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

Environmental management of groundwater from the Gnangara Mound

Annual compliance report to the Office of the Environmental Protection Authority
July 2013 to June 2014

December 2014

Securing Western Australia's water future

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1 Introduction

This report describes the Department of Water's compliance with Ministerial conditions and commitments, set by the Minister for Environment, for the Gnangara Groundwater Mound for the period 1 July 2013 to 30 June 2014. These conditions and commitments, including water level criteria, are stated in *Ministerial Statement No. 819* (Government of Western Australia 2009a). This report also outlines the environmental monitoring, management actions, research initiatives and consultation the department undertakes to manage the groundwater resources of the Gnangara system 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 conditions and commitments were established in 1986 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 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 in 2008 removed seven sites and amended the water level criteria at three 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 manages groundwater abstraction from the Gnangara system to meet water level criteria and to minimise environmental impacts. Water allocation limits and licensing of groundwater abstraction are the main mechanisms the department uses to manage groundwater resources. We set allocation limits for each aquifer by subarea by considering recharge estimates, modelling, environmental objectives and benefits of groundwater use. These limits guide water availability for individual licensing. The department also guides the appropriate use of domestic garden bores which are exempt from licensing, under the *Rights in Water and Irrigation Act 1914*.

This report presents the totals of licensed water entitlements from within the *Gnangara groundwater areas allocation plan* (DoW 2009a) boundary (see Figure 1) focusing on entitlements from the Superficial aquifer (see tables 1, 2 and 3).

In the 2013–14 period, there were 16 sites that were non-compliant with absolute minimum or peak water level criteria. This was one less than during the 2012–13 reporting period (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 and 2013–14

	Gnangara Mound (Superficial aquifer)	
	2012–13	**2013–14**
Rainfall [1]	584.8 mm	721.2 mm
Public water supply entitlements [2]	31.42 GL [3]	30.37 GL
Private licensed entitlements	110.56 GL	109.99 GL
Estimated garden bore use [4]	30.00 GL	30.00 GL
Non-compliance [5]	17/30	16/30

[1] Rainfall figures are for the months July to June, corresponding with the reporting period, from Perth Airport (BOM station no. 9021).

[2] Public water supply figures are comprised of water licensed to the Water Corporation as part of the Integrated Water Supply Scheme and water licensed for the Woodridge town water supply.

[3] This figure has been updated from the 31.52 GL reported in 2012–13 as it was found to include 0.1 GL of water licensed from Leederville aquifer.

[4] 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.

[5] 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 4 and Appendix A.

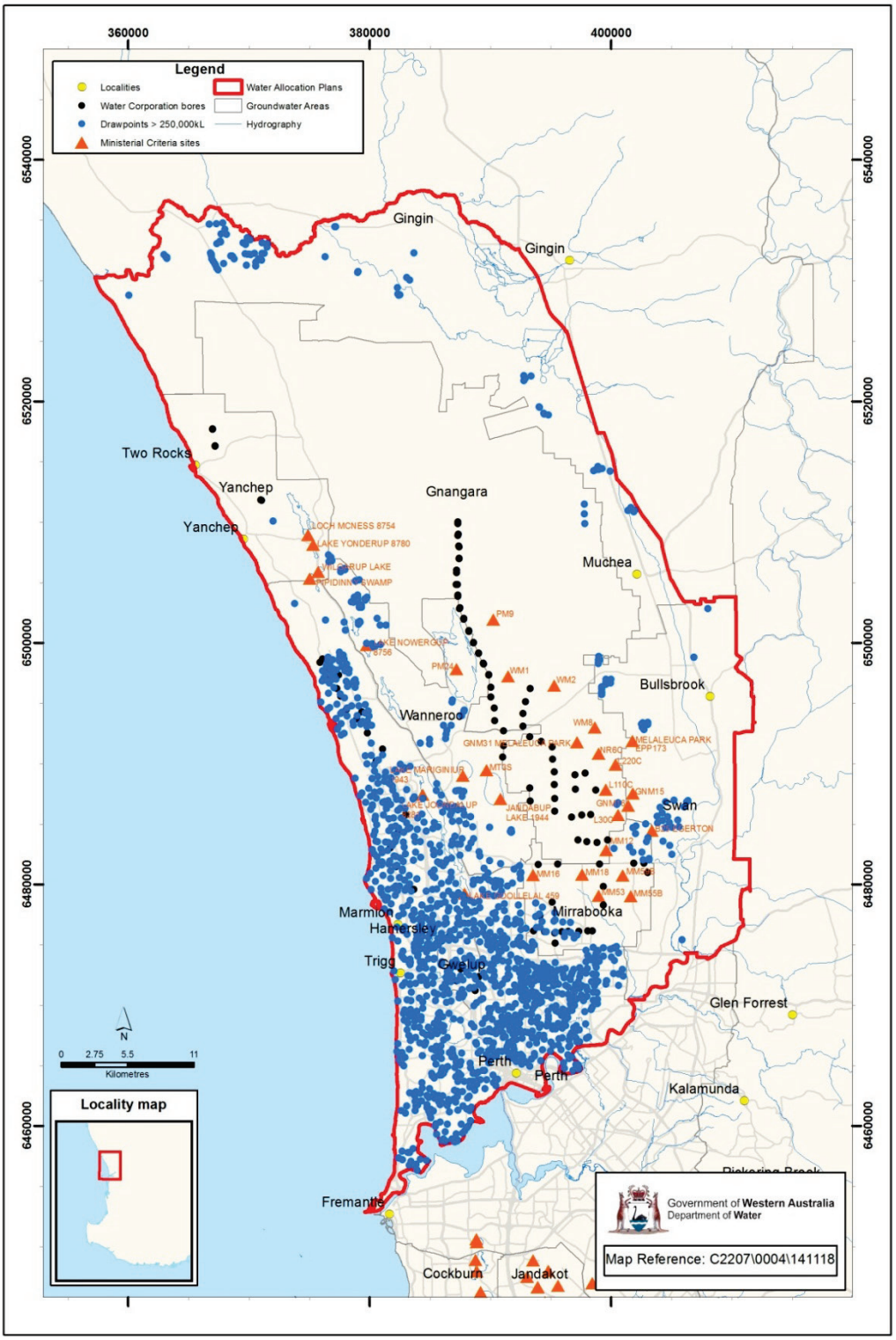


Figure 1 Gnangara groundwater system – location of Ministerial sites, public water supply production bores and private licensed entitlements (drawpoints)

2 The Gnangara groundwater system

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

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

Groundwater levels across the Gnangara Mound have generally declined over the last 30 years due to a combination of:

- the drying climate (less rainfall and recharge)
- pine plantations limiting recharge
- licensed groundwater abstraction for public water supply and private use
- groundwater abstraction from garden bores, which are exempt from licensing.

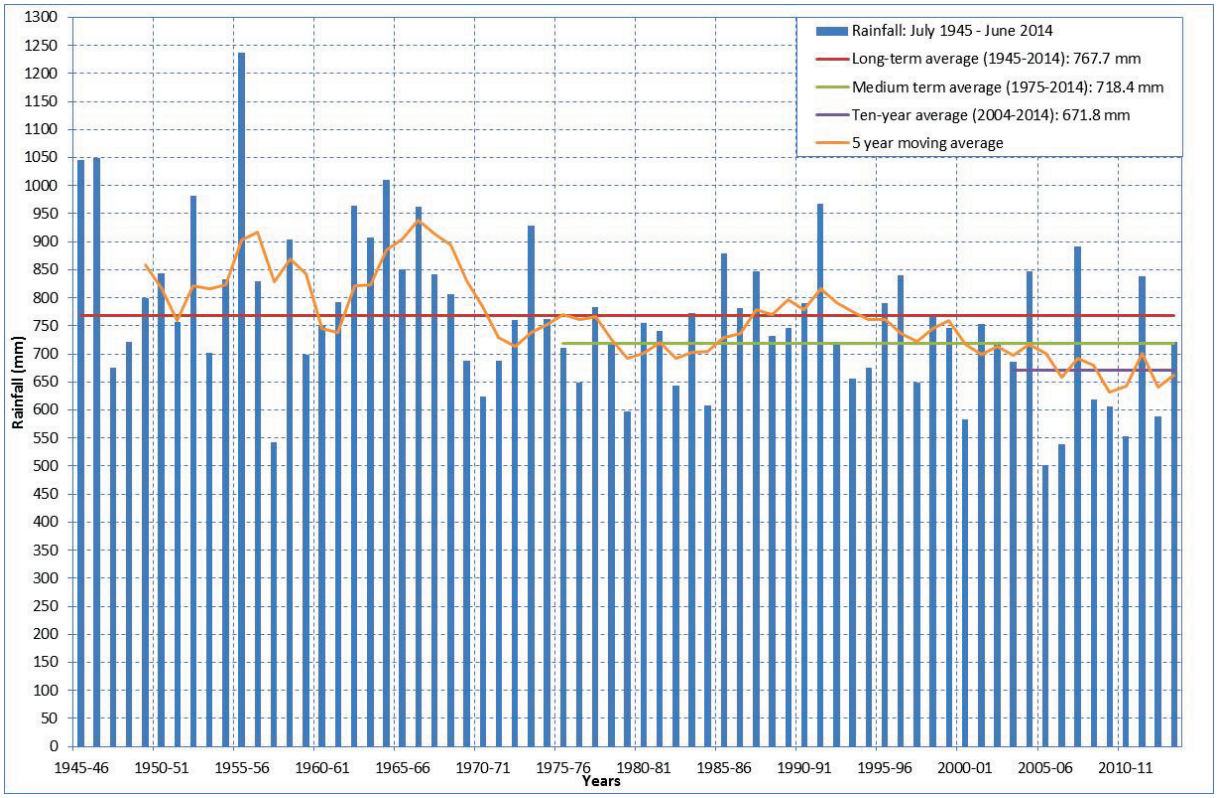
Environmental impacts from abstraction and reduced recharge occur where ecosystems depend on direct connection to the Superficial aquifer. Impacts can occur from abstraction within the Superficial aquifer itself and through abstraction from deeper aquifers where they are directly or indirectly connected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

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 (BOM site 9021) shows further declines since the 1970s (Figure 3). Over the 2013–14 reporting period, rainfall at Perth Airport (721.2 mm) was below the long term average (767.7 mm), but close to the medium term average (718.4 mm; Figure 2).

In 2013, the wet season rainfall between May and September was 587.4 mm, 161 mm more than during 2012 which was the second lowest year on record.



Note: Data sourced from the Bureau of Meteorology.

Figure 2 Annual and average rainfall over time by water year for Perth Airport (BOM site 9021)

4 Groundwater use

4.1 Public water supply

The Department of Water licenses the Water Corporation to take groundwater from the Gnangara and Jandakot systems for Perth's public water supply. Abstraction from these systems forms close to half of the Integrated Water Supply Scheme (IWSS). Within the Gnangara 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 aquifers of the Gnangara system.

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

The volumes of groundwater licensed over the 2013–14 reporting period for public water supply from all aquifers are shown in Table 2. The volumes licensed from the Gnangara system, includes:

- 110.65[1] GL for the IWSS (licence allows 120 GL per year to be abstracted from the combined Gnangara and Jandakot systems from 2012–13 to 2016–17)
- 2.8 GL licensed for the IWSS as part of the groundwater replenishment trial
- 0.16 GL licensed for Woodridge town water supply.

Table 3 shows licensed entitlements for public supply from the Superficial aquifer by groundwater subarea.

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 and recreation grounds.

Over the reporting period, private licensed entitlements from all aquifers in the Gnangara groundwater system had relatively minor fluctuations (Table 2). Table 3 shows volumes of private licensed entitlements from the Superficial aquifer over the reporting period by groundwater subarea.

4.3 Garden bore use

Groundwater is also abstracted from the Superficial aquifer through domestic garden bores that are exempt from licensing. The department has estimated garden bore use from data collected through surveys, the Australian Bureau of Statistics and household use data from the Water Corporation (Table 2).

[1] Note – includes 1 GL from bore MR17 which is located just outside the Gnangara groundwater areas allocation plan boundary in the Perth South Groundwater Area.

Table 2 Public water supply, private use and estimated garden bore use from all aquifers in the Gnangara groundwater system for 2012–13 and 2013–14

Aquifer	Public water supply entitlements [1] (GL)		Private licensed entitlements (GL)		Estimated garden bore use (GL)	
	2012–13	2013–14	2012–13	2013–14 [4]	2012–13	2013–14
Superficial	31.42 [2]	30.37	110.56	109.99	30.00	30.00
Mirrabooka [4]	2.65	1.17	2.24	2.52	-	-
Leederville	[3] 42.98	[3] 36.51	11.13	11.58	-	-
Yarragadee	51.79	[5] 45.57	0.68	0.68	-	-
TOTAL	**129.04**	**113.61**	**124.61**	**124.77**	**30.00**	**30.00**

[1] From 2012–13 onwards, public water supply figures include both the groundwater licensed to the Water Corporation as part of the Integrated Water Supply Scheme and groundwater licensed for the Woodridge town water supply.

[2] This figure has been updated from the 31.52 GL reported in 2012–13 as it was found to include 0.1 GL of water licensed from Leederville aquifer. The Leederville figure (note 3) has also been updated.

[3] A total of 1.30 GL was licensed as part of the groundwater replenishment scheme in 2012–13 and 2.80 GL in 2013–14.

[4] From 2013–14 onwards, Mirrabooka licensed entitlement figures are a combination of entitlements for the Mirrabooka and fractured rock aquifers.

[5] Includes 1 GL from bore MR17 which is located just outside the Gnangara groundwater areas allocation plan boundary in the Perth South Groundwater Area.

Table 3 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) [1, 2]		Public water supply licensed entitlements (GL)[3]			Private licensed entitlements (GL) [5]	
			2007	2011	2012–13	2013–14	Future water reserve [4]	2012–13	2013–14
Gingin [1, 4, 6]	Beermullah Plain South	No	3.00	2.70				3.13	2.83
	Deepwater Lagoon South	No	3.50	3.50				3.38	3.08
	Guilderton South	No	11.00	9.92	0.03	0.03		9.98	9.72
	Lake Mungala	No	3.40	3.16				2.90	2.90
Total for Gingin Groundwater Area			**20.90**	**19.29**	**0.13**	**0.03**	**Yes**	**19.30**	**18.53**
Gnangara [5]	Reserve	Yes	9.00	8.83	0.17	0.35		1.22	1.42
	Wanneroo Wellfield	Yes	12.00	11.85	5.92	5.97		0.50	2.04
Total for Gnangara Groundwater Area			**21.00**	**20.68**	**6.09**	**6.32**	**Yes**	**1.72**	**3.46**
Gwelup [1, 5]	Gwelup	No	7.95	7.85	2.65	2.49		1.11	1.12
Total for Gwelup Groundwater Area			**7.95**	**7.85**	**2.56**	**2.49**	**Yes**	**1.11**	**1.12**
Mirrabooka [4]	Ballajura	No	6.00	5.90	1.94	1.60		0.91	0.89
	Beechboro	No	1.00	0.90				0.25	0.25
	Henley Brook	No	1.60	1.57	0.55	0.50		0.27	0.27
	Improvement Plan 8	No	5.50	5.48	1.45	1.25		0.14	0.14
	Landsdale	Yes	1.40	1.40				0.75	0.66
	Plantation	No	0.60	0.60				0.40	0.36
	State Forest	No	1.00	0.90				1.07	0.99
	Whiteman Park	Yes	1.00	0.99	0.15	0.15		0.54	0.32
Total for Mirrabooka Groundwater Area			**18.10**	**17.75**	**4.09**	**3.50**	**Yes**	**4.33**	**3.88**
Perth [4]	City of Bayswater	No	2.30	2.30				1.72	1.73
	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	2.15
	City of Stirling	No	11.15	11.15	3.08	2.73		7.76	8.59
	City of Subiaco	No	1.00	1.00				1.12	1.07
	Eglington	No	15.45	15.45				2.02	2.62
	Quinns	No	24.65	24.65	11.75	11.65		2.84	3.03
	Shire of Peppermint Grove	No	0.10	0.10				0.08	0.08
	Shire of Swan North	No	1.00	0.90				0.53	0.55
	Town of Bassendean	No	0.50	0.45				0.34	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				1.82	0.77
	Whitfords	Yes	22.43	21.54	2.51	2.27		9.27	9.13
Total for Perth Groundwater Area			**89.08**	**88.04**	**17.34**	**16.65**	**Yes**	**37.03**	**36.32**
Swan	Bandy Spring	No	0.35	0.35				0.33	0.33
	Central Swan	No	1.00	0.92				1.31	1.32
	Cockman Bluff	No	1.50	1.35				1.18	1.18
	East Swan	No	0.75	0.68				1.08	0.94
	Neaves	No	2.00	1.80				3.43	3.29
	North Swan	Yes	2.00	1.83				2.91	2.88
	Radar	No	2.00	1.80				2.27	1.86
	South Swan	No	4.00	3.62				3.74	3.64
Total for Swan Groundwater Area			**13.60**	**12.35**	**0.00**	**0.00**	**No**	**16.24**	**15.44**
Wanneroo	Adams	Yes	1.00	0.91				1.11	1.09
	Carabooda	No	6.40	5.76				8.01	7.99
	Carramar	No	1.70	1.55				1.49	1.50
	Jandabup	No	0.20	0.18				0.18	0.18
	Joondalup	No	1.50	1.35				0.87	0.86
	Lake Gnangara	No	7.50	7.50				7.15	7.09
	Mariginiup	Yes	4.00	3.61				4.25	4.19
	Neerabup	No	2.65	2.39				2.56	2.57
	Nowergup	Yes	2.00	1.80				2.77	2.70
	Pinjar	Yes	0.50	0.45				0.62	0.61
Total for Swan Groundwater Area			**27.45**	**25.51**	**0.00**	**0.00**	**No**	**29.01**	**28.78**
Yanchep [4]	Yanchep	Yes	10.87	10.87	1.22	1.38		1.81	2.46
Total for Yanchep Groundwater Area			**10.87**	**10.87**	**1.22**	**1.38**	**Yes**	**1.81**	**2.46**
Total for Gnangara Groundwater areas			**208.95**	**202.33**	**31.42**	**30.37**		**110.56**	**109.99**

[1] 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.

[2] 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).

[3] 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.

[4] For subareas containing groundwater reserved for future public water supply, the reserve volumes are NOT included in the licensed entitlement figures presented. The reserved volumes do not consider the drying climate and are likely to be removed in the revised allocation limits set in the next Gnangara plan.

[5] The source of private licensed entitlement data is the department's Water Resourcing Licensing System (2012–13 report run on 1 July 2013, 2013–14 report run on 30 June 2014).

Also note:

From 2013-14 onwards the department has a new method for storing and extracting water licensing data.

Up-to-date figures on water availability are available from the Department of Water's Swan Avon Region office.

1 GL = 1 000 000 kL.

Figures have been rounded to two decimal places.

5 Compliance

The conditions and commitments that the Department of Water is required to comply with from *Ministerial Statement No. 819* are outlined in Appendices A and B (the 'audit tables'). The Office of the Environmental Protection Authority (OEPA) and the then Department of Environment and Conservation cleared some conditions and commitments in the statements in 2009 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 Gnangara Mound (Figure 1). There are 14 wetland sites and 16 terrestrial phreatophytic vegetation 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:

- absolute minimum levels and peak water levels – these are used as the main indication of compliance from year to year
- levels allowed between a preferred minimum and the absolute minimum at a rate of two in six years to replicate natural drying cycles – these are referred to as 'other' water level criteria in this report and provide information on water level trends.

During 2013–14 period, there were 16 sites that were non-compliant with absolute minimum or peak water level criteria, one less than during the 2012–13 reporting period. This improvement is likely due to a combination of a relatively wet year – in particular some good, late rains in August and September 2013 – and our ongoing efforts to ensure the Water Corporation's abstraction is moved away from the sites that are at risk of non-compliance.

Two additional sites were non-compliant with other criteria during 2013–14 due to levels falling between the preferred minimum and absolute minimum levels for more than two of the last six years. We use these criteria to indicate the longer term trends in water levels.

Although our level of compliance with absolute minimum levels and peak water levels slightly improved over the Gnangara Mound during this reporting period, the trend of declining water levels is still evidenced by increases in the breaches of other trend criteria. Combined with the projections of declining rainfall in the south-west of Western Australia, this means there will likely be further non-compliance in the future.

A summary of all non-compliant sites is in Table 4.

Our management and mitigation actions in response to non-compliance are in Section 6. Details for individual sites can be found in Appendix A.

Table 4 Summary of sites non-compliant with water level criteria

Year	Compliance [1]				
	Absolute minimum or peak water level criteria			Other water level criterion	
	Wetlands	Terrestrial vegetation	Total non-compliant	Wetlands	Total non-compliant
2011–12	Loch McNess Lake Yonderup Lake Jandabup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173 Lake Mariginiup Lake Nowergup	MM53 MM55B MM59B PM9 WM1 WM2 WM8	16/30	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 Lake Mariginiup Lake Nowergup	MM53 MM55B MM59B PM9 WM1 WM2 WM8	17/30	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 186	4/8
2013–14	Loch McNess Lake Yonderup Lake Jandabup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173 Lake Mariginiup Lake Nowergup	MM53 MM55B MM59B PM9 WM1 WM2 WM8	16/30	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 186 Lexia 86 Dampland 78	6/8

[1] Sites can be non-compliant with both absolute summer minimum water level and peak water level criteria. Also see Appendix A.

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*. The monitoring program was reviewed in 2009 and 2013 (see Appendix D) to improve the cost effectiveness and efficiency of the program. The program includes monitoring of:

- wetland vegetation
- wetland macroinvertebrates and water quality
- mound 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, disease and disturbance related to changing land use. The department uses environmental monitoring to continually improve our understanding of the relationship between water levels and ecological condition. 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 Wetland vegetation

Vegetation was monitored at 12 wetlands during 2013–14 (Wilson and Froend 2014). The monitoring showed improvement in canopy condition at a number of wetlands compared to the monitoring in 2012–13. This included Quin Swamp and Lake Bindiar, where the improvement was associated with increases in peak water levels. The monitoring highlighted Yeal Lake and Lake Yonderup as wetlands of concern, where notable changes in vegetation and hydrological conditions were observed compared to previous monitoring (Wilson and Froend 2014).

6.1.2 Wetland macroinvertebrates and water quality

Macroinvertebrates and water quality were monitored at 12 wetlands during 2013–14. Monitoring was conducted in spring to coincide with peak water levels (Sampey et al. 2014). Macroinvertebrate family richness increased compared to the previous year at a number of wetlands, including Lake Jandabup, Loch McNess and Melaleuca Park EPP173. These increases were associated with higher peak water levels at most wetlands since 2012–13. Family richness at Lake Nowergup was the lowest since monitoring begun with accessibility to some sampling sites at the lake affected by low water levels (Sampey et al. 2014).

Wetland nutrient concentrations were similar to the previous year and generally within historical ranges. Lakes Mariginiup and Melaleuca Park EPP173 continue to be the most acidic of the wetlands monitored (Sampey et al. 2014).

6.1.3 Mound spring macroinvertebrates and water quality

Macroinvertebrates and water quality were monitored at three mound springs in the Lexia/Bullsbrook area during 2013–14 (WRM 2014). Monitoring was carried out in spring to coincide with peak water levels.

Flows at Gaston Road and Sue's springs increased compared to previous years. Flow at Egerton Spring was strong compared to 2012–13 when it had ceased to flow. pH was relatively low at all sites. Dissolved oxygen recorded at Sue's and Egerton springs was moderate. Macroinvertebrate species richness at Gaston Road and Sue's springs was within historical ranges. Richness at Egerton Spring declined despite the improved flow (WRM 2014).

6.1.4 Wetland frogs

Frogs were monitored using trapping in spring and aural surveys of calling males in spring and autumn. Generally, the numbers of frogs trapped and calling was low compared to previous years. Annual variations are related to changes in rainfall, water levels and the annual inundation of wetlands (Huang and Bamford 2014).

6.2 Management actions

In response to the non-compliance identified in this, and previous reports, the department is implementing strategies to reduce abstraction to a sustainable level and to reduce environmental risks associated with abstraction.

Most of these strategies are outlined in the *Gnangara groundwater areas allocation plan* (DoW 2009a) however, some have been identified through subsequent evaluation of the plan. Our adaptive management is outlined in the *Gnangara groundwater areas allocation plan – evaluation statement (2009–2011)* (DoW 2013a).

We are currently evaluating the plan for the 2011–2014 period. The findings of the evaluation will continue to inform our day-to-day management of the system as well as inform the next Gnangara allocation plan which will include new strategies to further reduce abstraction in line with the drying climate and manage environmentally sensitive sites.

6.2.1 Managing public water supply allocations

As outlined in the *Gnangara groundwater areas allocation plan,* the addition of 50 GL from the Southern Seawater Desalination Plant to the Integrated Water Supply Scheme triggered a change in how groundwater for public water supply is allocated (DoW 2009a). Desalination capacity is now at 145 GL. In line with the plan, from 2012–13 the Water Corporation's groundwater allocation from the Gnangara and Jandakot systems for the Integrated Water Supply Scheme has been reduced from 145 GL to 120 GL per year from existing infrastructure.

Under the 120 GL per year allocation, the licensed volume from the Superficial aquifer has been reduced in environmentally sensitive areas. These reductions will most benefit water levels and ecological condition at sites with water level criteria set in *Ministerial Statement No. 819*. Licensed entitlements were also reduced from the Leederville and Yarragadee aquifers under the 120 GL per year allocation.

We review the distribution of the Water Corporation's licences every water year and implement changes, based on compliance and water level trends. The aim is to further reduce abstraction impacts at sites where water levels are non-compliant or approaching non-compliance with water level criteria. In 2013–14 we reduced abstraction from Leederville aquifer bores in the Pinjar borefield and also from Superficial aquifer bores in the Quinns borefield to reduce impacts on water levels at Loch McNess and Lake Nowergup. These changes were based on recommendations from recent hydrogeological investigations that were conducted to support a review of allocation limits in the North West Urban Growth Corridor.

Groundwater replenishment scheme

The department is working with the Water Corporation to progress the groundwater replenishment scheme at Beenyup Wastewater Treatment Plant. Increased use of Perth's wastewater resources is now the main strategy to meet increasing demands for water in our growing city.

We issue the Water Corporation with licences that allow them to abstract the volumes of treated wastewater injected at the Beenyup site. In 2013–14 a total of 2.8 GL of treated wastewater was injected at the Beenyup site.

Due to the success of the scheme and to reduce costs, in 2013–14 the Water Corporation brought forward their planned expansion of the scheme to 14 GL per year. The scheme has the potential to deliver up to 28 GL per year in future stages of expansion.

6.2.2 Managing private licensed use

Most of the groundwater licensed from the Superficial aquifer is to private users. Activities we undertake to manage private licensed use include on-ground compliance inspections, meter audits and water use surveys. We use the results of this work to check that groundwater use is within licensed entitlements and that site activities are authorised. In July 2013, this work resulted in a commercial driller being convicted and fined on charges relating to the construction of two illegal bores on properties that accessed the Gnangara groundwater system.

The department has prioritised its compliance and enforcement activities to consider conditions and commitments set in *Ministerial Statement No. 819*. This included expanding the scope of our compliance monitoring plan to focus on areas where non-compliance are potentially affecting water level criteria. There are also other ways the department works to manage the use of groundwater by private licensees:

- In 2013–14 we completed a review of allocation limits in the North West Urban Growth Corridor (along the coast between Quinns and Two Rocks). Demand for groundwater from both the Water Corporation and developers is high in this area in order to supply approximately 9000 ha of urban development. The department worked with the Water Corporation, the City of Wanneroo and

developers to apportion available water across the whole corridor and improve water efficiency and public open space design. We also ensured a sufficient amount of water was left in the groundwater system to protect up-stream wetlands like Loch McNess and Lake Nowergup.

- In 2013-14, the department commenced working with the City of Swan to develop a similar public open space water supply strategy for the North East Urban Corridor (the area between Midland and Bullsbrook). Groundwater resources in these areas are limited or over-allocated and there will likely be a need to transition over time to alternative water sources. This will ensure that we will reduce pressure on Ministerial criteria sites in the area.
- We worked with the Department of Parks and Wildlife to reduce abstraction impacts on Loch McNess by reducing abstraction in the Yanchep National Park and ceasing the Yanchep Caves supplementation program. This program was not meeting the success criteria for the root mat communities and was found to be impacting on water levels at Loch McNess. These changes were based on recommendations from recent local hydrogeological investigations.
- The department continues to work 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. The Waterwise Council program began in 2009 and continues to grow. The City of Vincent became the state's 22nd Waterwise Council in September 2013, following its successful lake restoration program that reduced the volume of water needed to refill Hyde Park's two lakes by 20 per cent.
- 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 maintains a web-based register of licensees to facilitate water trades as a way to optimise water use.

6.2.3 Managing garden bore use

The efficient use of water from domestic garden bores can reduce demand on scheme water. The department developed a garden bore use guideline in 2011, emphasising water conservation and efficiency, and now has an updated garden bore suitability map available online in the Perth Groundwater Atlas (accessed through the department's website). In suitable areas, the department supports the establishment and efficient use of domestic garden bores in preference to using scheme water. Garden bores are not encouraged in areas where there is a risk of acid sulfate soils, poor water quality or low yields. These areas are identified in the suitability map in the atlas.

The Western Australian 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 ban during winter. As a result of the restrictions, we have seen a significant reduction in garden bore water use.

The annual winter sprinkler ban is now in its fifth year. It has become an accepted part of the water use calendar, as evidenced by a strong reducing trend in infringements for using garden bores during the ban.

6.2.4 Updating the 2009 Gnangara areas groundwater allocation plan

Work for the next phase of Gnangara allocation planning began during 2013–14. The new allocation plan will update the framework and tools to better meet objectives associated with reducing groundwater use and protecting groundwater-dependent ecosystems, and facilitate our adaption to a changing climate. This includes a comprehensive assessment of abstraction and climate scenarios using the updated Perth Regional Aquifer Modelling System.

Once we have the initial modelling results, a formal consultation process will be initiated in mid 2015, with the new allocation plan expected in 2017.

6.3 Research initiatives

The department, in collaboration 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.

The Perth Regional Aquifer Modelling System (PRAMS) has recently been updated. We will use the updated PRAMS for detailed modelling studies to examine interactions between climate, land use and groundwater abstraction. This modelling will support decision making for how we manage the Gnangara system into the future and inform the next Gnangara allocation plan.

The department has developed a future climate tool that will help us to make better predictions of rainfall in our drying climate. The tool, which has been peer reviewed, was built using global climate models that perform well in matching actual data from Western Australia. It will ensure that we use robust, up-to-date and defensible climate science in our decision making. A report outlining how we developed the climate tool – *Selection of future climate projections for Western Australia* – is currently being finalised for publication. The climate tool will inform development of the next Gnangara allocation plan.

The Perth Regional Confined Aquifer Capacity (PRCAC) project is 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. Of particular interest is how managed aquifer recharge could be used to maximise abstraction from the Leederville and Yarragadee aquifers while protecting groundwater-dependent ecosystems and managing sea water intrusion. As part of the project we have initiated a study to improve our understanding of the relative influence of different types of groundwater abstraction (public water supply, private and supplementation) on declining lake and groundwater levels at Lake Nowergup. An important component of the study is to investigate the effects of pumping from the Leederville aquifer on the Superficial aquifer at the lake. The outcomes of this and other work undertaken as part of the PRCAC project will also inform the next Gnangara allocation plan.

Outcomes of the Perth shallow groundwater system investigation have now 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 continue to inform how we manage licensees and their abstraction in these areas and will also be used as part of the development of the next Gnangara allocation plan. In particular, these investigations will help us determine how we going to manage abstraction impacts and water levels at criteria sites into the future.

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 and will be used to assess risk to groundwater-dependent vegetation under modelling undertaken as part of the development of the next Gnangara groundwater allocation plan.

6.4 Consultation

The department engages regularly with the community through public seminars, conferences, workshops and community meetings. This will increase over the next couple of years as we develop the next Gnangara allocation plan.

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.

The department also uses the *Better urban water management framework* (Western Australian Planning Commission 2008) 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, 2000–2014

Sites non-compliant with water level criteria and other criteria for the reporting period are highlighted in **RED.**

Table A 1 Wetland sites

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
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	27.3	Compliance: **Compliant with absolute summer minimum and other criterion.**
						min	26.7	26.7	26.6	26.6	26.6	26.8	26.6	26.5	26.7	26.6	26.4	26.5	26.5	26.5	
Loch McNess	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	6.39	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The lake has been non-compliant since 2002–03 and lake levels have fallen since 2006. The minimum level in 2012–13 was the lowest on record. As of June 2014, water levels were still declining. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that a groundwater level of 5.27 mAHD at bore BH-LM2 (AWRC ref. 61640108) would meet the minimum groundwater requirements of wetland vegetation. The department is using levels at BH-LM2 to better relate groundwater levels to the ecological condition of vegetation at Loch McNess. The minimum groundwater level at the bore did not meet the minimum groundwater requirement of wetland vegetation in 2013–14. 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. Building on the work of the shallow groundwater systems 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. Based on the findings of the study the department has: • reduced abstraction from the Superficial aquifer in the Yanchep National Park • turned off the abstraction bores for the Yanchep caves supplementation trial • reduced public supply abstraction from the Leederville aquifer in the Pinjar bore field. The department has recently updated allocation limits in the Superficial aquifer along the North West coastal corridor, considering compliance and ecological condition at Loch McNess.
						min	6.97	6.96	**6.90**	**6.92**	**6.93**	**6.91**	**6.74**	**6.63**	**6.61**	**6.45**	**6.25**	**6.17**	**6.10**	**# 6.25**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
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	5.8	5.8	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The lake has been non-compliant since 2007–08 and lake levels have fallen since 1998, with the rate of decline increasing since 2006. The minimum level in 2013–14 was the lowest on record. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that a groundwater level of 5.48 mAHD at bore YDP_SC (AWRC ref. 61611840) would meet the minimum groundwater requirements of wetland vegetation (DoW 2011b). The minimum groundwater level at this bore did not meet the minimum groundwater requirement of wetland vegetation in 2013–14. The department is using levels at YDP_SC to better relate groundwater levels to the ecological condition of vegetation at the lake. In response to declines at the lake we reviewed the distribution of the Water Corporation's licences for 2013–14 and implemented changes aiming to further reduce abstraction impacts at the site. The department has recently updated allocation limits in the Superficial aquifer along the North West coastal corridor, considering compliance and ecological condition at Lake Yonderup.
						min	5.9	5.9	5.9	5.9	5.9	5.9	5.9	**5.8**	**5.8**	**5.8**	**5.7**	**5.7**	**5.6**	**5.6**	
Lake Joondalup	6162572 (8281 staff)			* 16.2	15.8	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	17.1	Compliance and trends: **Compliant with absolute summer minimum criterion.** **Non-compliant with other criterion.** The lake has been non-compliant since 1998–99. Lake levels have been relatively stable since 1998 and the minimum level in 2013–14 was higher than the previous three years. 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. Management and mitigation: Work completed as part of the Perth 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. The minimum groundwater level at this bore in 2013–14 increased from that recorded in 2012–13. 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.
						min	16.1 **4/6 yr**	16.1 **4/6 yr**	16.0 **4/6 yr**	16.0 **4/6 yr**	16.1 **4/6 yr**	16.4 **4/6 yr**	16.0 **4/6 yr**	16.0 **4/6 yr**	16.2 **4/6 yr**	16.2 **4/6 yr**	16.0 **4/6 yr**	16.0 **4/6 yr**	16.0 **4/6 yr**	16.2 **4/6 yr**	
	61610661 (8281 bore)					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	19.0	
						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	18.2	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
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**	**41.3**	Compliance and trends: **Non-compliant with absolute spring peak criterion.** Water levels have not reached the preferred spring peak since 1994 and have not reached the absolute minimum spring peak since 2005. Peak levels in 2013–14 were higher than in the two previous years. **Non-compliant with other criterion.** Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that: • bore MS10 (AWRC ref. 61610685) should be used to measure water level criteria when the lake is dry using a revised level of 41.1 mAHD • the newly installed bore MGP_C (AWRC ref. 61611440) should be used to relate changes in the watertable the wetland vegetation condition. Detailed findings and recommendations from the investigation can be found in Searle et al. (2010a). The department will consult with the OEPA as part of the development of the next Gnangara allocation plan on amending the water level criteria at this site considering recommendations from the investigation. We are using MGP_c to better relate groundwater levels to the condition of wetland vegetation. Minimum levels at bores MS10 and MGP_C improved marginally in 2013–14 compared to the previous year.
						min	41.3 **4/6 yr**	41.3 **4/6 yr**	41.3 **4/6 yr**	41.2 **4/6 yr**	41.3 **4/6 yr**	41.3 **4/6 yr**	41.3 **4/6 yr**	41.2 **4/6 yr**	41.2 **4/6 yr**	41.3 **4/6 yr**	41.1 **4/6 yr**	41.0 **4/6 yr**	41.0 **4/6 yr**	41.0 **4/6 yr**	
	61610685 (MS10 bore)					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	41.0	
						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	40.1	
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	44.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Lake levels are artificially maintained by the Water Corporation to attempt to meet the absolute spring peak water level criteria and to prevent the lake from acidifying. Though non-compliant since 2009–10 levels have been relatively stable and the artificial maintenance has been relatively successful in preventing it acidifying. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that bore JB12B (61610764) should be used to relate groundwater levels to the ecological condition of vegetation on the transect. The minimum level at JB12B fell in 2013–14 compared to the level recorded in the previous year.
						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**	**44.2**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
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**	**16.0 4/6yr**	Compliance and trends: **Non-compliant with absolute spring peak criterion.** Lake levels have been non-compliant in most years since 1996 despite the lake being artificially maintained by the department. **Non-compliant with other criterion.** Management and mitigation: Recommendations from work completed as part of the Perth shallow groundwater systems investigation included (Searle et al. 2011b): • the artificial maintenance regime should be continued • the spring peak criteria should be revised to 16.2 m AHD, which should be gradually reduced to this level from the 2009 peak of 16.5 mAHD • groundwater levels at bore LN2-89 (AWRC ref. 61611247) should be used to relate changes in the watertable to the wetland vegetation condition. Despite continued artificial maintenance lake levels have fallen in recent years. In response, we reviewed the distribution of the Water Corporation's licences for 2013–14 and implemented changes aiming to further reduce abstraction impacts at the site. The department will consult with the OEPA as part of the development of the next Gnangara allocation plan on amending the water level criteria at this site and is using bore LN2-89 to better relate groundwater levels to condition of wetland vegetation. The minimum levels at bore LN2-89 have been declining since 2009 but improved marginally from 2012–13 to 2013–14. The department has recently updated allocation limits in the Superficial aquifer along the North West coastal corridor, considering compliance and ecological condition at Lake Nowergup. The revised allocation limits have reduced the risks of increased abstraction to the west of the lake impacting on lake levels. As part of the Perth Regional Confined Aquifer Capacity project we have initiated a study to improve understanding of the relative influence of different groundwater abstraction (public supply, private and supplementation) on declining lake and groundwater levels at Lake Nowergup.
						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	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**	**6.00**	Compliance and trends: **Non-compliant with absolute spring peak criterion.** No surface water has been present in the lake since 1998. **Non-compliant with absolute summer minimum criterion.** Groundwater levels have declined since 1998 with some stabilisation since 2011. Levels were first non-compliant with the absolute minimum criteria in 2006–07 and have been non-compliant since. Management and mitigation: The department has recently updated allocation limits in the Superficial aquifer along the North West coastal corridor, considering compliance and ecological condition at Lake Wilgarup. The revised allocation limits have reduced the risks of increased abstraction to the west of the lake impacting on lake levels.
						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	4.41	
						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**	**3.82**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
Pipidinny Swamp	6162624 (staff)	2.70	2.40		1.6	max	2.8	2.8	2.4	2.7	**2.2**	2.9	**2.3**	**2.1**	**2.1**	**2.0**	**2.0**	**1.6**	**1.8**	**2.2**	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** From 2004 to 2010, levels below 2.0 mAHD could not be measured at the staff gauge at the swamp. This meant the staff gauge could not be used to determine if water levels were non-compliant with the absolute summer minimum criteria. In 2010, an extra staff gauge plate was fixed underneath the existing plate to allow levels to be measured to 1.0 mAHD and allowing us to measure non-compliance with the absolute summer minimum criteria. These issues with recording water levels resulted in the swamp being incorrectly reported in previous compliance reports as compliant with the absolute minimum water level criteria in 2009–10 and 2010–11. The department has notified the OEPA of this error. **Non-compliant with absolute spring peak criterion.** Spring peak levels have been non-compliant since 2005–06. Management and mitigation: A new bore, PIP_C (AWRC ref. 61610764) was installed as part of the Perth shallow groundwater system investigation (Searle 2009). Levels at this bore are well correlated with the staff gauge and can be used to measure compliance with absolute summer minimum criteria when the staff gauge dries. Levels have shown a rising trend since the bore was installed in 2009. The department has recently updated allocation limits in the Superficial aquifer along the North West coastal corridor, considering compliance and ecological condition at the swamp.
						min	1.7	2.0	1.8	**1.5**	2.0	2.0	2.0	2.0	2.0	**1.3**	**1.0**	**1.0**	**1.0**	**1.0**	
Lexia 86 (GNM16)	61613215			* 47.3	47.0	max	48.6	48.4	48.4	48.7	48.4	48.6	48.1	48.2	48.4	48.2	47.7	47.9	47.6	47.8	Compliance and trends: **Compliant with absolute summer minimum.** Water levels have declined since 2005 with some stabilisation evident in 2013–14. **Non-compliant with other criterion.**
						min	47.5	47.5	47.5	47.5	47.4	47.6	47.4	47.4	47.3	47.3	47.1	47.2	47.0	47.0 **4/6yr**	
Lexia 186 (GNM15)	61613214			* 47.5	47.2	max	48.0	47.8	47.8	48.0	47.7	48.0	47.5	47.5	47.6	47.5	47.0	47.1	46.9	47.2	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant with the absolute summer minimum water level criteria since 1997. Levels in 2013–14 improved compared to the previous year. **Non-compliant with other criterion.** Water levels have not been recorded above the preferred summer minimum water level criteria since before 1995. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that poor water quality is probably the most immediate threat to the wetland. Detailed findings are published in DoW 2011c.
						min	**47.0** **4/6 yr**	**47.0** **4/6 yr**	**47.0** **4/6 yr**	**47.1** **4/6 yr**	**46.9** **4/6 yr**	47.2 **4/6 yr**	**46.8** **4/6 yr**	**46.9** **4/6 yr**	**46.8** **4/6 yr**	**46.8** **4/6 yr**	**46.5** **4/6 yr**	**46.5** **4/6 yr**	**46.5** **4/6 yr**	**46.6** **4/6yr**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)													Comments on compliance during the 2013–14 reporting period
		Spring peak		End of summer minimum															
		Pref	Abs	Pref	Abs		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	2013–14	
Melaleuca Park EPP173	6162628 (staff)				50.2	max	51.1	51.0	51.0	51.1	51.0	51.1	51.0	51.1	51.0	51.0	50.5	50.7	50.6	50.9	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant with absolute summer minimum water levels since before 1995. The peak surface water level in 2013–14 was the highest since 2009 and groundwater levels have stabilised since 2011. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area including Melaleuca Park EPP173. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
						min	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	
	61613213 (GNM14 bore)					max	51.0	50.6	50.5	50.9	50.4	50.9	50.3	50.7	50.9	50.5	49.5	50.0	49.7	50.3	
						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**	**48.8**	
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	65.3	Compliance and trends: **Compliant with absolute summer minimum criterion.** 2012–13 was the first year the site was non-compliant with water level criteria. Water levels recovered marginally in 2013–14. **Non-compliant with other criterion.** Management and mitigation: A cluster of bores were installed adjacent to GNM31 as part of the Perth shallow groundwater systems investigation (Searle 2009).
						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**	65.1 **4/6yr**	
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	40.17	Compliance and trends: **Compliant with absolute summer minimum criterion.** Water levels have been compliant since 2003 and have risen over the past 10 years, probably in response to increased recharge from runoff due from surrounding urban development.
						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	39.73	

* 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 2014, water levels were still declining. The minimum water level reported is the minimum water level recorded during the 2013–14 water year.

Table A 2 Terrestrial phreatophytic vegetation sites

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)		Water levels (mAHD)													Comments on compliance during the 2013–14 reporting period
				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	2013–14	
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	40.1	Compliance: **Compliant with absolute summer minimum criterion.** Peak water levels in 2013–14 were the highest recorded since 2005–06 and minimum levels were the highest since 1994. Water levels have shown a rising trend since 2011.
			min	38.8	39.1	38.9	38.8	38.8	39.0	**38.6**	38.8	39.0	39.0	**38.6**	38.9	39.0	39.2	
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	39.9	Compliance: **Compliant with absolute summer minimum criterion.** Peak levels have risen in recent years but the minimum level in 2013–14 was the lowest since 2011.
			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	38.6	
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	34.0	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have generally declined since 2005. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer from bores located close to Whiteman Park. This aimed to reduce abstraction impacts at sites in the area including MM53. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria. .
			min	33.3	33.4	33.3	33.3	**33.2**	33.3	**33.1**	**33.2**	**33.1**	**33.0**	**32.8**	**33.0**	**33.0**	**32.8**	
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	30.5	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have stabilised since 2011. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer from bores located close to Whiteman Park. This aimed to reduce abstraction impacts at sites in the area including MM55B. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
			min	29.6	29.6	**29.4**	29.5	**29.4**	29.5	**29.4**	**29.4**	**29.4**	**29.3**	**29.0**	**29.3**	**29.2**	**29.2**	
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	36.3	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have generally declined since 2000 with some stabilisation evident since 2011. As of June 2014 water levels were still declining. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer from bores located close to Whiteman Park. This aimed to reduce abstraction impacts at sites in the area including MM59B. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
			min	**36.2**	**36.2**	**35.9**	**36.0**	**35.9**	**35.8**	**35.6**	**35.8**	**35.8**	**35.7**	**35.3**	**35.5**	**35.5**	**# 35.5**	
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	44.6	Compliance and trends: **Compliant with absolute summer minimum criterion.**

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)		Water levels (mAHD)													Comments on compliance during the 2013–14 reporting period
				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	2013–14	
			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	43.7	Water levels have generally declined since 1992 with some stabilisation evident since 2011.
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	59.7	Compliance: **Compliant with absolute summer minimum criterion.** Water levels have generally declined since 1992 and the minimum level in 2012–13 was the lowest on record. Levels improved marginally in 2013–14.
			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	58.9	
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	55.0	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have declined since 1996 and were first non-compliant in 2006–07. In 2013–14 recharge occurred at this site for the first time in two years. As of June 2014 water levels were still declining. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area including PM9. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria. .
			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**	**# 54.3**	
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	42.1	Compliance: **Compliant with absolute summer minimum criterion.** Water levels have generally declined since 1998 with some stabilisation evident since 2011.
			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	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	54.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant since 2001–02 and have declined since 2005. Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area including WM1. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
			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**	**# 54.2**	
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	66.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** 2011–12 was the first year the site was non-compliant with water level criteria. In 2013–14 recharge occurred at this site for the first time in two years. As of June 2014 water levels were still declining.

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)		Water levels (mAHD)													Comments on compliance during the 2013–14 reporting period
				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	2013–14	
			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**	**# 66.2**	Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area including WM2. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
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	65.0	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have declined since 2005 and were non-compliant for the first time in 2010–11. In 2013–14 recharge occurred at this site for the first time in two years. As of June 2014 water levels were still declining.
			min	65.6	65.4	65.4	65.5	65.3	65.5	65.1	65.1	65.1	65.1	**64.7**	**64.7**	**64.4**	**# 64.7**	Management and mitigation: As part of the move to the 120 GL per year for the IWSS in 2012–13 the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area including WM8. We review the distribution of the Water Corporation's licences annually, considering water level trends and compliance with water level criteria.
MM12	61610989	42	max	45	44	43	44	43	44	43	43	43	43	43	43	43	43	Compliance and trends: **Compliant with absolute summer minimum criterion.** Peak levels have increased since 2010 but the minimum level in 2013–14 fell to the third lowest level on record. As of June 2014 water levels were still declining.
			min	43	43	43	43	43	43	42	42	43	43	42	42	43	# 43	
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	47.9	Compliance: **Compliant with absolute summer minimum criterion.** Levels have generally fallen since 2005. As of June 2014 water levels were still declining.
			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	# 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	57.7				57.4	Compliance: **Compliant with absolute summer minimum criterion.** Levels have generally fallen since 1999. Minimum levels could not be measured at the Ministerial criteria bore between March 2010 and July 2013 due to a blockage.
			min	58.1	58.0	57.7	57.8	57.6	57.7	57.3	57.2	57.5	57.5				# 57.1	
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	53.1	Compliance: **Compliant with absolute summer minimum criterion.** Levels have generally fallen since 1991.
			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	52.3	

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 2014, water levels were still declining. The minimum water level reported is the minimum water level recorded during the 2013–14 water year.

Appendix B — Audit table: Environmental conditions, procedures and commitments, Gnangara Mound groundwater resources (including groundwater resources allocation, East Gnangara, City of Swan)

Proponent: Department of Water

Period: 1 July 2013 to 30 June 2014

Sites non-compliant with water level criteria and other criteria for the reporting period are highlighted in **RED.**

Table B 1 Ministerial conditions and procedures

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: 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 given in EPA Bulletin 1155 and *Ministerial Statement No. 819*.	Compliance report	Minister for the Environment		Overall		**Partly compliant.** 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 Gnangara groundwater areas allocation plan.
819: M 2-1	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 (EPA).	Implement commitments given in Schedule 1 of EPA Bulletin 1324 and *Ministerial Statement No. 819*.	Compliance report	Minister for the Environment	EPA	Overall		**Partly compliant.** Compliant with majority of proponent commitments – refer to the 'status' column of this audit table (Appendix B).
819: M 3-1	Proponent nomination and contact details	The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the *Environmental Protection Act 1986* 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 *Ministerial Statement No. 819*. Maintain responsibility for implementation of proposal.	Letter notifying the Chief Executive Officer of the Office of the Environmental Protection Authority (OEPA) of any change in proponent details. Compliance report.	Minister for the Environment	EPA	Overall		**N/A at this time.**
819: M 3-2	Proponent nomination and 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 OEPA of any change in proponent details.	Minister for the Environment		Overall		**N/A at this time.**
819: M 3-3	Proponent nomination and contact details	The nominated proponent shall notify the Chief Executive Officer of the OEPA 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 OEPA of any change in proponent details.	CEO		Overall	60 days of change	**N/A at this time.**
819: M 4-1 1	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the Chief Executive Officer of the OEPA 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	**Compliant.** Summarised in the compliance report and the 'status' column of this audit table (Appendix B).

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 4-1 2	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the Chief Executive Officer of the OEPA 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	**Compliant.** Environmental management plans and programs are ongoing and include: 1. The final *Gnangara groundwater areas allocation plan* 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 (DoW 2013a). 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. 2. Initiating work on the next phase of the Gnangara allocation planning is a business priority for the department. The new allocation plan will focus on the framework and tools to better meet the following objectives: • reduce the total volume of water abstracted from the Gnangara system towards a level that better reflects the current recharge from rainfall • protect groundwater-dependent ecosystems from direct impacts associated with abstraction.
819: M 4-2 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 Chief Executive Officer of the OEPA, 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.	**Compliant.** Refer to 819: M 4-1 2. Compliance with conditions can found in the 'status' column of audit tables (Appendix B).
819: M 4-2 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 Chief Executive Officer of the OEPA, 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.	**Compliant.** Evidence of achievement of the objectives is given by the 'evidence' and 'status' columns of this audit table (Appendix B).
819: M 4-2 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 Chief Executive Officer of the OEPA, 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.	**Compliant** The final *Gnangara groundwater areas allocation plan* was released in November 2009. The accompanying *Gnangara groundwater areas allocation plan statement of response* (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 (DoW 2013a). 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.
819: M 4-2 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 Chief Executive Officer of the OEPA, 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.	**Compliant.** 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	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 4-3	Compliance audit and 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 OEPA.	Available on Department of Water's website.	Reports made available on the Department of Water's website.	CEO		Overall	After OEPA acknowledg-ement letter being received. Department of Water website.	**Compliant.** The following Gnangara compliance reports have been formally audited or commented on by DEC or the OEPA and can be found on the department's website: • 2003–06 triennial (DoW 2007) • 2006–07 annual (DoW 2008a) • 2006–09 triennial (DoW 2010a). The following Gnangara compliance reports that haven't been formally audited or commented on can also be found on the department's website: • 2007–08 annual (DoW 2009c) • 2009–10 annual (DoW 2010b) • 2010–11 annual (DoW 2011d) • 2009–12 triennial (DoW 2013). • 2012–13 annual (DoW 2013b)
819: M 4-4	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 or environmental objectives to the Chief Executive Officer of the OEPA immediately it becomes evident to the proponent.	Report in regular summaries sent to the Chief Executive Officer of the OEPA.	Letter to the Chief Executive Officer of the OEPA reporting non compliances with water level and other criteria as required. Compliance report.	CEO		Overall	Immediately as it becomes evident.	**Compliant.** The department reported regularly to the OEPA 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 Gnangara 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		**Compliant.** The concept of sustainable yield using PRAMS modelling was applied in the calculation allocation limits for the *Gnangara groundwater areas allocation plan* (DoW 2009a). This plan provides the basis for water management decisions on the Gnangara Mound. The department recognises that sustainable yield has diminished as recharge has decreased in recent years. Sustainable yields of Gnangara resources will be reassessed as part of an allocation limit review for the next Gnangara 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 Gnangara Mound, to the requirements of the Environmental Protection Authority on advice of Department of Parks and Wildlife (DPaW) – formerly the Department of Environment and Conservation (DEC).	Present relevant material in annual/triennial reports. Refer draft groundwater management planning reports to the OEPA and the DPaW for comment. Make compliance reports publicly available (on the Department of Water's website).	Compliance report. Draft groundwater management documents sent to DPaW/OEPA for comment. Reports made available on Department of Water's website.	EPA	DPaW	Overall	Subject to regular review every three years.	**Compliant.** 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 *Gnangara groundwater areas allocation plan* provides the foundation for water allocation decision-making on the Gnangara Mound. The first Gnangara plan evaluation statement was recently completed (DoW 2013a). 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 *Gnangara sustainability strategy* (Government of Western Australia 2009b) indicates the association of other factors (e.g. land uses) with water management decisions on the Gnangara Mound. The following Gnangara compliance reports have been formally audited or commented on by DPaW or the OEPA and can be found on the department's website: • 2003–06 triennial (DoW 2007) • 2006–07 annual (DoW 2008a) • 2006–09 triennial (DoW 2010a). The following Gnangara compliance reports that haven't been formally audited or commented on can also be found on the department's website: • 2007–08 annual (DoW 2009c) • 2009–10 annual (DoW 2010b) • 2010–11 annual (DoW 2011d) • 2009–12 triennial (DoW 2013). • 2012–2013 annual (DoW 2013b)

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 6-1	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		**Compliant.** As outlined in the *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 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 works with the Water Corporation on an annual basis 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 allocation plan.
819: M 7-1	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 OEPA and the DPaW .	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/ DPaW	Overall		**Compliant.** Section 6.1 and Appendix C describe the department's environmental monitoring program (in line with the commitments in *Ministerial Statement No. 819*). Section 6.2 describes management actions and research initiatives the department is undertaking to limit impacts of abstraction on groundwater-dependent ecosystems.
819: M 8-1	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: <www.water.wa.gov.au/ags/WaterRegister>	Minister for the Environment		Overall	End of October each year	**Compliant.** 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: <www.water.wa.gov.au/ags/WaterRegister>
819: M 8-2	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: <www.water.wa.gov.au/ags/WaterRegister>	Minister for the Environment		Overall	End of October each year	**Compliant.** 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: <www.water.wa.gov.au/ags/WaterRegister>
819: M 9-1	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 report	Minister for the Environment		Overall		**Compliant.** In accordance with the *State Water Plan* (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 *Operational policy no. 1.2 – 'Policy on water conservation and efficiency plans*' (DoW 2009d). The department's Water Recycling and Efficiency staff undertake projects to reduce water demand and achieve water conservation initiatives. These include implementing *Operational policy no. 1.2 – 'Policy on water conservation and efficiency plans*' (in particular by local government authorities), implementing the permanent winter sprinkler ban and implementing metering programs. In 2013–14 the department finalised working with the City of Wanneroo and developers to reduce planned water use in the North West Urban Growth Corridor. 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	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 10-1 1	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara 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 OEPA and the DPaW.	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/ DPaW	Overall		**Compliant.** 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 Gnangara allocation plan.
819: M 10-1 2	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara 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 EPA and the DPaW.	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/ DPaW	Overall		**Compliant.** 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 Gnangara 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 Gnangara groundwater resources. Several projects have been undertaken to address improving the understanding of this relationship. They include: • fire regimes on the Gnangara Mound – potential for water gain and impacts on biodiversity • options and implications of continuing plantation forestry on the Gnangara Mound • biodiversity values on the Gnangara Mound. For further information see sections 4.1.2 and 4.1.3 of the draft *Gnangara sustainability strategy* and the department's website.
819: M 10-1 3	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: 3. improvement in the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gnangara Mound to the requirements of the Minister for the Environment on advice of the EPA and the DPaW.	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 Gnangara Mound.	Compliance report	Minister for the Environment	EPA/ DPaW	Overall		**Compliant.** PRAMS modelling is being used to improve the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gnangara 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 allocation plan. The Perth Regional Confined Aquifer Capacity project is 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. 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	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 10-1 4	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara 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 EPA and the DPaW.	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/ DPaW	Overall		**Compliant.** The department has undertaken hydrogeological investigations at a number of sites across the Gnangara 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: • *East Wanneroo integrated groundwater-lake flow modelling: Predictive scenario modelling to support the draft Gnangara Sustainability Strategy* (Bourke 2009) • *Local area model of groundwater flows and lake interactions: Lakes Mariginiup and Jandabup* (RPS 2009) • *Development of local area groundwater models – Gnangara Mound, Lake Nowergup* (SKM 2009a) • *Development of local area groundwater models – Gnangara Mound, Lexia Wetlands* (SKM 2009b). These reports are available on the department's website.
819: M 10-1 5	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara 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 EPA and the DPaW.	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/ DPaW	Overall		**Partly compliant.** 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.
819: M 10-1 6	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: 6. improvement in understanding of the conservation value of wetland and other groundwater-dependent ecosystems on the Gnangara Mound to the requirements of the Minister for the Environment on advice of the EPA the DPaW.	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 Gnangara Mound.	Compliance report	Minister for the Environment	EPA/ DPaW	Overall		**Compliant.** The conservation value of wetlands issue is a prime responsibility of the DPAW. 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 Proced-ure 1		Where a condition states "to the requirements of the Minister for the Environment on advice of the EPA", the EPA will prepare the written notice to the proponent.	The EPA to provide written notice to the proponent (Department of Water).		Minister for the Environment		Overall		Not the responsibility of the Proponent.
819: M Proced-ure 2		The EPA may seek advice from other agencies or organisations, as required, in order to provide its advice.	The EPA to seek advice as required.		EPA	Other agencies as required.	Overall		Not the responsibility of the Proponent.
819: M Proced-ure 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 OEPA.	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		**Compliant.** Refer to commitments: • 2,4,6,8,21 = CALM/DPaW • 21 = FPC. 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 *Gnangara Sustainability Strategy*. Also, both the DEC and Forest Products Commission made public submissions to the *Gnangara groundwater areas water management plan: draft for public comment* (DoW 2008b) which dealt with similar issues as the conditions.

Table B 2 Proponent environmental management conditions

Audit code	Subject	Objective	Action	How	Evidence	Require-ment 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 (*Ministerial Statement No. 819*).	Meet objectives and EWPs criteria presented in tables 1 and 2 (*Ministerial Statement No. 819*).	Compliance report	Minister for the Environment		Overall		**Partly compliant.** 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 and 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		**Compliant.** 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 *Review of Ministerial Conditions on the groundwater resources of the Gnangara Mound* (DoW 2008b) and confirmed in *Ministerial Statement No. 819*. Allocation limits of Gnangara resources will be reviewed as part of the development of the next Gnangara 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		**Partly compliant.** 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 monitoring 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 DPAW, 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		**Compliant.** During the reporting period the department finalised the following plan dealing with drainage for the area: • *Swan Urban Growth Corridor drainage and water management plan* (DoW 2009e). See the department's website for more information.
819: P 5 1	Research and investigation program	Improving understanding of: • groundwater-environmental relationships on the Swan Coastal Plain; • the associated management requirements, and • potential management techniques.	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: • groundwater – environmental relationships on the Swan coastal plain; • the associated management requirements, and • potential management techniques; 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	**Compliant.** 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. • The Perth regional aquifer modelling system (PRAMS) is currently being updated. • Investigations to determine whether additional abstraction from the Leederville and/or Yarragadee aquifers could be a viable source option for public water supply. • 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. • 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. 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 and 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		**Compliant.** 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	Require-ment of	On advice from	Phase	When/ Where	Status
819: P 5 3	Research and 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)	**Compliant.** 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 Gnangara 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: • monitoring of groundwater levels in all relevant aquifer systems; • relevant wetland water levels and water quality; • condition of vegetation and fauna associated with groundwater-dependent ecosystems • cave water levels.	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	**Compliant.** 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 Gnangara 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 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		**Compliant.** (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)	**Compliant.** 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 revisions as required. Recent revisions were made in 2010 and 2013 – see Appendix D. Environmental objectives and monitoring will be reviewed as part of the development of the next Gnangara 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		**Compliant.** 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	Gnangara 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 Gnangara 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 Gnangara Coordinating Committee. Provide executive duties for the Gnangara Consultative Committee (see P 9).	Compliance report. See P 9.	Minister for the Environment		Overall		**Compliant.** (See P 9)
819: P 9	Community consultation	Useful forum for information exchange and advice.	Continue to chair and provide support for the Gnangara Consultative Committee as an ongoing forum for information exchange and advice.	Chair and provide support for the Gnangara Consultative Committee.	Compliance report	Minister for the Environment		Overall		**Partly compliant.** While there is currently no formal Gnangara Consultative Committee, the department continues to consult with a range of stakeholders on Gnangara as required. There will be focused consultation undertaken as part of the development of the next Gnangara allocation plan.

Audit code	Subject	Objective	Action	How	Evidence	Require-ment 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 the Water Corporation operating strategy.	Compliance report	Minister for the Environment		Overall		**Compliant.** 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		**Non-compliant.** 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		**Compliant.** 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 *Integrated Water Supply Scheme water monitoring summary* 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		**Cleared.** 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 Gnangara 2000–03 triennial compliance report. However, the department is continuing work in this area. The department completed a management area review (McHugh and Bourke 2007) that summarised the current monitoring and management issues facing particular wetlands on the Gnangara 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 Gnangara 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 the 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 commiss-ioning of the Lexia scheme	**Partly compliant.** 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 Gnangara 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 Gnangara Mound.

Appendix C – Background information

The importance of managing the Gnangara 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 Gnangara Mound when the former Water Authority of Western Australia (WAWA) published the *Gnangara 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.

Section 46 review of Ministerial conditions and commitments for Gnangara and Jandakot

In 2001, as a consequence of changes in land use and lower rainfall, the EPA endorsed a two-stage approach to review the Ministerial conditions and commitments for the Gnangara 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 Gnangara and Jandakot based on existing knowledge (DoE 2005). This review led to *Statement No.687* for Gnangara (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 Gnangara 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 Gnangara 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 overtaken 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 Gnangara groundwater resources.

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

In mid 2009, the department commenced a series of workshops in collaboration with our consultant ecologists to review 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 long-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 long-term.

The main outcomes and recommendations of this workshop were:

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

Another review was held in 2013 to further refine the frequency of the monitoring program. The monitoring program will be reviewed again as part of the next Gnangara allocation plan.

Appendix E – Map information and disclaimer

Datum and projection information

Vertical datum: Australian Height Datum (AHD)

Horizontal datum: Geocentric Datum of Australia 94

Projection: MGA 94 Zone 50

Spheroid: Australian National Spheroid

Project information

Client: R.Rowling

Map Author: S.Edgar

Task ID: 0012

Filepath: J:\gisprojects\Project\C_series\C2105\0012\mxd\090625_Gnangara_Plan_Location.mxd

Filename: C2207

Compilation date: November 2013

Disclaimer

This map is a product of the Department of Water, Water Allocation Planning and was printed in November 2013.

While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Western Australia Towns – DLI – 12/07/2001

WA Coastline, WRC (Poly) – DoW – 13/10/2000

Hydrography, Linear (Hierarchy) – DoW – 05/11/2007

RIWI Act, Groundwater Areas – DoW – 06/03/2008

WIN Groundwater Sites – Water Corporation – DoW – 10/2009

WIN Sites – Ministerial Criteria Sites (2005) – DoW – 10/2009

Water Allocation Plans – DoW – 10/06/2009

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