated Water Supply Scheme water monitoring summary</i> for 2012–13 which reports on compliance with environmental commitments made in the operating strategy.
819: P 13	Vegetation protection	To minimise environmental and/or significant impact	Establish additional monitoring wells in those areas where suitable wells do not exist to monitor groundwater levels under phreatophytic vegetation.	Review monitoring program and recommend construction of additional monitoring wells as required.	Compliance report	Minister for the Environment		Overall		<b>Cleared.</b> A similar commitment from previous statement 438: P 2 was stated as 'cleared' by Department of Environmental Protection (DEP) Environmental Audit Branch 28/10/1997, refer to Appendix 7 of the Gngangara 2000–03 triennial compliance report. However, the department is continuing work in this area. The department completed a management area review (McHugh & Bourke 2007) that summarised the current monitoring and management issues facing particular wetlands on the Gngangara and Jandakot groundwater mounds and identified the information and data required to address these issues. The review recommended sites to be included in the Perth shallow groundwater systems investigation, prioritised by a combination of ecological significance, management issues and geomorphic setting. The investigations redesigned and upgraded the existing monitoring infrastructure and installed new monitoring networks at ecologically important sites.
819: P 14	East Gngangara wetlands	Offset environmental impact with environmental benefit.	Require the Water Corporation to implement its 2001 wetland mitigation strategy and subsequent approved revision and report to the DoW on implementation.	Require information in Water Corporation annual production summary and report on compliance with environmental commitments defined in operating strategy.	Compliance report	Minister for the Environment		Overall	Prior to the commissioning of the Lexia scheme	<b>Partly compliant.</b> The department has been in discussions with the Water Corporation regarding this issue. In light of the work undertaken by DEC to assess biodiversity values on the Mound (as part of the draft Gngangara sustainability strategy) and other investigations outlined in the status against commitment 819: P 5 1, the department and the Corporation have agreed to include a process for offsetting these wetlands in the next phase of planning for the Gngangara Mound.

## Appendix C – Water level monitoring results for Ministerial sites on the Jandakot Mound, 2000–2013

Sites non-compliant with water level criteria and other criteria are highlighted in **RED**. See also Table 9 for further information about the circumstances of non-compliance and mitigation actions.

### Criteria wetlands

Wetland	AWRC Ref.	Water level criteria (mAHD)		Other criteria	Water level (mAHD)													Comments on compliance in 2012–13	
		Preferred	Absolute			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12		2012–13
North Lake	Staff 424 6142521	13.29	12.68	<0.1 m decline per year	Max	13.67	13.56	13.42	13.50	13.24	13.79	13.18	13.07	13.22	12.93	12.68	12.93	12.71	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>                      The lake has been non-compliant since 2006–07.                      2012–13 minimum groundwater level lowest on record.  <b>Non-compliant with other criterion.</b>  <u>Location:</u>                      Bibra suite of wetlands. West of the Jandakot Mound crest. City of Cockburn subarea of the Perth groundwater area.  <u>Management and mitigation:</u>                      A shallow groundwater investigation is currently being completed to improve our understanding of the lake's hydrogeology in relation to its ecological health.                      The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake.  <u>Additional information:</u>                      The EPA did not support the Department of Water's recommendation (Strategen 2004) to revise the absolute minimum to 12.32 mAHD.</p>
	Min				<b>12.38</b>	<b>12.48</b>	<b>12.38</b>	<b>12.38</b>	<b>12.38</b>	12.97	<b>12.38</b>	<b>12.38</b>	<b>12.38</b>	<b>12.38</b>	<b>12.38</b>	<b>12.38</b>	<b>12.27</b>	<b>12.30</b>	
Bore 61410726	Min	<b>12.01</b>	<b>12.10</b>	<b>11.91</b>	<b>11.79</b>	<b>11.72</b>	<b>12.45</b>	<b>11.74</b>	<b>11.81</b>	<b>11.74</b>	<b>11.59</b>	<b>11.48</b>	<b>11.60</b>	<b>11.45</b>					
Bibra Lake	Staff 6142520	13.6 – 14.2 <15.0 peak	13.6	Not to dry more than 2 in 3 years, and preferably less than 1 in 3 years.	Max	15.0	14.9	14.7	14.7	14.5	14.8	14.5	14.3	14.3	14.2	13.7	14.0	13.9	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>                      The lake has been non-compliant since 2006–07.                      2012–13 minimum groundwater level lowest on record.  <b>Non-compliant with other criterion.</b>                      The lake has dried every summer since 2006–07.  <u>Location:</u>                      Bibra suite of wetlands. West of the Jandakot Mound crest. Kogalup subarea of the Cockburn groundwater area.  <u>Management and mitigation:</u>                      The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake.</p>
	Min	14.0			14.0	13.7	<b>13.5</b>	<b>13.5</b>	14.1	<b>13.5</b> dry 15/03	<b>13.5</b> dry 19/03	<b>13.5</b> dry 12/03	<b>13.5</b> dry 19/02	<b>13.5</b> dry 07/12	<b>13.5</b> dry 01/02	<b>13.5</b> dry 05/03			
	Bore BM7C 61410177	<15 peak			Min														
Kogolup Lake (South)	Staff 6142522	13.1 – 14.0 <14.8 peak	13.1		Max										15.2	14.5	14.8	<p><u>Compliance:</u>  <b>Compliant with absolute summer minimum and other criterion.</b>  <u>Location:</u>                      Bibra suite of wetlands. West of the Jandakot Mound crest. Kogolup subarea of the Cockburn groundwater area.</p>	
	Min													14.0	14.0	14.0			
	Bore 6015 61410727				Max	15.4	14.9	14.8	14.9	14.7	15.2	14.6	14.5	14.9	14.5	14.5	14.8		14.6
	Min				14.0	13.7	13.7	13.8	13.7	14.2	13.6	13.6	13.8	14.0	13.6	13.9	13.6		

Wetland	AWRC Ref.	Water level criteria (mAHD)		Other criteria	Water level (mAHD)													Comments on compliance in 2012–13	
		Preferred	Absolute			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12		2012–13
Thomsons Lake	Staff 609 6142517	11.3-11.8	10.8	For 30 % of time water levels > 11.8 mAHD (wet year – 10 %) 11.3-11.8 mAHD (medium year – 80 %) 10.8-11.3 mAHD (dry year – 10 %)	Max						12.9	11.5	12.4	12.7	12.7	12.1	12.3	<p><u>Compliance and trends:</u> <b>Compliant with absolute summer minimum.</b> <b>Non-compliant with other criterion.</b> 2012–13 was classed as a dry year with 548.8 mm of rainfall received at Perth Airport (BOM station no. 9021). Clarification is required from OEPA over which BOM station should be used for rainfall data. The lake dries at 11.5 mAHD. Absolute minimum water levels are measured at the bore. 2012–13 peak marginally lower than 2010–11 peak. <u>Location:</u> Bibra suite of wetlands. West of the Jandakot Mound crest. Thompsons subarea of the Cockburn groundwater area. <u>Management and mitigation:</u> Public water supply abstraction from environmentally sensitive bores was reduced in 2011–12 (see section 6.2.5). The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake. <u>Additional information:</u> As part of the Jandakot Drainage Scheme, the Water Corporation monitors water levels at this site. A supplementation and sampling analysis plan was completed in 2004–05. The Department of Parks and Wildlife (DPAW) (was Department of Environment and Conservation) supervises the ongoing supplementation program.</p>	
	Min											11.5 dry		11.5 dry					
	Max				12.3	12.0	12.0	12.0	12.0	12.4	11.3	12.0	12.2	12.2	11.8	12.1	11.8		
	Min				11.3	11.3	11.2	11.2	11.2	11.6	11.1	11.3	11.2	11.3	11.0	11.2	11.4		
Lake Forrestdale	Staff 6162557	21.2-21.6	21.1	Preferred earliest drying by April (wet year), February – March (medium year) or January (in a dry year). At least 0.9 m water at peaks levels (22.6 mAHD)	Max	22.4	22.0	22.0	22.3	22.1	22.4	21.7	21.9	22.1	22.0	21.7	21.9	21.7	<p><u>Compliance and trends:</u> <b>Non-compliant with absolute summer minimum.</b> The lake dries at 21.6 mAHD. Absolute minimum water levels are measured at the bore. Non-compliant since 2010–11. 2012–13 groundwater minimum was the third lowest on record. <b>Non-compliant with other criterion.</b> The lake did not achieve a minimum depth of 0.9 m (22.6 mAHD) in 2012–13. 2012–13 was classed as a dry year with 548.8 mm of rainfall received at Perth Airport (BOM station no. 9021). Clarification is required from the OEPA over which BOM station should be used for rainfall data. <u>Location:</u> Bennet Brook suite of wetlands. East of the Jandakot Mound crest. City of Armadale subarea of the Perth groundwater area. <u>Management and mitigation:</u> The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake. <u>Additional information:</u> The OEPA did not support the Department of Water's recommendation (Strategen 2004) to revise the absolute minimum to 20.2 mAHD.</p>
	Min				dry 30/01	dry 30/01	dry 30/12	dry 28/01	dry 16/05	dry 28/03	dry 25/10	dry 05/12	dry 13/01	dry 09/12	dry 07/12	dry 11/01	dry 04/02		
	Max				23.4	23.2	23.3	23.3	23.3	23.3	22.9	23.2	23.2	23.2	23.0	23.2	22.9		
	Min				21.0	20.9	20.9	20.8	20.8	21.4	20.7	21.2	21.0	21.2	20.6	21.0	20.9		
Yangebup Lake	Staff 605 6142523	<16.5 peak 13.9-15.5	13.8	Either Bibra or Yangebup Lake must contain 0.3 m water, preferably 0.5 m.	Max	16.5	16.6	16.1	16.5	15.6	16.7	16.1	16.0	16.6	16.6	15.9	15.9	<p><u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Bibra suite of wetlands. West of the Jandakot Mound crest. Kogolup subarea of the Cockburn groundwater area. <u>Additional information:</u> As part of the Jandakot Drainage Scheme, the Water Corporation monitors water levels at the site and lowers water levels if the peak is exceeded.</p>	
	Min				15.5	15.6	15.4	15.3	15.3	15.7	15.0	15.0	15.6	15.4	14.5	15.1			
	Max				16.1	16.2	16.1	16.1	15.6	16.1	15.6	15.9	15.9	16.1	15.3	15.3	15.3		
	Min				15.1	15.1	14.9	14.8	14.7	15.2	14.6	14.8	15.1	15.0	14.1	14.6	14.6		

Wetland	AWRC Ref.	Water level criteria (mAHD)		Other criteria	Water level (mAHD)													Comments on compliance in 2012–13		
		Preferred	Absolute			2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12		2012–13	
Banganup Lake	Staff 5719 6142516		11.5		Max			12.5	12.7	12.7	12.8	12.7	12.7	12.7	12.7	12.7	12.7	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  The lake dries at 12.7 mAHD. Absolute minimum water levels are measured at the bore.  Non-compliant since 2010–11. 2012–13 groundwater minimum was the third lowest on record.  <u>Location:</u>  Bibra suite of wetlands. West of the Jandakot Mound crest. Thompsons subarea of the Cockburn groundwater area.  <u>Management and mitigation:</u>  The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake.</p>		
	Min									12.7	12.7	12.7	12.7	12.7	12.7	12.7				
	Max											12.7	12.4	12.6	12.6	12.5	12.0		12.3	12.1
	Min				11.6	11.6	11.5	11.5	11.5	11.8	11.5	11.7	11.5	11.6	11.2	11.4	11.4			
Twin Bartram Swamp	Staff JE7C 6142544	22.8	22.5	Not to dry before end of January. Must be above preferred minimum 4 in every 6 years.	Max			24.1	24.4	24.5	24.4	23.8	23.8	24.4	24.4	23.7	23.8	24.3	<p><u>Compliance and trends:</u>  <b>Compliant with absolute summer minimum and other criterion.</b>  The lake dries at 23.0 mAHD.  <u>Location:</u>  Jandakot suite of wetlands. On the crest of the Jandakot Mound. Success subarea of the Jandakot groundwater area.</p>	
	Min				23.0 dry 07/03	23.0 dry 03/02	23.0 dry 26/02	23.0 dry 25/03	23.0 dry 22/03	23.6	23.0 dry 12/01	23.0 dry 09/01	23.5	23.2	23.0 dry 04/01	23.1	23.2			
	Max									24.5	23.9	24.4	24.5	24.5	23.8	23.9	24.3			
	Min				23.0	23.1	23.0	23.2	23.2	23.6	23.0	23.1	23.5	23.4	22.7	23.1	23.3			
Shirley Balla Swamp	Staff 6142576		23.1 or 0.5 m below lake base, whichever is the higher  24.5	Not to dry before end of January. Must be above preferred minimum 4 in every 6 years. Water levels should not decline at rate greater than 0.1 m/year. Monitor staff gauge.	Max			25.2	25.2	25.6	25.1	25.0	25.0	25.0	25.1	25.1	25.0	<p><u>Compliance and trends:</u>  <b>Non-compliant with absolute summer minimum.</b>  Swamp levels are consistently non-compliant with the absolute minimum criteria. 2012–13 groundwater minimum was the third lowest on record.  <b>Non-compliant with other criterion.</b>  The swamp dries every year.  <u>Location:</u>  Jandakot suite of wetlands. On the crest of the Jandakot Mound. Banjup subarea of the Jandakot groundwater area.  <u>Management and mitigation:</u>  The department is currently reviewing allocation limits in the Jandakot groundwater area, considering compliance, water level trends and ecological health at the lake.  <u>Additional information:</u>  The EPA endorsed new absolute minimum water level criterion in 2004. However, no preferred minimum was established. Therefore the 4 in 6 year criteria cannot be applied. Further review of criteria is required.</p>		
	Min				dry 02/01	dry 03/12	dry 03/12	dry 27/11	dry 27/11	dry 21/02	dry 27/09	dry	dry	dry	dry	dry 01/09	dry 01/12		dry 05/11	
	Max							25.4	25.2	25.7	24.9	25.0	25.4	25.3	24.6	24.6	25.1			
	Min				24.3	24.3	24.2	24.2	24.1	24.5	24.0	24.3	24.2	24.2	23.8	24.3	24.1			
Beenyup Road Swamp	Staff 6142547	24.0	23.6	Bore must be above preferred minimum 4 in every 6 years.	Max			24.7	24.9	24.8	25.2	24.6	24.7	25.1	25.1	24.7	25.1	25.1	<p><u>Compliance:</u>  <b>Compliant with absolute summer minimum and other criterion.</b>  <u>Location:</u>  Jandakot suite of wetlands. On the crest of the Jandakot Mound. Banjup subarea of the Jandakot groundwater area.</p>	
	Min									24.6	24.6 dry	24.6 dry	24.6 dry	24.6 dry	24.6 dry	24.6 dry	24.6 dry			
	Max				25.0	24.7	24.3	24.8	24.6	25.2	24.5	24.9	25.1	25.2	24.7	25.2	25.1			
	Min				23.7	23.7	23.5	23.7	23.8	24.2	23.8	24.1	24.2	24.2	23.9	24.3	24.3			

Rare flora and phreatophytic flora criteria monitoring bores

Monitoring bore	AWRC Ref.	Water level criteria (mAHD)		Other criterion	Water level (mAHD)													Comments	
		Preferred	Absolute			2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12		2012-13
<b>Vegetation wells</b>																			
JM14	61610247	24.39	23.89		Max			25.67	25.72	25.74	26.27	25.33	25.08	25.65	25.64	25.08	25.30	25.16	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Canning Vale subarea of the Jandakot groundwater area.
					Min	24.71	24.53	24.47	24.59	24.34	24.91	24.05	24.39	24.63	24.64	23.82	24.59	24.34	
JM16	61610445	23.90	23.40		Max			25.47	25.73	25.37	25.95	25.02	25.19	25.51	25.50	24.95	25.27	24.94	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> City of Armadale subarea of the Jandakot groundwater area.
					Min	24.59	24.31	24.29	24.30	24.28	24.59	24.09	24.30	24.26	24.38	23.98	24.31	24.17	
JM19	61610177	25.26	24.76		Max			26.16	26.02	25.95	26.57	25.77	25.68	26.51	26.27	25.59	25.90	25.65	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Boundary of the Airport and Canning Vale subareas of the Jandakot groundwater area.
					Min	25.08	25.16	24.76	24.90	24.90	25.33	24.41	24.90	25.16	25.26	24.29	25.12	24.86	
JM35	61610333	21.25	20.75		Max			25.58	26.03	25.83	26.24	25.43	25.64	25.95	25.82	24.33	25.68	25.44	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Forrestdale subarea of the Jandakot groundwater area.
					Min	23.44	23.47	23.32	23.41	24.44	24.86	24.23	24.63	23.60	23.11	21.22	21.74	23.42	
JM39	61410142	21.20	20.70		Max			24.10	24.49	24.20	24.48	23.06	23.12	23.87	24.27	22.66	23.86	23.46	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Boundary of the Forrestdale and Oakford subareas of the Jandakot groundwater area.
					Min	21.56	21.65	21.49	21.67	21.66	22.06	21.30	21.56	21.56	21.62	21.16	21.86	21.88	
JM49	61410111	22.34	21.84		Max	23.65	23.78	23.69	23.81	23.88	24.04	23.71	23.76	23.80	23.81	23.49	23.86	23.73	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Boundary of the Banjup and Wandi subareas of the Jandakot groundwater area.
					Min	23.09	23.10	23.04	23.15	23.12	23.29	22.92	23.15	23.12	23.19	22.75	23.25	22.98	
8284	61610178	24.82	24.32		Max			25.90	25.80	25.90	26.30	25.60	25.80	25.80	25.70	25.35	25.62	25.38	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Airport subarea of the Jandakot groundwater area. <u>Additional information:</u> Unable to monitor compliance with absolute summer minimum when levels fall below 25 mAHD as the current Ministerial criteria bore is not deep enough to measure levels below this. A new bore (8284B) was installed adjacent to the existing bore in early 2009 and the department has been monitoring water levels at this bore. The department recommends changing the Ministerial criteria bore to 8284B (AWRC ref. 61611864) as water levels at this bore correspond with water levels at 8284. Compliance with absolute minimum water levels can be determined, even when levels fall below 25 m AHD.
					Min	25.40	25.30	25.00	25.10	25.10	25.30	25.00	25.00	25.00	25.00	25.00	25.03	25.00	
JE4C	61610234	24.00	23.50		Max			24.93	25.54	25.32	26.06	25.19	25.18	25.85	25.70	24.83	25.63	23.85	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Boundary of the Banjup and Forrestdale subareas of the Jandakot groundwater area.
					Min	24.10	24.05	23.95	24.14	24.21	24.76	24.00	24.41	24.49	24.43	24.00	24.78	23.30	
JE10C	61410250	21.80	21.30		Max			26.09	26.14	23.25	26.10	26.32	25.21	25.39	25.79	25.98	24.86	25.06	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Banjup subarea of the Jandakot groundwater area.
					Min	23.08	23.86	23.67	23.83	23.68	23.86	22.66	23.70	23.46	23.25	22.46	23.81	23.26	

Monitoring bore	AWRC Ref.	Water level criteria (mAHD)		Other criterion	Water level (mAHD)													Comments	
		Preferred	Absolute			2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12		2012-13
<b>Rare Flora Wells</b>																			
JM7	61610180		22.06	< 0.1 m decline per year	Max			23.65	23.73	23.42	24.01	23.29	23.38	23.86	23.84	23.27	23.84	23.85	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Airport subarea of the Jandakot groundwater area.
					Min	23.06	22.97	22.80	22.79	22.71	23.06	22.52	22.82	22.90	22.97	22.30	23.13	23.06	
JM8	61610248		23.38	< 0.1 m decline per year	Max			25.08	25.21	24.98	25.51	24.63	24.57	25.00	25.12	24.49	24.88	24.66	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Airport subarea of the Jandakot groundwater area.
					Min	24.34	24.24	24.10	24.11	24.05	24.34	23.77	24.02	24.09	24.19	23.67	24.15	23.96	
JM45	61610179		22.71	< 0.1 m decline per year	Max			24.34	24.22	24.12	24.70	23.88	23.57	24.12	24.12	23.62	23.91	23.85	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Airport subarea of the Jandakot groundwater area.
					Min	23.68	23.69	23.42	23.43	23.34	23.67	23.03	23.17	23.38	23.38	22.71	23.45	23.30	
JE17C	61419703		16.35	< 0.1 m decline per year	Max			18.08	18.12	18.10	18.19	18.01	18.12	18.15	18.13	18.06	18.05	18.06	<u>Compliance:</u> <b>Compliant with absolute summer minimum.</b> <u>Location:</u> Kogolup subarea of the Cockburn groundwater area.
					Min	17.31	17.44	17.38	17.50	17.63	17.67	17.37	17.46	17.53	17.68	16.97	17.48	17.36	

Note: Water levels are permitted to fall between the preferred and absolute criteria levels. Non-compliances exist when groundwater levels fall below the absolute minimum criteria.

## Appendix D – Audit table. Environmental conditions, procedures and commitments, Jandakot Mound groundwater resources

Proponent: Department of Water

Period: 1 July 2008 to 30 June 2013

[Text in blue represents Conditions/Proponent Commitments for which the Department of Water seeks 'Clearance' from DEC/EPA.](#)

Note: *Ministerial Statement 688* refers to the Water and Rivers Commission (now Department of Water) responsibilities to the EPA. In some cases, although referred below as EPA, some responsibilities now lie with the Department of Environment and Conservation (DEC).

### Ministerial conditions and procedures

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
688: M 1-1	Implementation	The proponent shall implement the proposals as documented in "Section 46 Review of Environmental Conditions on Management of the Gnangara and Jandakot Mounds – Stage 1 Proposal for Changes to Conditions" (August 2004), as modified and documented in Environmental Protection Authority Bulletin 1155.	Implement proposals (conditions, procedures) given in EPA Bulletin 1155 and <i>Ministerial Statement No. 688</i> .	Compliance report.	Minister for the Environment		Overall		<b>Partly compliant.</b> Compliant with majority of Ministerial conditions – refer to the 'status' column of Appendix C.
688: M 2-1	Proponent commitments	The proponent shall implement the environmental management commitments, as revised in December 2004, and documented in schedule 1 of Statement 688, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.	Implement environmental management commitments given in EPA Bulletin 1155 and <i>Ministerial Statement No. 688</i> .	Compliance report	Minister for the Environment	EPA	Overall		<b>Partly compliant.</b> Compliant with majority of proponent commitments – refer to the 'status' column of Appendix D.
688: M 3-1	Proponent nomination & contact details	The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the <i>Environmental Protection Act 1986</i> is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.	Adhere to conditions, procedures and commitments given in EPA Bulletin 1155 and <i>Ministerial Statement No. 688</i> .	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details.	Minister for the Environment	EPA	Overall		<b>N/A at this time.</b>
688: M 3-2	Proponent nomination & contact details	If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent and provide a letter with a copy of this statement endorsed by the proposed replacement proponent that the proposal will be carried out in accordance with this statement. Contact details and appropriate documentation on the capability of the proposed replacement proponent to carry out the proposal shall also be provided.	Follow procedure given in 'action'.	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details.	Minister for the Environment		Overall		<b>N/A at this time.</b>
688: M 3-3	Proponent nomination & contact details	The nominated proponent shall notify the Environmental Protection Authority of any change of contact name and address within 60 days of such change.	Follow procedure given in 'action'.	Letter notifying the Chief Executive Officer of the Department of Environment and Conservation of any change in proponent details.	CEO		Overall	60 days of change	<b>N/A at this time.</b>
688: M 4-1	Commencement and time limit of approval	The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposals have been substantially commenced or the approvals granted in the statements of 8 March 1988 and 17 February 1999 shall lapse and be void.	Provide evidence in annual/triennial reports.	Compliance report.			Overall	Condition complete	<b>The Department of Water seeks 'clearance' of this condition.</b> The 'status of implementation of the proposals' is 'completed' as Jandakot scheme stage 1 and 2 are fully commissioned.
688: M 5-1 1	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the Environmental Protection Authority which address: 1. the status of implementation of the proposals	Detail in annual/triennial reports. Compliance report will include: 1. the status of implementation of the proposals	Compliance report.	CEO		Overall	Condition complete	<b>The Department of Water seeks 'clearance' of this condition.</b> Audit program prepared (see 688: P 14) and submitted to EPA 25 November 2005. The 'status of implementation of the proposals' is 'completed' as Jandakot scheme stage 1 and 2 are fully commissioned.
688: M 5-1 2	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the Environmental Protection Authority which address: 2. evidence of compliance with the conditions and commitments	Detail in annual/triennial reports. Compliance report will include: 2. evidence of compliance with the conditions and commitments	Compliance report.	CEO			Annually	<b>Compliant.</b> Detailed in the annual report and the 'status' column of this audit Table (Appendix D).

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
688: M 5-1 3	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the Environmental Protection Authority which address: 3. the performance of the environmental management plans and programs. Note: Under delegation No. 54 issued on 18 June 2004 and section 48(1) of the <i>Environmental Protection Act 1986</i> , the Environmental Protection Authority is empowered to monitor the compliance of the proponent with the statement and should directly receive the compliance documentation, including environmental management plans, related to the conditions, procedures and commitments contained in this statement.	Detail in annual/triennial reports. Compliance report will include: 3. the performance of the environmental management plans and programs.	Compliance report.	CEO			Annually	<b>Compliant.</b> Detailed in the annual report and the 'status' column of this audit table (Appendix D). Also refer to the results given in Appendix C and Tables 7 and 9.
688: M 5-2 1	Compliance audit and performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Environmental Protection Authority, which address: 1. compliance with the conditions	The performance review will address: 1. compliance with the conditions	Compliance report.	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Detailed in the annual report and the 'status' column of this audit table (Appendix D). Also refer to the results given in Appendix C and Tables 7 and 9.
688: M 5-2 2	Compliance audit and performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Environmental Protection Authority, which address: 2. the achievement of environmental objectives set for the proposal	The performance review will address: 2. the achievement of environmental objectives set for the proposal	Compliance report.	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Detailed in the annual report. Evidence of achievement of the 'objectives' are given in the 'evidence' & 'status' columns of the audit table (Appendix B).
688: M 5-2 3	Compliance audit and performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Environmental Protection Authority, which address: 3. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed	The performance review will address: 3. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed. Comply with commitments 688: P 7, 9, 10, 11, 16, 17.	Compliance report.	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> Detailed in annual report. The Jandakot Community Consultative Committee (JCCC) met on 23 August 2012 and discussed the environmental management of abstraction from the Jandakot groundwater system.
688: M 5-2 4	Compliance audit and performance review	The proponent shall submit a performance review report by 1 December each year and more detailed reports by 1 February every three years, to the requirements of the Environmental Protection Authority, which address: 4. proposed environmental management over the next three years to comply with conditions and environmental objectives set for the proposal.	The performance review will address: 4. proposed environmental management over the next three years to comply with conditions and environmental objectives set for the proposal.	Compliance report.	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	<b>Compliant.</b> The department is continuing to review and refine its environmental management of Jandakot groundwater resources using results from: <ul style="list-style-type: none"> <li>environmental monitoring (see section 6.1)</li> <li>hydrogeological investigations including the Perth shallow groundwater systems investigation (see section 6.3).</li> </ul> Outcomes from environmental monitoring and hydrogeological investigations are being incorporated into a review of allocation limits for the Jandakot groundwater area and are used in licence assessments.
688: M 5-3	Compliance audit and performance review	The proponent shall make the reports required by condition 5-2 publicly available, to the requirements of the Environmental Protection Authority.	Available on Department of Water website: < <a href="http://www.water.wa.gov.au">www.water.wa.gov.au</a> >	Reports made available on the Department of Water website: < <a href="http://www.water.wa.gov.au">www.water.wa.gov.au</a> >	CEO		Overall	After OEPA acknowledgement letter being received. Department of Water website.	<b>Compliant.</b> The following Jandakot compliance reports can be found on the department's website < <a href="http://www.water.wa.gov.au">www.water.wa.gov.au</a> >: <ul style="list-style-type: none"> <li>2006–07 annual (DoW 2007b)</li> <li>2005–08 triennial (DoW 2008c)</li> <li>2008–09 annual (DoW 2009f)</li> <li>2009–10 annual (DoW 2010b)</li> <li>2008–11 triennial (DoW 2012).</li> </ul>

Audit code	Subject	Action	How	Evidence	Requirement of	On advice from	Phase	When/Where	Status
688: M 5-4	Compliance audit and performance review	The proponent shall report any breach or anticipated breach of the environmental criteria set out in tables 1 and 2 (attached to statement 688) or environmental objectives to the Environmental Protection Authority immediately it becomes evident to the proponent.	Report in regular summaries sent to the Chief Executive Officer of the Department of Environment and Conservation.	Letter to the Chief Executive Officer of the Office of the Environmental Protection Authority reporting non-compliances with water level and other criteria as required. Compliance report.	CEO		Overall	Immediately as it becomes evident.	<b>Compliant.</b> The department reports regularly to the DEC (now the Office of the EPA) over the reporting period to inform non-compliance with criteria water levels and other criteria. <ul style="list-style-type: none"> <li>DG DoW to GM OEPA 2011–12 Q2 CEOW36/12.</li> </ul>
688: M 6-1	Management plan	The proponent shall implement the Environmental Management Plan prepared by the Water Authority of Western Australia (1992) to the requirements of the Environmental Protection Authority.	Comply with environmental objectives and criteria listed in WAWA EMP (1992).	Compliance report	EPA		Overall		<b>The Department of Water seeks 'clearance' of this condition.</b> The condition to implement the requirements set out in the Environmental Management Plan are covered and met by water level, environmental monitoring and management commitments in Ministerial Statement No. 688. The Environmental Management Plan was submitted to the OEPA in 1992 and since then there have been a number of amendments to Ministerial conditions relating to the plan. The department considers the implementation of the Environmental Management Plan an ongoing commitment. From 2005 onwards the Department of Environment, now Department of Water has been demonstrating its implementation through annual/triennial compliance reports to the OEPA. Implementation is reported as: <ul style="list-style-type: none"> <li>compliance with water level and other criteria</li> <li>predictions of non-compliance with water level criteria</li> <li>reporting on proponent and Ministerial conditions/commitments (audit tables)</li> <li>implementation of the environmental monitoring program (required under other conditions).</li> </ul>
688: M 7-1	Groundwater allocations	The proponent shall inform the Environmental Protection Authority immediately of any proposed changes to allocations, abstraction limits and licence or allocation periods.	Detail limits on availability on the Department of Water website. <www.water.wa.gov.au> Detailed in annual/triennial reports.	Reports made available on the Department of Water website: <www.water.wa.gov.au>	Minister for the Environment		Overall		<b>Compliant.</b> Documented in annual and triennial compliance reports. There has limited change (mostly reductions in abstraction) over the last five years. The department's current management focus is an allocation limit review for the Jandakot groundwater area (see section 6.2). The OEPA and DEC will be consulted regarding possible changes that result from the allocation limit review.
688: M 8-1	Water conservation	The proponent shall actively encourage further reduction in public and private water demand in accordance with the State Water Strategy (2003) and other water conservation initiatives.	Engage in activity that supports water conservation.	Compliance reports	Minister for the Environment		Overall		<b>Compliant.</b> Section 6 outlines management actions the department is undertaking to encourage further reduction in public and private water demand. Following extensive consultation with the mining and irrigation industries as well as local government, the Department of Water developed and implements <i>Operational policy no. 1.2 – Policy on water conservation/efficiency plans</i> (DoW 2009c). The department's Water Recycling and Efficiency Branch undertakes projects (see section 6.2) to reduce water demand and achieve water conservation initiatives. This includes implementing <i>Operational policy no. 1.2 – Policy on water conservation/efficiency plans</i> and implementing the permanent winter sprinkler ban.
688: M Procedure 1		Where a condition states 'to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority', the Environmental Protection Authority will prepare the written notice to the proponent.	The Environmental Protection Authority to provide written notice to the proponent (Department of Water).		Minister for the Environment		Overall		<b>The Department of Water seeks 'clearance' of this condition.</b> It is not responsibility of Proponent.
688: M Procedure 2		The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice.	The Environmental Protection Authority to seek advice as required.		EPA	Other agencies as required	Overall		<b>The Department of Water seeks 'clearance' of this condition.</b> It is not responsibility of Proponent.
688: M Procedure 3		Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Environmental Protection Authority.	Department of Water liaises with advisory body as required.	Liaison with advisory body in compliance report	EPA	Agencies listed as part of compliance reporting	Overall		<b>Compliant.</b>

## Proponent environmental management conditions

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	When/Where	Status
688: P 1	Groundwater-dependent ecosystems	To protect significant environmental values.	Ensure that groundwater abstraction satisfies the environmental criteria presented in tables 1 and 2 ( <i>Ministerial Statement 688</i> ).	Meet objectives and Environmental Water Provisions criteria presented in Tables 1 and 2 ( <i>Ministerial Statement 688</i> ).	Compliance report.	Minister for the Environment		Overall	<b>Partly compliant.</b> Detailed in Annual report, refer to results given in Appendix A .
688: P 2 1	Environmental management and monitoring	To minimise environmental and/or significant impact.	In the event that monitoring indicates that there will be significant impacts of a nature not predicted or indicates that a breach of the specified criteria has occurred or is likely to occur, then one or more of the following actions will be undertaken: 1. demonstrate to the satisfaction of the EPA that the breach of criteria is not a result of groundwater abstraction; or	Review of monitoring results, advice from expert hydrogeologists, groundwater modelling.	Compliance report. See Condition 688: M 5-4	EPA		Overall	<b>Compliant.</b> The department predicts the sites that are likely to be non-compliant with water level criteria during the coming summer (see Table 6). The department uses these predictions to distribute public water supply abstraction to limit impacts at Ministerial sites.
688: P 2 2	Environmental management and monitoring	To minimise environmental and/or significant impact.	2. satisfy the EPA that the breach of a criterion is transient and not of permanent significance; or	Review of similar occurrence in the past and consequences from environmental monitoring results Advice from expert hydrogeologists.	Compliance report	EPA		Overall	<b>Partly compliant.</b> Water levels at a number of Ministerial sites, including North Lake, Bibra Lake and Shirley Balla Swamp are consistently non-compliant with water level and other criteria. The department is considering non-compliance and ecological condition at these in the current review of allocation limits for the Jandakot groundwater area. The non-compliance at these sites is also considered in distributing public supply abstraction and in licensing decisions for private use.
688: P 2 3	Environmental management and monitoring	To minimise environmental and/or significant impact.	3. take the following actions: a. modify pumping from any bore where such changes can have a measurable effect (say raise water levels 1 centimetre or more), except in extenuating circumstances such as where significant economic hardship would occur, or CALM declare that the low water levels would be beneficial b. in the case of a wetland, artificially maintain the 'action minima' water level c. implement a short-term detailed monitoring program to establish the condition of agreed species in the affected area.	Implement actions as outlined.	Compliance report	EPA		Overall	<b>Compliant.</b> No new actions were required in the reporting period. As described in previous compliance reports, the department restricts Water Corporation abstraction from bores that impact on Ministerial sites and other groundwater-dependent ecosystems.
688: P 3	Water allocation	To minimise environmental and/or significant impact and manage the resource sustainability.	Regularly review the bulk allocations for private abstraction, as part of the total water abstraction allocation for the Jandakot PWSA, with regard to the sustainable yield of the superficial aquifer, including consideration of the environmental impacts of that abstraction.	Make part of Department of Water, water allocation planning program.	Compliance report	EPA		Overall	<b>Compliant.</b> The department's current management focus is an allocation limit review for the Jandakot groundwater area (see section 6.2). This review is considering allocations both private and public abstraction.
688: P 4	Water allocation	To minimise environmental and/or significant impact and manage the groundwater resource sustainability.	Restrict the issuing of licences for private abstraction to the limits set by the bulk allocations for both the Jandakot PWSA in its entirety and the licensing sub-areas.	Set sub-area groundwater allocation limits to values equal to or less than those set for the Jandakot PWSA.	Compliance report	EPA			<b>Compliant.</b> Total private licensed entitlements are below allocation limits originally set for subareas of the Jandakot groundwater area (see Table 5). The department's current management focus is an allocation limit review for the Jandakot groundwater area (see section 6.2).
688: P 5	Water allocation	Provide up-to-date mechanisms for groundwater allocation.	Investigate and implement efficient mechanisms for groundwater allocation.	Incorporate in regular Department of Water water allocation work program.	Compliance report	EPA			<b>Compliant.</b> The department's current management focus is an allocation limit review for the Jandakot groundwater area (see section 6.2). This review is using contemporary methods for determining sustainable limits.
688: P 6	Groundwater protection	To minimise environmental and/or significant impact and manage the groundwater resource sustainability.	Assist the EPA in the development of environmental protection policies to protect groundwater.	Liaise with the EPA as required	Compliance report	EPA			<b>N/A at this time.</b>

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	When/Where	Status
688: P 7	Groundwater protection	Integrated land and water resource planning to minimise environmental and/or significant impact.	Participate in the review of regional plans proposed by the Department for Planning and Infrastructure, local government town planning schemes, and rezoning and development applications.	Liaise with local government, the Department for Planning and Infrastructure, and other relevant land-use planning agencies.	Compliance report	EPA			<b>Compliant.</b> The department assesses land use proposals with potential water resource issues referred from local and state government agencies. In partnership with the Department of Planning and Infrastructure (and other agencies), the department produced the <i>Better urban water management</i> publication (WAPC 2008). The department also recently produced the <i>Jandakot drainage and water management plan</i> (DoW 2009g) which aims to assist land developers and local government to better manage groundwater quantity and quality. The department recently provided advice on the <i>South Metropolitan and Peel regional structure plan - Regional water management strategy</i> which identifies water related constraints and opportunities associated with proposed urban/industrial areas.
688: P 8	Groundwater protection	Integrated land and water resource planning to minimise environmental and/or significant impact.	Participate in the review of development submissions to the EPA.	Provide advice to the EPA as requested.	Compliance report. See 688: P 7	EPA			<b>Compliant.</b> See 688: P 7
688: P 9	Groundwater protection	Integrated land and water resource planning to minimise environmental and/or significant impact.	Work with the Department for Planning and Infrastructure to prepare an integrated Land Use and Water Management Strategy for the Jandakot Mound.	Liaise with the Department of Planning and Infrastructure to prepare an integrated Land Use and Water Management Strategy for the Jandakot Mound.	Compliance report	EPA			<b>Compliant.</b> The department recently produced the <i>Jandakot drainage and water management plan</i> (DoW 2009c) which aims to assist land developers and local government to better manage groundwater quantity and quality. With the Department of Planning and Infrastructure (and other agencies) the department has produced the <i>Better urban water management</i> publication (WAPC 2008). The department recently provided advice on the <i>South Metropolitan and Peel regional structure plan - Regional water management strategy</i> which identifies water related constraints and opportunities associated with proposed urban/industrial areas.
688: P 10	Water conservation	Water conservation.	Actively pursue programs in both supply and demand management. This includes ongoing public information programs and, where appropriate, regulation for design changes and regular reviews of pricing to conserve water. Improvements in the Water Corporation's supply system will also be pursued.	Engage in activity that supports water conservation. Development of a policy on water conservation plans.	Compliance report	EPA			<b>Compliant.</b> Section 6 outlines actions the department is undertaking to pursue supply and demand management and support water conservation.
688: P 11	Groundwater protection	Integrated land and water resource management to minimise environmental and/or significant impact.	Actively participate in integrated management of the Jandakot catchment.	Liaise with other water and land-use agencies.	Compliance report	EPA			<b>Compliant.</b> The department liaise with other water and land-use agencies in integrated management of the Jandakot catchment including the Water Corporation, DEC and the Western Australian Planning Commission. For example, the department, with some modelling assistance from the Water Corporation, prepared the <i>Jandakot drainage and water management plan</i> for the (WAPC) Jandakot structure plan area (see 688: P 9).
688: P 12	Environmental management and monitoring	Environmental management of groundwater abstraction is based on best available scientific knowledge.	Review and revise the management criteria and strategies, with the agreement of the EPA, as knowledge of the Jandakot environment and its interaction with groundwater improves.	Stage 1 and 2 Section 46 review supported by scientific research results.	Compliance report	EPA	EPA		<b>Compliant.</b> <i>Stage I Section 46</i> completed and a number of changes were supported by the OEPA (refer Bulletin 1155). <i>Stage II Section 46</i> work has concentrated on the Gngara Mound area due to priorities (refer 2007-08 Gngara compliance report, December 2008). The department's current management focus is an allocation limit review for the Jandakot groundwater area (see section 6.2).
688: P 13	Environmental management and monitoring	Monitor compliance with Ministerial water level criteria. Management of groundwater levels to protect environmental values of select wetlands.	Monitor water levels in groundwater monitoring bores and North, Bibra, Yangebup, Kogolup, Thomsons and Forrestdale lakes, and The Spectacles and Twin Bartram Swamp, as well as some other small wetlands.	Include in Department of Water regional groundwater monitoring program.	Compliance report. Hydrographs available on the Department of Water website: <www.water.wa.gov.au> See 688: P 14	EPA			<b>Compliant.</b> Detailed in the annual report, refer to the results given in Appendix C. Wetlands were included in the department's Jandakot Environmental Monitoring Program referred to the EPA in December 2005 (see 688: P 14). Hydrographs of Ministerial criteria wetland and terrestrial vegetation sites are available on the department's website.

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	When/Where	Status
688: P 14 1	Environmental management and monitoring	Provide a means for the assessment of compliance with Ministerial environmental criteria for the Jandakot Mound.	1. Prepare an environmental monitoring program for submission to the EPA for review and subsequent finalisation of the program to the satisfaction of the EPA. The monitoring program will include: <ul style="list-style-type: none"> <li>monitoring of groundwater levels in all relevant aquifer systems</li> <li>relevant wetland water levels and water quality</li> <li>condition of vegetation and fauna associated with groundwater-dependent ecosystems.</li> </ul>	Prepare an environmental monitoring program.	Submit monitoring program to the EPA for approval. Compliance report.	EPA	DEC	Within four months of a revised statement being issued following the 2004 Stage 1 section 46 review	<b>Compliant.</b> The department's monitoring program includes: <ul style="list-style-type: none"> <li>monitoring of groundwater levels in all relevant aquifer systems</li> <li>relevant wetland water levels and water quality</li> <li>condition of vegetation and fauna associated with groundwater-dependent ecosystems.</li> </ul> The previous environmental monitoring program was produced and submitted to the EPA on 21 December 2005. It was detailed in Appendix 7 of Gnarara Triennial report 2003–06 (DoW 2007a). The audit of 2006–07 compliance report agreed commitment could be 'cleared' upon confirmation from the DEC. A review of the environmental monitoring program was undertaken in June 2009 in collaboration with the ecologists who undertake the monitoring (see Appendix F). A number of amendments were made. A letter was sent to Director General of the DEC in December 2009, seeking advice and input on the amendments. Further revisions may result from recommendations from the Perth shallow groundwater systems investigations and the eco-hydrological states investigation (see section 6.3).
688: P 14 2	Environmental management and monitoring	To enable assessment of compliance with Ministerial environmental criteria for the Jandakot Mound.	2. Implement the approved environmental monitoring plan	Make part of annual departmental work program	Compliance report	EPA	DEC		<b>Compliant.</b> A summary of the results of the environmental monitoring conducted in 2011–12 is reported in section 6.1. These results are used to distribute public supply abstraction to limit environmental impacts and inform licensing decisions for private use. The results are also being considered in the current review of allocation limits in the Jandakot groundwater area.
688: P 14 3	Environmental management and monitoring	Monitoring program is a reflection of the best available knowledge of groundwater/environment interaction.	3. Review and revise the program every six years (coinciding with triennial reports), to the satisfaction of the EPA.	Incorporate review in triennial reporting in 6 year intervals.	Triennial compliance report	EPA	DEC	Every six years (coincide with Triennial report)	<b>Compliant.</b> A review of the environmental monitoring program was undertaken in June 2009 in collaboration with the ecologists who undertake the monitoring (see Appendix D). A number of amendments were made. A letter was sent to Director General of the DEC in December 2009, seeking advice and input on the amendments. Further revisions may result from recommendations from the Perth shallow groundwater systems investigations and the eco-hydrological states investigation (see section 6.3).
688: P 15	Environmental management and monitoring	Monitor habitat shifts in conjunction with the assessment of potential impacts on environmental values from groundwater abstraction on the Jandakot Mound.	Use aerial photographs or equivalent on a triennial basis to detect habitat shifts in North Lake, Yangebup, Kogolup, Thomsons and Forrestdale lakes.	Aerial photographs not an effective method. Instead the department focuses on field surveys of vegetation transects.	Triennial compliance report	EPA		Every three years (coincide with Triennial report)	<b>Partly-compliant.</b> There may be limited value for use of aerial photos solely as a diagnostic tool. This was recognised and the commitment modified in Bulletin 1155. The department undertakes monitoring at established transects annually at each of these wetland sites. This monitoring identifies shifts in habitat. The department commissioned Edith Cowan University to develop a model for determining ecological risk to groundwater dependent vegetation in a drying climate. The model is based on 30 years of ecological and hydrological monitoring data from the Gnarara mound. It will be an important management tool for assessing risk to groundwater dependent vegetation (including likely habitat shifts) under different climate and abstraction regimes.
688: P 16	Community consultation	Inform major stakeholders of Department of Water and Water Corporation activities on the Jandakot Mound. Provide mechanism for feedback.	Hold meetings at least annually with the Jandakot Community Consultative Committee (JCCC) established in consultation with the EPA. This committee will be informed on the groundwater scheme's operation and will provide feedback to the proponent.	Department of Water to organise JCCC meetings.	Compliance report	EPA			<b>Compliant.</b> The Jandakot Community Consultative Committee (JCCC) met in August 2013 and discussed environmental management of abstraction from the Jandakot groundwater system during the 2012–13 reporting period. A wide range of major stakeholders were represented at the meeting.
688: P 17	Community information	Maintain good public image and up-to-date knowledge of community concerns of water resource issues.	Continue to monitor community response to relevant water resource issues as reported by the media and maintain the current practice of public accessibility of WRC staff. Upon request and adequate notice, staff will address community groups on issues associated with groundwater management.	Monitor media for relevant issues. Address community groups as requested.	Compliance report	EPA			<b>Compliant.</b> The department subscribes to the 'Media Watch' service, which forwards newspaper articles relating to water resource issues to department employees. The department's staff are involved in conferences, meetings, and workshops that include community group representation (for example JCCC meetings).
688: P 18	Environmental management and monitoring	Improved environmental monitoring facility at this significant wetland.	Install monitoring wells and improved wetland water level monitoring facilities for Forrestdale Lake, and evaluate monitoring data to determine groundwater/wetland water level relationship. Subject to CALM/WRC installing permanent vegetation monitoring transect and undertaking flora and fauna studies to establish environmental values, the proponent will review available information to propose revised management criteria, if appropriate.	Being addressed as part of the Department of Water project 'Perth shallow groundwater systems investigation'.	Compliance report	EPA			<b>Compliant.</b> Groundwater monitoring bores were installed at Lake Forrestdale (see Bourke 2008) and North Lake (see Searle 2009) as part of the Perth shallow groundwater systems investigation. The Spectacles and Thomsons Lake were also included (Searle 2009) with sampling undertaken at existing bores (see section 6.3). Monitoring data at these wetlands is being evaluated to determine groundwater/wetland water level relationship.

Audit code	Subject	Objective	Action	How	Evidence	Requirement of	On advice from	When/Where	Status
688: P 19	Environmental management and monitoring	Enable good water resource management including environmental protection on the Jandakot Mound.	<ol style="list-style-type: none"> <li>1. Prepare a Management and Monitoring Program.</li> <li>2. Implement the Management and Monitoring Program.</li> </ol>	Prepare Management and Monitoring Program and submit to EPA.		EPA		Completed	<p><b>Completed.</b>  <b>The Department of Water seeks 'clearance' of this condition.</b>  This commitment was required prior to commissioning of the Stage 2 scheme. Stage 2 has been in operation for over 10 years and the implementation of the management and monitoring program has been described in numerous annual and triennial compliance reports. In addition, following publication of Ministerial statement 688, a revised monitoring program was developed and submitted to EPA (refer Commitment 688: P 14) in December 2005.</p>
688: P 20		Improve understanding of groundwater/wetland ecology relationships	Continue to fund the research projects 10.6.3 listed in Appendix 2 of the EPA Bulletin 587 for the duration of the studies.	Include research projects in annual business planning.		EPA		Completed	<p><b>Completed.</b>  <b>The Department of Water seeks 'clearance' of this condition.</b>  Auditor's comments in the 2003–04 annual report state commitment can be 'cleared'. Research projects given in Appendix C (Table A12.2) of EPA <i>Bulletin 587</i> refer to commitments given in numbers 21, 22, and 23 below.</p>
688: P 21		Improve understanding of aquatic fauna of the select Jandakot wetlands.	<p>Develop a fauna monitoring program which will focus on:</p> <ol style="list-style-type: none"> <li>1. waterbird species diversity and breeding success</li> <li>2. the number of families of aquatic invertebrate and, at infrequent intervals, species richness.</li> </ol>	Develop a fauna monitoring program.		EPA	CALM	Completed	<p><b>Completed.</b>  <b>The Department of Water seeks 'clearance' of this condition.</b>  Auditor's comments in the 2003–04 annual report agreed such a program had been developed prior to commissioning of the Stage 2 scheme and implemented and that the commitment can be 'cleared'. Fauna monitoring program has been developed and results presented in numerous annual and triennial reports to date.</p>
688: P 22		Improve understanding of the environmental significance of this wetland and means of protecting values.	Undertake study of Banganup Lake, in conjunction with CALM and The University of WA to establish management criteria and consider effectiveness of artificial maintenance of water levels.	Undertake a study of Banganup Lake as described.		EPA	CALM	Completed	<p><b>Completed.</b>  <b>The Department of Water seeks 'clearance' of this condition.</b>  Study undertaken and Auditor's comments in 2003–04 annual report states that Commitment can be 'cleared'.</p>
688: P 23		Improve understanding of the environmental significance of this wetland and means of protecting values.	Undertake a study of Twin Bartram Swamp to consider the feasibility and effectiveness of artificial maintenance of water levels.	Undertake a study of Twin Bartram Swamp as described.		EPA	CALM	Completed	<p><b>Completed.</b>  <b>The Department of Water seeks 'clearance' of this condition.</b>  Study was undertaken and Auditor's comments in 2003–04 annual report state that the commitment can be 'cleared'.</p>

## Appendix E – Background information

### Gngangara

The importance of managing the Gngangara Mound to protect groundwater-dependent ecosystems was formally recognised in the late 1980s. The Environmental Protection Authority (EPA) set the first conditions on abstracting groundwater to protect the environment on the Gngangara Mound when the former Water Authority of Western Australia (WAWA) published the *Gngangara Mound Water Resources Environmental Review and Management Program* in 1986 (WAWA 1986). The conditions included Ministerial water level criteria based on environmental knowledge at the time. These were considered by the WAWA to provide a reasonable level of maintenance of values of key elements of the environment. The Ministerial water level criteria took into account expected groundwater abstraction limits for the region, future land use expectations and historical rainfall variations.

In 1995, the WAWA reviewed the Ministerial water level criteria (WAWA 1995). In the review, the importance of climate as a factor affecting groundwater levels was highlighted, as was the difficulty of predicting future groundwater levels given the uncertainty of future climatic conditions.

### Jandakot

In 1988, the Water Authority of Western Australia (WAWA) referred plans for the construction of Stage 2 of the Jandakot Groundwater Scheme to the Environmental Protection Agency (EPA). The EPA applied a Public Environmental Review (PER) level of assessment to the proposal. In 1992, the Minister for the Environment issued a statement (EPA Bulletin 587, *Ministerial Statement No. 253 – Assessment 196*) advising that the proposal could be implemented subject to conditions and commitments imposed on the WAWA. The majority of these conditions and commitments relate to ensuring that groundwater and surface water levels across the Jandakot Mound are maintained at acceptable levels.

A key element of *Ministerial Statement No. 253* was confirming environmental water provisions for the maintenance of environmental values on the Jandakot Mound. These were set in the form of water level criteria to be achieved in key wetlands and other groundwater-dependent ecosystems such as areas of phreatophytic vegetation and rare flora.

### Section 46 review of Ministerial conditions and commitments for Gngangara and Jandakot

In 2001, as a consequence of changes in land use and lower rainfall, the EPA endorsed a two-stage approach to a review of the Ministerial conditions and commitments for the Gngangara and Jandakot mounds under section 46 of the *Environmental Protection Act, 1986*.

The first stage was for the department (then Department of Environment) to review Ministerial conditions and commitments on Gngangara and Jandakot based on existing knowledge (DoE 2005). This review led to *Statement No.687* for Gngangara (Government of Western Australia 2005a) and *Statement No. 688* for Jandakot (Government of Western Australia 2005b), released in 2005.

The department conducted a further review of Ministerial conditions and commitments on Gngangara in 2007 (DoW 2008b). The purpose of this review was to refine Ministerial criteria sites to those with significant ecological value and those where abstraction is the main factor influencing groundwater levels. This review led to the *EPA Bulletin 1324* in May 2009, with recommendations to the Minister for Environment on the proposed changes. *Statement No.819* (Government of Western Australia 2009a) for Gngangara was released later that year containing the consolidated and refined conditions and commitments.

The second stage of the Section 46 review was proposed as a more comprehensive review to improve management of public and private abstraction and to incorporate ecological information from work underway at the time. This work has been subsequently outdated by more recent investigations into the shallow groundwater systems and ecological responses to climate. Analysis of this investigative work will be used to focus management effort on those areas which will show the most benefit from changes to abstraction.

The intent of the stage two review will be covered by the next phase of planning for Gngangara groundwater resources. For Jandakot, analysis of this investigative work will be used to focus management effort on those areas which will show the most benefit from changes to abstraction.

## Appendix F – Review of environmental monitoring program (819: P 6 3)

In mid 2009, the department commenced a series of workshops to review monitoring in collaboration with the ecologists contracted to carry out the monitoring. The workshops aimed to improve both the effectiveness and efficiency of the monitoring program. In revising the monitoring program we:

- refocused the program on the relationships between groundwater levels, ecological condition and abstraction
- improved the efficiency of our monitoring by reducing the monitoring frequency from annually to every three years, unless annual monitoring is warranted on a management or information-needs basis
- improved the presentation and communication of monitoring data.

A second review workshop, held in late April 2010, considered the following two key issues:

- how monitoring results could be presented spatially so that they represent short-term and longer-term trends across an entire groundwater management area
- how modelling results could be used to ensure the monitoring effort is focussed on the correct areas in the longer-term.

The main outcomes and recommendations of this workshop were as follows:

- Future monitoring programs should include sites where improvements in ecological health and compliance are possible through the managing abstraction (based on modelling).
- The department can make a difference to important areas on the Gngangara Mound by managing abstraction – even minor benefits to groundwater levels can be significant for certain groundwater-dependent ecosystems.
- Where possible, abstraction should be reduced where it would benefit wetlands that still retain some of their key environmental values.

The following tables contain a summary of the amended environmental monitoring program for the Gngangara and Jandakot mounds.

Frequency	
*	Monthly
✓	Annually
◆	Triennially
◆	Episodic (when water is present)

## Gngangara

Site	Water levels	Wetland vegetation	Rapid end of summer	Macro-invertebrate	Water quality	Frog	Terrestrial vegetation
<b>Criteria wetlands</b>							
Lake Goollelal	*	◆	✓	✓	✓		
Lake Gngangara	*			✓	✓		
Loch McNess	*	✓	✓	✓	✓		
Lake Yonderup	*	✓	✓	◆	✓		
Lake Joondalup	*	◆	✓	✓	✓		
Mariginiup Lake	*	◆	✓	◆	◆		
Lake Jandabup	*	✓	✓	✓	✓		
Lake Nowergup	*	✓	✓	✓	✓		
Wilgarup Lake	*	✓	✓	●	●		
Pipidinny Swamp	*						
Lexia 94 (GNM17a)	*	✓	✓			✓	
Lexia 86 (GNM16)	*	✓	✓	●	●	✓	
Lexia 186 (GNM15)	*	◆	✓	●	●	✓	
Melaleuca Park (EPP) 173	*	✓	✓	✓	✓	✓	
Melaleuca Park (Dampland) 78	*	◆	✓			✓	
Egerton Swamp	*		✓	✓	✓		
<b>Criteria monitoring wells</b>							
MM12	*		✓				
MM16	*		✓				
MM18	*		✓				
MM53	*		✓				
MM55B	*		✓				
MM59B	*		✓				
MT3S	*		✓				
NR6C	*		✓				
PM9	*		✓				

Site	Water levels	Wetland vegetation	Rapid end of summer	Macro-invertebrate	Water quality	Frog	Terrestrial vegetation
PM24	*		✓				
WM1	*		✓				
WM2	*		✓				
WM8	*		✓				
L30C	*		✓				
L110C	*		✓				
L220C	*		✓				
<b>Other sites</b>							
PM6	*		✓				
PM7	*		✓				
NR11C	*		✓				
Lexia 132		◆					
Coogee Springs				●	●		
Gaston Road Swamp (Jacquie's Spring)				✓	✓		
ALPACA01 (Sue's Spring south)				✓	✓		
Lake Yakine						✓	
GSS sites						✓ Aural surveys at 23 sites	
<b>Perth SGS investigation sites</b>							
Lake Bindiar	*	✓					
Lake Muckenburra	*	✓		✓	✓		
Quin Brook	*	✓		✓	✓		
Yeal Lake	*	✓		✓	✓		
Tangletoe Swamp	*	✓					
PM4	*	✓					
Lake Bambun	*	◆		✓	✓		
<b>Phreatophytic terrestrial vegetation sites (11/17 sites monitored triennially)</b>							
Tangletoe							◆
Tick Flat							◆
Yeal							◆
Ridges							◆
P50							◆

Site	Water levels	Wetland vegetation	Rapid end of summer	Macro-invertebrate	Water quality	Frog	Terrestrial vegetation
Yanchep							◆
Nowergup							◆
Neaves							◆
Joondalup							◆
Jandabup							◆
South Kendall							◆
West Gironde							◆
Whiteman Park							◆
Melaleuca Park							◆
Bell							◆
Maralla							◆
Bombing Range							◆

\* Water levels in Yanchep caves have been declining for a number of years and the majority of caves are now dry. Additionally, we can no longer gain access to a number of the caves above due to safety concerns. This informed the decision to discontinue macroinvertebrate and water quality at Yanchep caves.

## Jandakot

Site	Water levels	Wetland vegetation	Rapid end of summer	Macro-invertebrate	Water quality	Terrestrial vegetation
<b>Criteria wetlands</b>						
North Lake	*	✓	✓			
Bibra Lake	*	◆	✓			
Kogolup Lake South	*	◆	✓	◆	◆	
Thomsons Lake	*	✓	✓	✓	✓	
Forrestdale Lake	*	◆	✓	◆	◆	
Yangebup Lake	*			✓	✓	
Banganup Lake	*	✓	✓	◆	◆	
Twin Bartram Swamp	*	◆	✓			
Shirley Balla Swamp	*	◆	✓	◆	◆	
Beenyup Road Swamp	*	✓	✓			
<b>Criteria monitoring wells</b>						
JM14	*					
JM16	*					
JM19	*		✓			
JM35	*					
JM39	*		✓			
JM49	*					
8284	*					
JE4C	*					
JE10C	*					
JM7	*					
JM8	*					
JM45	*					
JE17C	*					
<b>Other sites</b>						
Kogolup Lake North		◆	✓	✓	✓	
Gibbs Road Swamp				◆	◆	
Warton Road Swamp				◆	◆	
<b>Perth SGS Investigation sites</b>						

Site	Water levels	Wetland vegetation	Rapid end of summer	Macro-invertebrate	Water quality	Terrestrial vegetation
The Spectacles	*	✓		✓	✓	
<b>Phreatophytic terrestrial vegetation sites</b>						
Airport						◆
Liddelow						◆
Modong West						◆
Modong East						◆
Thomsons Lake						◆

\* The structure of the wetland waterbird monitoring has changed. During 2009–10 an analysis of the current dataset was undertaken. This analysis involved reviewing hydrological and rainfall data across the state to determine wider influences on population structure and abundance of waterbirds. This review informed the decision to discontinue waterbird monitoring.

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