Government of **Western Australia**
Department of **Water and Environmental Regulation**

Environmental management of groundwater from the Gnangara Mound

Annual compliance report

July 2016 – June 2017

Securing Western Australia's water future

Department of Water and Environmental Regulation
December 2017

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Figures

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1 Summary

The Department of Water and Environmental Regulation was established by the Government of Western Australia on 1 July 2017. It is a result of the amalgamation of the Department of Environment Regulation, Department of Water and the Office of the Environmental Protection Authority. This report contains references to previous government departments and programs.

This report describes the previous Department of Water's compliance with Ministerial conditions and commitments for the Gnangara Mound for the period 1 July 2016 – 30 June 2017. These conditions and commitments, including water level criteria, were set by the Minister for Environment in *Ministerial statement no. 819* (Government of Western Australia 2009a).

Over the 2016–17 reporting period, the number of sites that were non-compliant with absolute minimum or peak water level criteria decreased from 18 in 2015–16 to 16 (see section 5). Water levels at Lexia 86 were compliant after falling below the absolute minimum criteria for the first time in 2015–16 and levels at Lake Jandabup were compliant for the first time since 2008–09.

This report presents total licensed groundwater entitlements covered by the *Gnangara groundwater areas allocation plan* (DoW 2009a) from all aquifers of the Gnangara system (Figure 1, Table 1, 2 and 3). Public water supply entitlements in 2016–17 included 13.5 GL of temporary groundwater licences that were approved for the Integrated Water Supply Scheme under exceptional circumstances conditions (Table 1). The temporary volume was required to secure supply to the scheme after very low inflows to our dams by the end of winter in 2015.

This report also outlines the environmental monitoring, management, research and consultation the department is doing to improve sustainable management of the Gnangara groundwater system. In response to this year's and previous non-compliance, we are implementing strategies to reduce abstraction towards a sustainable level and reduce impacts on environmentally important sites (section 6.2). We initiated many of these strategies through the *Gnangara groundwater areas allocation plan* (DoW 2009a), which has been a key step in reducing groundwater use in the context of a drier climate. The department is currently working on the next Gnangara groundwater allocation plan, which will include new strategies to return the system to balance.

Table 1 Rainfall, licensing totals from all aquifers and compliance summary

	2015–16	2016-17
Rainfall	602.0 mm	633.6 mm
Public water supply entitlements	121.31 GL	123.70 GL
Private licensed entitlements	127.16 GL	128.11GL
Estimated garden bore use [1]	36 GL	36 GL
No. of non-compliant sites with absolute minimum or peak water level criteria	18 out of 30	16 out of 30

1 Domestic 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. We last reviewed domestic garden bore use in 2014.

2 Background

2.1 Ministerial statement no. 819

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). Phreatophytic vegetation is vegetation that uses groundwater to meet at least part of its water needs.

Ministerial conditions and commitments were proposed in 1986 to manage how groundwater was abstracted for public water supply and manage the expected growth in private licensed use. Since then, the conditions and commitments have been revised several times to remove sites where environmental values have been lost due to causes other than abstraction (Appendix C). 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. The water level criteria at the current sites represent contemporary environmental water provisions, suitable for protecting significant environmental values of groundwater-dependent ecosystems supported by the Gnangara Mound.

2.2 Allocation limits and licensing

The department uses allocation limits, licensing of groundwater abstraction and monitoring as the main mechanisms to manage groundwater resources. An allocation limit is the annual volume of water set aside for consumptive use from a water resource. This usually includes:

- water that is available for licensing
- water we account for that is exempt from licensing, including water used by domestic garden bores
- water we set aside for future public water supply.

Water for the environment is not included in the allocation limit as it is left in the system and considered a non-consumptive use. Allocation limits are set considering recharge estimates, modelling, environmental objectives and benefits of groundwater use. The limits guide water availability for individual licences. The department guides the appropriate use of domestic garden bores through sprinkler restrictions and identifying the areas that are unsuitable for the installation of new bores.

The department reviewed allocation limits for the Gnangara groundwater areas in 2007 and these were finalised in the Gnangara groundwater areas allocation plan (DoW 2009a). We reviewed allocation limits again in 2011 to account for reduced rainfall and recharge, and in 2014 finalised a review of allocation limits for subareas in the North West Urban Growth Corridor. The current allocation limits for Superficial aquifer resources are shown in Table 3.

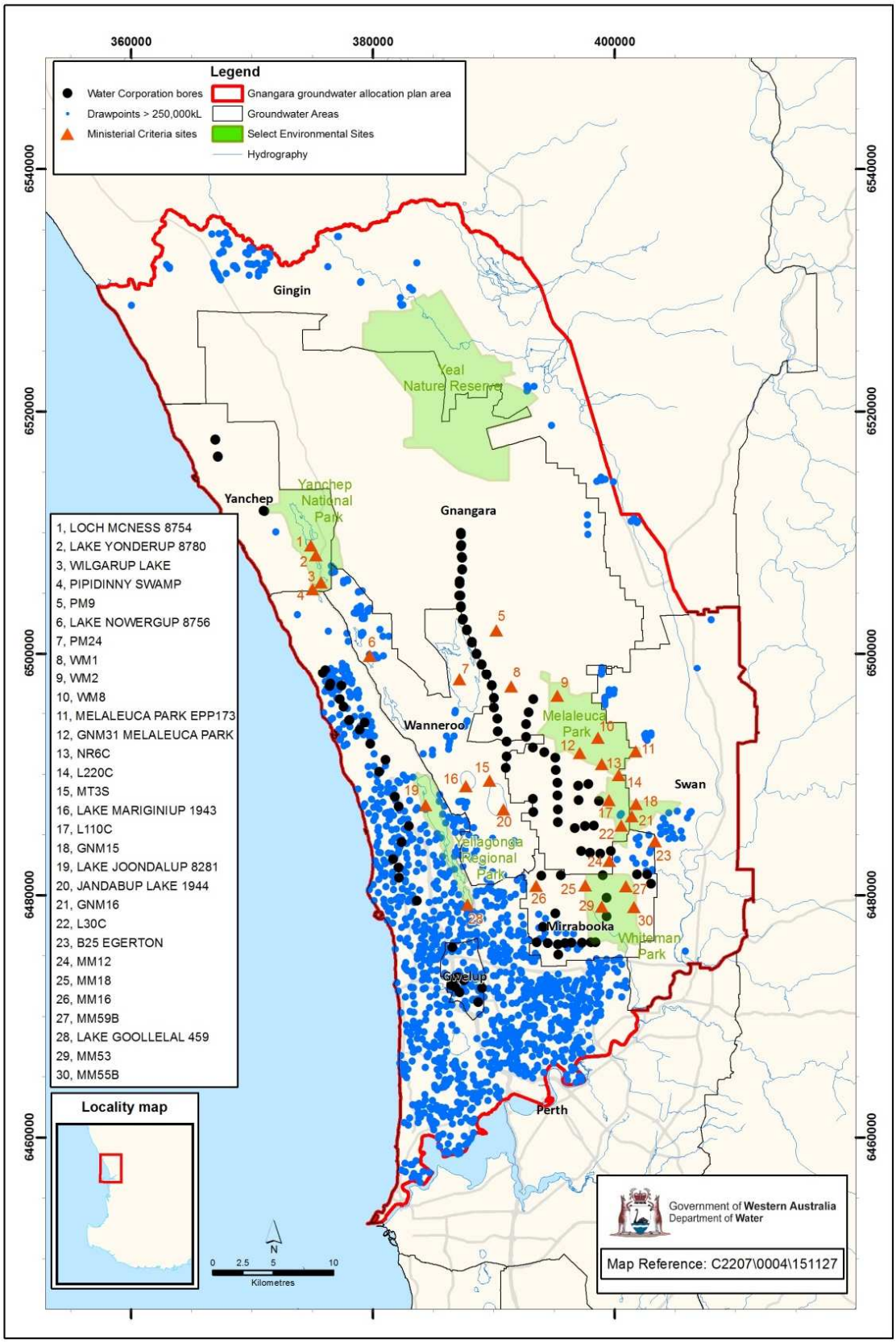

Figure 1 Location of Gnangara Ministerial sites, public water supply production bores and private licensed drawpoints

2.3 The Gnangara groundwater system

The Gnangara groundwater system is located on the Swan Coastal Plain, extending from the Swan River in the south to Moore River and Gingin Brook in the north and covering an area of about 2200 km^2. 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
- the deep, mostly-confined Yarragadee aquifer.

Environmental impacts from abstraction and reduced recharge occur where ecosystems are directly supported by the Superficial aquifer. Impacts can occur from abstraction within the Superficial aquifer itself or through abstraction from deeper aquifers where they are directly or indirectly connected to the Superficial aquifer, such as in the northern half of the Gnangara plan area.

The Gnangara system is currently over-allocated and water levels have generally declined over the last 40 years because of:

- groundwater abstraction for public water supply and private use
- the drying climate (less rainfall and recharge)
- pine plantations limiting recharge to groundwater.

These declines have meant that important wetlands and other groundwater-dependent ecosystems on Gnangara are under significant pressure and, in many cases, on a pathway to further decline in health and ecological function.

3 Rainfall

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

Over the 2016–17 reporting period, rainfall at the Bureau of Meteorology's (BoM) Perth Airport station was 633.6 mm – well below the long-term average (762.2 mm) and also below the short-term, 10 year average (672 mm) (Figure 2).

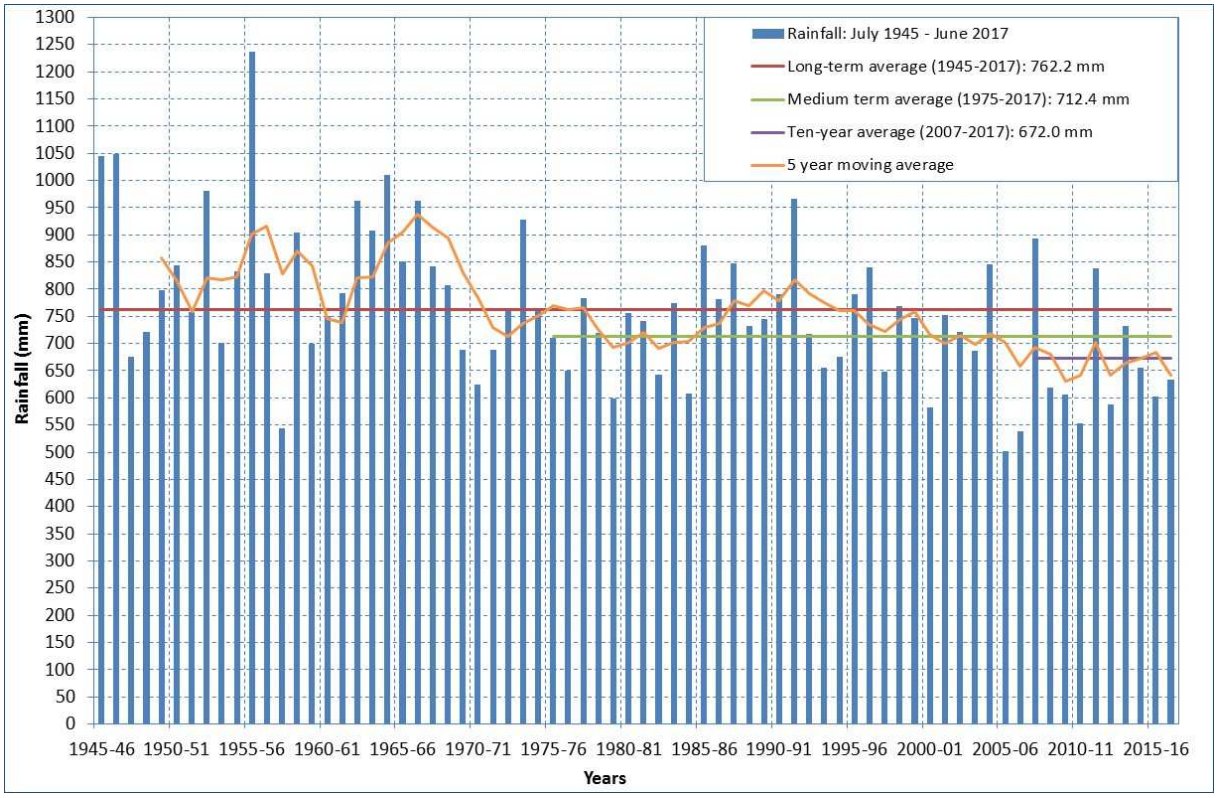

Figure 2 Annual and average water-year (July–June) rainfall at Perth Airport (BoM site no. 9021)

4 Groundwater use

The Gnangara groundwater system is the Perth region's largest source of good quality, fresh water. It provides almost half of Perth's public water supply as well as water for public open spaces, an extensive area of local agriculture and our gardens.

4.1 Public water supply

The Department of Water and Environmental Regulation licenses the Water Corporation to take groundwater from the Gnangara and Jandakot groundwater systems for Perth's public water supply. Groundwater from these systems forms a crucial component of Perth's Integrated Water Supply Scheme. 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 Integrated Water Supply Scheme.

The volumes of groundwater licensed for public water supply from all aquifers increased from 121.31 GL in 2015–16 to 123.70 GL in 2016–17 (Table 2). These volumes include additional temporary groundwater licences of 10 GL in 2015–16 and 13 GL in 2016–17 that were required to secure supply to the scheme because of very low inflows into our dams by the end of winter in 2015.

The decision to allocate additional volumes for public water supply was a contingency action after the Water Corporation also:

- increased production from desalination plants
- used low dam storage
- invested in stronger demand management including their "Drop 2" media campaign
- brought forward investment in the next stage of groundwater replenishment and investigations into the next water source options.

Licensed entitlements for public water supply are further divided into groundwater subareas for the Superficial aquifer in Table 2 (section 4.3).

4.2 Private licensed use

Groundwater licensed for private use from the Gnangara system mostly comes from the Superficial aquifer and mainly includes groundwater for agriculture and for irrigation of public open space, such as parks and sporting grounds.

Private licensed entitlements have remained steady since we've implemented the *Gnangara groundwater areas allocation plan* (DoW 2009a) and in 2016–17 remained similar to the previous year across all aquifers (Table 2, section 4.3).

4.3 Use that is exempt from licensing

When we review allocation limits, we estimate and account for groundwater that is exempt from licensing. The main type of exempt water use from Gnangara is domestic garden bores. As of 2014 we estimate there are 70 000 domestic garden bores in the Gnangara plan area using 36 GL per year.

Domestic garden bores are widely used across Gnangara. They access the Superficial aquifer, and provide an affordable and fit-for-purpose source for irrigating household gardens in urban areas and for gardens and non-commercial stock watering in rural areas.

We estimate domestic garden bore use based on the best available information – such as surveys and the department's Perth garden bore metering project – and update this as new information becomes available. Because domestic garden bore use is exempt from licensing and is generally not metered, both the number of bores and volume of water used is an estimate only.

To estimate total water usage by garden bores we multiply the (approximate) number of domestic bores in the plan area and by their average water usage as estimated by metering studies. In urban areas and across the Perth metropolitan area we have good information on the rate of domestic bore instalment from on-the-ground surveys by the Water Corporation, surveys by the Australian Bureau of Statistics in 2003, 2006 and 2009, and phone surveys we conducted in 2012 and 2016.

We also have good information on the average water use per bore in urban areas from the metering trial conducted as part of the department's Perth garden bore metering project in 2009, 2010 and 2011.

Table 2 Licensed and garden bore water use from all aquifers in the Gnangara groundwater system, comparing 2015–16 and 2016–17

Aquifer	Public water supply entitlements[1] GL		Private licensed entitlements GL		Garden bore use exempt from licensing GL	
	2015–16	**2016–17**	**2015–16**	**2016–17**	**2015–16**	**2016–17**
Superficial	31.08	32.25	112.75	113.68	36.00	36.00
Mirrabooka (and fractured rock)[2]	1.30	3.61	2.42	2.46	-	-
Leederville	40.03	38.82	11.31	11.28	-	-
Yarragadee	48.90[3]	49.02[3]	0.68	0.68	-	-
TOTAL	**121.31**	**123.70**	**127.16**	**128.11**	**36.00**	**36.00**

1 Public water supply volumes include groundwater licensed to the Water Corporation for both the Integrated Water Supply Scheme and the Woodridge town water supply.

2 From 2013–14 onwards, the Mirrabooka volumes are a combination of licensed entitlements for the Mirrabooka and fractured rock aquifers.

3 Yarragadee volumes include 0.7 GL in 2015–16 and 0.95 GL in 2016-17 from bore MR17, which is located outside of the Gnangara plan boundary in the Perth South Groundwater Area.

Table 3 Licensed entitlements from the Superficial aquifer in subareas of the Gnangara groundwater areas allocation plan

Groundwater area	Subarea	Ministerial criteria site present?	Current allocation limit [1, 2] GL	Public water supply licensed entitlements [3] GL			Private licensed entitlements [5] GL	
				2015–16	2016–17	Future water reserve[4]	2015–16	2016–17
Gingin	Beermullah Plain South	No	2.70				2.80	3.30
	Deepwater Lagoon South	No	3.50				3.02	3.08
	Guilderton South	No	9.92	0.03	0.03		9.87	9.82
	Lake Mungala	No	3.16				2.85	2.84
Total for Gingin Groundwater Area			**19.29**	**0.03**	**0.03**	**Yes**	**18.54**	**19.04**
Gnangara	Reserve	Yes	8.83	0.22	0.28		1.42	1.42
	Wanneroo Wellfield	Yes	11.85	6.08	6.00		2.10	2.12
Total for Gnangara Groundwater Area			**20.68**	**6.30**	**6.28**	**Yes**	**3.53**	**3.54**
Gwelup	Gwelup	No	7.85	3.20	3.37		1.17	1.12
Total for Gwelup Groundwater Area			**7.85**		**3.37**	**Yes**	**1.17**	**1.12**
Mirrabooka	Ballajura	No	5.90	1.80	2.10		0.89	0.89
	Beechboro	No	0.90				0.32	0.33
	Henley Brook	No	1.57	0.50	0.50		0.27	0.27
	Improvement Plan 8	No	5.48	1.05	1.05		0.13	0.27
	Landsdale	Yes	1.40				0.66	0.52
	Plantation	No	0.60				0.36	0.36
	State Forest	No	0.90				1.03	1.03
	Whiteman Park	Yes	0.99	0.15	0.15		0.60	1.09
Total for Mirrabooka Groundwater Area			**17.75**	**3.50**	**3.80**	**Yes**	**4.26**	**4.75**
Perth	City of Bayswater	No	2.30				1.81	2.45
	City of Fremantle North	No	0.70				0.04	0.05
	City of Nedlands	No	2.30				2.35	2.41
	City of Perth	No	1.50				2.95	2.16
	City of Stirling	No	11.35	2.60	3.82		7.68	7.65
	City of Subiaco	No	1.00				0.99	0.99
	Eglinton	No	7.05				2.44	2.51
	Quinns	No	16.69	11.00	10.36		3.67	3.52
	Shire of Peppermint Grove	No	0.10				0.08	0.08
	Shire of Swan North	No	0.90				0.64	0.61
	Town of Bassendean	No	0.45				0.39	0.39
	Town of Cambridge	No	3.50				2.47	2.42
	Town of Claremont	No	0.70				0.70	0.70
	Town of Cottesloe	No	0.30				0.27	0.27
	Town of Mosman Park	No	0.50				0.48	0.48
	Town of Vincent	No	1.00				2.23	0.74
	Whitfords	Yes	21.71	2.92	3.08		8.93	8.90
Total for Perth Groundwater Area			**71.75**	**16.52**	**17.26**	**Yes**	**38.12**	**36.32**
Swan	Bandy Spring	No	0.35				0.33	0.33
	Central Swan	No	0.92				1.26	1.24
	Cockman Bluff	No	1.35				1.45	1.39
	East Swan	No	0.68				0.72	0.73
	Neaves	No	1.80				3.20	3.20
	North Swan	Yes	1.83				3.21	3.19
	Radar	No	1.80				1.86	1.86
	South Swan	No	3.62				3.54	3.45
Total for Swan Groundwater Area			**12.35**	**0.00**	**0.00**	**No**	**15.56**	**15.39**
Wanneroo	Adams	Yes	0.91				1.08	1.08
	Carabooda	No	5.76				7.91	7.71
	Carramar	No	1.55				1.50	1.50
	Jandabup	No	0.18				0.18	0.18
	Joondalup	No	1.35				0.86	0.84
	Lake Gnangara	No	6.79				6.55	6.50
	Mariginiup	Yes	3.61				4.13	4.05
	Neerabup	No	2.39				2.53	2.57
	Nowergup	Yes	1.80				2.58	2.54
	Pinjar	Yes	0.45				0.58	0.58
Total for Wanneroo Groundwater Area			**24.79**	**0.00**	**0.00**		**27.90**	**27.56**
Yanchep	Yanchep	Yes	20.48	1.54	1.55		3.69	5.96
Total for Yanchep Groundwater Area			**20.48**	**1.54**	**1.55**		**3.69**	**5.96**
Total for Gnangara groundwater allocation plan area			**194.73**	**31.08**	**32.25**		**112.75**	**113.68**

1 The department reviewed allocation limits for the Gnangara groundwater areas in 2007 and these were finalised in the *Gnangara groundwater areas allocation plan* (DoW 2009a). The allocation limit is the sum of all components including private use, public water supply, managed aquifer recharge, public open space and exempt use.

2 The department reviewed allocation limits again in 2011 to account for reduced rainfall, and also in 2014 for subareas in the North West Urban Growth Corridor.

3 Public water supply information is from both the Water Resources Licensing System and annual reports submitted to the department as a condition of the Water Corporation's licences.

4 Where groundwater is 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 when allocation limits are reviewed for the next Gnangara groundwater allocation plan.

5 Private licensed entitlement data is sourced from the department's Water Resources Licensing System (2015–16 report run on 1 July 2016, 2016–17 report run on 1 June 2017). The report was run earlier in 2017, due to timing of upgrades to the licensing and reporting systems.

- 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 and Environmental Regulation is required to comply with from *Ministerial statement no. 819* are outlined in Appendices A and B (the 'audit tables').

5.1 Compliance with water level criteria

Ministerial statement no. 819 sets water level criteria at 30 sites across the Gnangara Mound (Figure 1). 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 indicator for compliance from year to year
- levels allowed to fall between a preferred minimum and the absolute minimum in two out of 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.

The number of sites non-compliant with absolute minimum or peak water level criteria decreased from 18 in 2015–16 to 16 in 2016–17. Water levels at Lake Jandabup and Lexia 86 increased above their absolute minimum criteria (Table 4).

The management and mitigation actions we implement in response to non-compliance are described in Section 6. Details for individual sites can be found in the 'audit tables' in Appendix A.

Table 4 Summary of non-compliance with Ministerial criteria for the Gnangara Mound

Year	Non-compliant sites[1]				
	Absolute minimum or peak water level criteria			Other water level criteria	
	Wetlands	Terrestrial vegetation	Total non-compliant	Wetlands	Total non-compliant
2015–16	Loch McNess Lake Yonderup Lake Mariginiup Lake Jandabup Lake Nowergup Lake Wilgarup Pipidinny Swamp Lexia 86 Lexia 186 Melaleuca Park-EPP173 Melaleuca Park-Dampland 78	MM53 MM55B MM59B PM9 WM1 WM2 WM8	18 out of 30	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 86 Lexia 186 Melaleuca Park-Dampland 78	6 out of 8
2016–17	Loch McNess Lake Yonderup Lake Mariginiup Lake Nowergup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park-EPP173 Melaleuca Park-Dampland 78	MM53 MM55B MM59B PM9 WM1 WM2 WM8	16 out of 30	Lake Joondalup Lake Mariginiup Lake Nowergup Lexia 86 Lexia 186 Melaleuca Park-Dampland 78	6 out of 8

1 A site can be non-compliant with both absolute summer minimum and peak water level criteria but are only counted as one site. Also see Appendix A.

6 Environmental monitoring, management, research and consultation

6.1 Environmental monitoring

Expert environmental consultants undertake environmental monitoring for the department in line with the commitments in *Ministerial statement no. 819*. The monitoring program includes:

- 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, such as groundwater abstraction, fire, disease, and disturbance from changing land use. We use 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 reduced abstraction is likely to improve ecological condition. These programs provide a representative indication of the health of the system.

Wetland vegetation

In 2016–17 the condition of wetland vegetation was monitored in spring at the following Ministerial sites: Lake Jandabup, Loch McNess, Lake Yonderup, Lake Nowergup, Melaleuca Park EPP173, Lexia 86 and Lexia 186. Other environmentally important sites across the northern part of the Gnangara system not covered by Ministerial sites, such as the Yeal Nature Reserve, were also monitored. Details of this monitoring can be found in Buller et al. (2017).

Although groundwater levels improved at most sites since the previous year, the monitoring showed variable changes in vegetation health with:

- decreased canopy condition at Lake Yonderup associated with several *Melaleuca rhaphiophylla* deaths
- decreased canopy condition at Loch McNess associated with declines in health of *Melaleuca rhaphiophylla*
- increased canopy condition at Lake Nowergup due to improved health of *Eucalyptus rudis.*

Over the longer term most monitored wetlands show general declines in canopy condition and species similarity, and a general increase in exotic species cover and abundance.

The 2016–17 monitoring identified a number of wetlands where declining groundwater levels have contributed to declines in canopy condition of overstorey species, and/or the disappearance or decline in condition and abundance of some key wetland species. These wetlands include:

- Lake Nowergup – prolonged declines in maximum water levels have led to declines in native species such as the key wetland macrophyte *Baumea articulata* and poor health of *Melaleuca rhaphiophylla*.
- Lake Yonderup – water level declines have contributed to declining condition of *Melaleuca rhaphiophylla* and recent deaths of mature trees.
- Loch McNess – declines in groundwater levels and frequency of fire since 2004 have contributed to the recent disappearance of *Baumea articulat*a at the transect.

Wetland macroinvertebrates and water quality

The following sites were surveyed in 2016–17: Lake Goollelal, Lake Jandabup, Lake Joondalup, Loch McNess, Melaleuca Park EPP173, Lake Nowergup, Lake Yonderup, Lake Mariginiup, Lake Bambun and Lake Gnangara. For details refer to Judd and Horwitz (2017).

The monitoring identified that despite water level improvements at some sites, critically low water levels at Loch McNess, Lake Nowergup, Lake Yonderup, Lake Mariginiup, Lake Jandabup and Melaleuca Park EPP173 continue to contribute to:

- risk of acidification at Lake Jandabup and Lake Nowergup (though acididy results improved at both lakes compared to the previous year)
- degradation and loss of aquatic habitat at Loch McNess, Lake Nowergup, Lake Yonderup and Melaleuca Park EPP173
- changes in macroinvertebrate assemblages and loss of key taxa at Loch McNess and Lake Nowergup
- localised extinction of the native fish *Galaxiella nigrostriata* from Melaleuca Park EPP173.

Mound spring macroinvertebrates and water quality

Four springs along the edge of the Gnangara Mound were monitored in 2016–17: Egerton Spring, Edgecombe Spring, Gaston Rd Spring, and Sue's Spring (WRM 2017).

Increased peak groundwater levels in 2016 contributed to surface water flow improving at all sites since the previous year. Water quality at the springs was similar to recent years, with conductivity, dissolved oxygen, pH, and water temperature relatively stable, and of little ecological concern.

The springs continue to support highly diverse assemblages of aquatic and semi-aquatic invertebrates, including several rare, regionally endemic and/ or undescribed groundwater-dependent species.

Wetland frogs

Frog populations were monitored using trapping and aural surveys of calling males (Bamford & Everard 2017). At some sites a number of species have stopped calling for an extended period, suggesting that these populations have died out. Disappearances from wetlands relate mostly to declining hydroperiods, which can be related to declining groundwater levels. The disappearances are most marked at sites where the impact of falling groundwater has been greatest (e.g. Lexia 86 and Lexia 186).

The monitoring suggests that current groundwater regimes are not sufficient to maintain frog distributions. Unless groundwater levels rise, it is likely that the local distribution of some frog species will contract in the short term (3–5 years), with the greatest declines in the middle and north of the Gnangara area (Bamford & Everard 2017).

Frog assemblages remain intact at some of the urban wetlands, such as Lake Joondalup and Lake Goollelal, where groundwater levels have been relatively stable (Bamford & Everard 2017).

6.2 Management actions

In response to the level of non-compliance identified in this and previous reports, the department is implementing strategies to reduce abstraction towards a sustainable level and reduce impacts on environmentally important sites. Many of these strategies are outlined in the *Gnangara groundwater areas allocation plan* (DoW 2009a), which has been a key step in adjusting groundwater management in the context of a drier climate.

By implementing the Gnangara plan, we have:

- significantly reduced abstraction for public water supply
- increased licensing compliance and enforcement activities
- effectively capped abstraction for private licensed water supply.

We are using findings of our compliance monitoring and reporting to develop the next Gnangara groundwater allocation plan. The plan will include new strategies to return the system to balance and set lower allocation limits in line with the drying climate.

Managing public water supply use

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 public water supply is allocated. In line with the plan, we reduced the Water Corporation's groundwater allocations from the Gnangara and Jandakot systems from 145 GL to 120 GL per year from existing infrastructure. As part of the reduced allocation, the licensed volume from the Superficial and other aquifers was reduced in areas that most benefit water levels and ecological condition at non-compliant Ministerial sites.

Every water year we review the distribution of Water Corporation's entitlements based on compliance and water level trends. The aim is to further reduce the impacts of abstraction on Ministerial sites where water levels are or may become non-compliant with water level criteria.

Groundwater replenishment scheme

Increased recycling of Perth's wastewater resources is critical to meet increasing demands in our growing city without negative impacts to groundwater levels. The Beenyup Groundwater Replenishment Scheme was recently commissioned and will be able to supply 14 GL per year from 2018–19.

In response to the poor winter in 2015, the Water Corporation have brought forward planning for the next 14 GL expansion. This second stage of the scheme will bring production up to 28 GL per year.

Managing private licensed use

The department monitors private licensed use through on-ground compliance inspections, meter audits and water use surveys. Through this work we check that groundwater use is within licensed entitlements and that site activities are authorised.

Over the reporting period the department conducted compliance monitoring on 875 licences taking water from the Gnangara groundwater system. A total of 66 incidents of alleged non-compliance were detected, with 42 of these relating to alleged exceedance of annual water entitlements. The department's response to these alleged non-compliances ranged from educational letters and warning notices, to statutory direction and infringement notices.

When prioritising our licence compliance and enforcement activities we considered the conditions and commitments set in *Ministerial statement no. 819*. This included expanding the scope of our licensing compliance plan to include areas potentially affecting non-compliant Ministerial sites.

The department also manages groundwater used by private licensees in other ways, by continuing to work with:

- local governments, urban developers, and other licensees that use large volumes, to improve water use efficiency, reduce demand for groundwater, and assess water needs and supply options
- Water Corporation on the Waterwise Council program which began in 2009 and continues to grow with around 80 per cent of councils now participating in the program
- 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.

Managing groundwater use exempt from licensing

Responsible and efficient use of domestic garden bores as a fit-for-purpose source of water helps reduce use of highly treated, valuable scheme water for irrigation of lawns and gardens. It not only reduces pressure on the scheme, but spreads and minimises the impacts of water abstraction that would otherwise come from scheme borefields.

Domestic garden bores are managed through permanent sprinkler restrictions including a three-day-week roster, a daytime sprinkler ban, and a total winter sprinkler ban. In addition to enforcing sprinkler restrictions, the Department of Water and Environmental Regulation guides where new bores can be installed without increasing the risk of impacting on groundwater quality or on environmentally sensitive areas such as wetlands. Further information on garden bore suitability can be found on the Perth Groundwater Map on the department's website.

Updating the 2009 Gnangara groundwater areas allocation plan

We are now preparing the next groundwater allocation plan which will include new sustainable allocation limits. The plan aims to achieve a productive and sustainable groundwater supply and a healthy environment under a continuing drying climate. To develop the plan we are working with water users to identify groundwater recovery pathways that minimise impacts on people and businesses.

Our key stakeholders have been working with us for many years to adapt water use to a drying climate and growing population. Over the last year our engagement with key water use sectors has increased significantly as we build a pathway to recovery. Key stakeholders include the Water Corporation, the horticultural industry including peak representative bodies, environmental groups, and a number of local and state government agencies. We expect to have the next Gnangara groundwater allocation plan ready for public comment in 2018.

Strategic Assessment of the Perth and Peel region

Work is continuing on the Strategic Assessment of the Perth and Peel region, released in December 2015 as the draft Green Growth Plan. A major focus of this work is to ensure that the strategic assessment maximises the transformative effect of METRONET on the Perth and Peel regions. Work is also being undertaken to refine post-pine harvesting scenarios in the Gnangara, Yanchep and Pinjar plantations to optimise water and conservation outcomes. Release of a revised draft for public consultation is planned for the first half of 2018, subject to further government decision-making.

6.3 Research initiatives

The department, together with research partners, is completing a number of major projects that are helping us develop the next Gnangara groundwater allocation plan, and help focus management effort on the areas that will show the most benefit from changes to abstraction.

Perth Regional Aquifer Modelling System

The department is using the recently updated Perth Regional Aquifer Modelling System (PRAMS) to examine the interactions between climate, land use and groundwater abstraction for the next Gnangara groundwater allocation plan. The current focus of modelling is examining how different abstraction and land use scenarios will affect water levels, water users, and environmental values over the period to 2030.

In a three year research partnership with the Water Corporation and the University of Western Australia PRAMS is being used as a case study, and will provide improved modelling tools to aid future allocation decision making.

Future climate tool

The department has developed a future climate tool that helps us better predict rainfall in our drying climate. The peer-reviewed tool was built using global climate models that perform well in Western Australia. It provides robust, up-to-date, and defensible climate science for our decision making. A report outlining how we developed the climate tool is available on the department's website – Selection of future climate projections for Western Australia (DoW 2015b). We are using the climate tool in PRAMS modelling to develop the next Gnangara allocation plan.

Perth Region Confined Aquifer Capacity project

One of the goals of the department's $7 million Perth Region Confined Aquifer Capacity project was to optimise the way we take water from the Gnangara system, including new locations to draw water from deep aquifers that have less impact on the system.

The recently completed four-year study included research partnerships with Curtin University and the University of Western Australia, and contributed to updating and using PRAMS.

The study started with several data collection programs covering over 7000 square kilometres of the Perth region using geophysical equipment mounted to planes and helicopters. More detailed investigative work followed, including seismic surveys, drilling groundwater monitoring bores up to 900 metres deep, and processing geophysical data using the Magnus Cray supercomputer at the Pawsey centre.

The department and the Water Corporation are using the new model to assess the best locations for reinjecting recycled water to help recharge the system.

The department is also continuing work to better understand the deep aquifers of Gnangara with a State Groundwater Investigation Program funded drilling underway at Kings Park to examine the vertical connection of the deeper aquifers with the Superficial aquifer in the area.

Smarter solutions for recycled water

In an uncertain climate, we must be smart about how we use our finite supplies of water. Recycled water that has been suitably treated may be an option where no more groundwater is available.

In response to reduced groundwater availability and local salinity issues, the Western Suburbs Regional Organisation of Councils is investigating new ways of using recycled water to irrigate parks and public open space either directly from the treatment plant or to 'top up' the Superficial aquifer for reuse later.

The department is also partnering with the Housing Authority, the City of Swan and consultants to develop a water supply solution for the Housing Authority's Brabham subdivision, a water-sensitive precinct in Perth's north-east. Brabham is a proposed 220-hectare, 3000 residential lot development planned for where groundwater is fully allocated. The partners are currently investigating recycled water and managed aquifer recharge. Prefeasability modelling is underway and an aerial electromagnetic survey is planned to help map out connectivity between the Superficial and Leederville aquifer in the area.

6.4 Consultation

During the last yaer t here has been extensive consultation with stakeholders over the development of the next Gnangara groundwater allocation plan 2018-2030 over the last year. We have focussed on working with the actual water users, their industry reference groups and other government agencies to find practical pathways to bring the system back into balance and prepare for a future with less groundwater availability.

We regularly consult with the Water Corporation as well as private licensees such as local councils and growers in the Swan Valley, North Wanneroo and Gingin areas, and their various grower associations.

We have also engaged with environmental groups, such as Urban Bushland Council, the Conservation Council, and other government agencies such as Department of Planning to share information and align planning objectives.

Appendices

Appendix A – Water level monitoring results for Ministerial sites on the Gnangara Mound for 2006–2017

Bold text refers to compliance with water level criteria and other criteria, with **black bold text** for compliant sites and **red bold text** for non-compliant sites.

Table A 1 Wetland sites

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)											Comments on compliance during the reporting period (1 July 2016 – 30 June 2017)
		Spring peak		End of summer minimum													
		Pref	Abs	Pref	Abs		2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	
Lake Goollelal	6162517			26.2*	26.0	Max	27.3	27.2	27.4	27.4	27.2	27.1	27.2	27.3	27.2	27.1	27.3	Compliance: **Compliant with absolute summer minimum and other criteria.**
						Min	26.6	26.5	26.7	26.6	26.4	26.5	26.5	26.5	26.6	26.4	26.8	
Loch McNess	6162564				6.95	Max	7.02	6.94	6.85	6.80	6.64	6.43	6.40	6.39	6.25	6.25	6.25	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The lake has been non-compliant since 2002–03 and lake levels have fallen rapidly since 2006. The staff gauge at the lake is now dry. 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. The minimum groundwater level at the bore did not meet the minimum groundwater requirement of wetland vegetation over the reporting period and declined over the period. 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 the Loch McNess report (DoW 2011a). Building on this work, the department completed a study into the cause of rapidly declining levels in Loch McNess (Kretschmer & Kelsey, 2016. This study improved our understanding of the hydrogeology of the lake and surrounding areas, including the Yanchep caves nearby. Based on the findings of the study the department has: • reduced Superficial aquifer abstraction in the Yanchep National Park • ceased the Yanchep caves supplementation trial • reduced public supply abstraction from the Leederville aquifer in the Pinjar borefield. The department updated allocation limits in the Superficial aquifer along the North West coastal corridor in 2014, considering compliance and ecological condition at Loch McNess.
						Min	**6.74**	**6.63**	**6.61**	**6.45**	**6.25**	**6.17**	**6.10**	**6.25**	**6.25**	**6.07**	**6.25**	
Lake Yonderup	6162565				5.9	Max	6.0	5.9	5.9	5.9	5.9	5.9	5.8	5.8	5.8	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 water level in 2015–16 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 over the reporting period. The department updated allocation limits in the Superficial aquifer along the North West coastal corridor in 2014, considering compliance and ecological condition at Lake Yonderup.
						Min	5.9	**5.8**	**5.8**	**5.8**	**5.7**	**5.7**	**5.6**	**5.6**	**5.6**	**5.5**	**5.6**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)											Comments on compliance during the reporting period (1 July 2016 – 30 June 2017)
		Spring peak		End of summer minimum													
		Pref	Abs	Pref	Abs		2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	
Lake Joondalup	6162572 (Staff 8281)			16.2*	15.8	Max	16.9	16.8	17.0	17.0	16.8	16.8	16.8	17.1	17.0	16.9	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 2014–15 was above the preferred minimum for the first time since 2005–06. The staff gauge dries at around 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 upgradient 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 increased over the reporting period. 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	16.0 **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**	16.3 **4/6yr**	16.1 **4/6yr**	16.5 **4/6yr**	
	61610661 (Bore 8281)					Max	18.5	18.5	18.7	18.9	18.7	18.6	18.6	19.0	18.9	18.7	19.0	
						Min	17.8	17.9	18.1	18.3	17.9	18.0	18.0	18.2	18.3	18.1	18.5	
Lake Mariginiup	6162577 (Staff 1943)	42.1*	41.5			Max	**41.4**	**41.4**	41.5	41.5	**41.3**	**41.2**	**41.1**	**41.3**	**41.3**	**41.1**	**41.4**	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. **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 to wetland vegetation condition. Detailed findings and recommendations from the investigation can be found in Searle et al. (2010). 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 and 2014–15. As part of developing the next Gnangara allocation plan, the department will consult with the OEPA to amend the water level criteria at this site by considering findings from Searle et al. (2010a).
						Min	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**	41.0 **4/6 yr**	41.0 **4/6 yr**	41.0 **4/6 yr**	
	61610685 (Bore MS10)					Max	41.1	41.0	41.3	41.1	40.8	40.9	40.8	41.0	41.2	40.8	41.1	
						Min	40.0	40.2	40.2	40.2	40.0	40.1	40.1	40.1	40.2	40.0	40.4	
Lake Jandabup	6162578 (Staff 1944)	44.7*	44.2		44.3	Max	44.6	44.7	44.8	44.8	44.5	44.7	44.6	44.7	44.7	44.6	44.7	Compliance and trends: **Compliant with absolute spring peak criterion.** **Compliant with absolute summer minimum criterion.** 2016–17 was the first time the site has been compliant with water level criteria since 2008–09. The Water Corporation supplements lake levels aim to meet the absolute spring peak water level criterion and to prevent the lake from acidifying. Although non-compliant since in most years, levels have been relatively stable and the supplementation has been relatively successful in preventing it from 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 remained relatively stable over the reporting period.
						Min	**44.2**	**44.1**	44.3	**44.2**	**44.1**	**44.2**	**44.1**	**44.2**	**44.2**	**44.1**	44.3	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)											Comments on compliance during the reporting period (1 July 2016 – 30 June 2017)
		Spring peak		End of summer minimum													
		Pref	Abs	Pref	Abs		2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17
Lake Nowergup	6162567 (Staff)	17.0*	16.8			Max	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**	**16.0 4/6yr**	**16.0 4/6yr**	**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 supplemented by the department. **Non-compliant with other criterion.** Management and mitigation: From work completed as part of the Perth shallow groundwater systems investigation, Searle, Hammond and Bathols (2010) recommends to: • continue the supplementation regime • revise the spring peak criteria to 16.2 mAHD, which should done gradually from the 2009 peak of 16.5 mAHD • use groundwater levels at bore LN2-89 (AWRC ref. 61611247) to relate changes in the watertable to wetland vegetation condition. Despite continued supplementation, lake levels have fallen in recent years. In response, we reviewed how the Water Corporation's licences for 2013–14 and 2014–15 are distributed and made changes that aim to further reduce abstraction impacts at the site. As part of developing the next Gnangara allocation plan, the department will consult with the OEPA to amend water level criteria at this site. We are using bore LN2-89 to better relate groundwater levels to condition of wetland vegetation. Minimum levels at bore LN2-89 have been declining since 2009 but stabilised over the reporting period. We updated allocation limits in the Superficial aquifer along the North West coastal corridor in 2014, considering compliance and ecological condition at Lake Nowergup.
						Min	16.1	16.5	16.2	16.0	16.0	15.9	16.0	16.0	16.0	16.0	16.0	
Lake Wilgarup	6162623 (Staff)	6.10	5.65	4.8	4.5	Max	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	**6.00 dry**	Compliance and trends: **Non-compliant with absolute spring peak criterion.** The lake has been dry since 1998. **Non-compliant with absolute summer minimum criterion.** Groundwater levels have declined since 1998 and have been non-compliant with the absolute minimum criteria since 2006–07. Management and mitigation: We updated allocation limits in the Superficial aquifer along the North West coastal corridor in 2014, considering compliance and ecological condition at Lake Wilgarup.
						Min												
	61618500 (Bore)					Max	4.88	4.77	4.77	4.64	4.47	4.38	4.31	4.41	4.29	4.21	4.34	
						Min	**4.34**	**4.18**	**4.08**	**4.02**	**3.80**	**3.84**	**3.83**	**3.82**	**3.79**	**3.66**	**3.88**	
Pipidinny Swamp	6162624 (Staff)	2.70	2.40		1.6	Max	**2.3**	**2.1**	**2.1**	**2.0**	**2.0**	**1.6**	**1.8**	**2.2**	**1.9**	**1.6**	**2.0**	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** We could not confirm compliance with the absolute summer minimum criteria from 2004 to 2010 because levels below 2.0 mAHD could not be measured at the staff gauge at the swamp. In 2010, we fixed an extra staff gauge plate to measure to 1.0 mAHD and any non-compliance. The swamp was incorrectly reported as compliant in 2009–10 and 2010–11 in previous compliance reports because of this issue. 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 been relatively stable at the bore since it was installed in 2009. We updated allocation limits in the Superficial aquifer along the North West coastal corridor in 2014, considering compliance and ecological condition at the swamp.
						Min	2.0	2.0	2.0	**1.3**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	
Lexia 86 (GNM16)	61613215			47.3*	47.0	Max	48.1	48.2	48.4	48.2	47.7	47.9	47.6	47.8	47.7	47.3	47.7	Compliance and trends: **Compliant with absolute summer minimum.** 2015–16 was the first year that the site was non-compliant with absolute summer minimum water levels. **Non-compliant with other criterion.**
						Min	47.4	47.4	47.3	47.3	47.1	47.2	47.0	47.0 **4/6yr**	47.0 **4/6yr**	**46.9 4/6yr**	47.1 **4/6yr**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)											Comments on compliance during the reporting period (1 July 2016 – 30 June 2017)
		Spring peak		End of summer minimum													
		Pref	Abs	Pref	Abs		2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	
Lexia 186 (GNM15)	61613214			47.5*	47.2	Max	47.5	47.5	47.6	47.5	47.0	47.1	46.9	47.2	47.1	46.7	47.0	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. The spring peak in 2015–2016 was the lowest on record. **Non-compliant with other criterion.** Water levels have not reached the preferred summer minimum water level criteria since 1995. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that poor water quality is potentially the most immediate threat to the wetland (DoW 2011c).
						Min	**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**	**46.5 4/6yr**	**46.3 4/6yr**	**46.5 4/6yr**	
Melaleuca Park EPP173	6162628 (Staff)				50.2	Max	51.0	51.1	51.0	51.0	50.5	50.7	50.6	50.9	50.7	50.4	50.8	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant with absolute summer minimum criterion since1995. The spring peak in 2015–2016 was the lowest on record. Water levels were still declining as of June 2017. Management and mitigation: As part of the transition to 120 GL per year for the Integrated Water Supply Scheme in 2012–13, the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to the crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area, including Melaleuca Park EPP173. We also review public water supply abstraction annually, considering water level trends and criteria compliance.
						Min	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	50.4	
	61613213 (Bore GNM14)					Max	50.3	50.7	50.9	50.5	49.5	50.0	49.7	50.3	50.1	49.3	50.2	
						Min	**48.9**	**49.1**	**48.9**	**48.9**	**48.6**	**48.8**	**48.7**	**48.8**	**48.7**	**48.5**	**# 49.0**	
Melaleuca Park Dampland 78 (GNM31)	61613231			65.4*	65.1	Max	65.9	66.0	66.0	65.9	65.5	65.3	65.2	65.3	65.2	64.9	65.1	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The site received very little recharge in 2015–16 and 2016-17 and the minimums were the lowest on record. **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	65.5	66.0	65.6	65.5	65.1	65.1	**64.9**	65.1 **4/6yr**	**64.9 4/6yr**	**64.7 4/6yr**	**64.7 4/6yr**	
Egerton Spring (B25)	61618607				39.29	Max	39.7	40.03	40.22	40.15	40.01	40.05	40.04	40.17	40.12	39.97	40.10	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 localised recharge associated with the surrounding urban development.
						Min	39.50	39.54	39.72	39.72	39.49	39.70	39.69	39.73	39.79	39.58	39.84	

* Water levels are allowed to fall between the preferred minimum and absolute minimum for two out of six years to replicate natural drying cycles.

The minimum water level reported is the minimum water level recorded during the 2015–16 water year. As of June 2016, water levels were still declining.

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 reporting period (1 July 2016 – 30 June 2017)
				2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	
MM16	61610835	38.8	Max	39.4	39.4	39.8	39.9	39.4	39.6	39.6	40.1	40.2	40.1	40.3	Compliance: **Compliant with absolute summer minimum criterion.**
			Min	**38.6**	38.8	39.0	39.0	**38.6**	38.9	39.0	39.2	39.5	39.3	39.5	
MM18	61610918	38.6	Max	39.4	39.3	40.0	39.8	39.3	39.5	39.6	39.9	40.0	39.6	40.0	Compliance: **Compliant with absolute summer minimum criterion.**
			Min	38.6	38.8	39.0	39.0	38.7	38.9	39.0	38.6	39.2	39.1	39.2	Water levels have shown a rising trend since 2011 and have stabilised over the past couple of years.
MM53	61610493	33.3	Max	33.8	33.9	34.1	33.9	33.3	33.8	33.6	34.0	34.0	33.5	33.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Minimum levels have generally declined since 2005 but have stabilised since 2011. Management and mitigation: As part of the transition to 120 GL per year allocation for the Integrated Water Supply Scheme 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 also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	**33.1**	**33.2**	**33.1**	**33.0**	**32.8**	**33.0**	**33.0**	**32.8**	**33.1**	**32.9**	**33.1**	
MM55B	61610559	29.5	Max	30.3	30.6	31.0	30.8	30.1	30.3	30.3	30.5	30.5	30.3	30.4	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Minimum levels have stabilised since 2011.
			Min	**29.4**	**29.4**	**29.4**	**29.3**	**29.0**	**29.3**	**29.2**	**29.2**	29.7	**29.2**	**29.4**	
MM59B	61611025	36.3	Max	36.2	36.4	36.8	36.6	36.0	36.1	36.2	36.3	36.3	36.0	36.1	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have generally declined since 2000 but seem to have stabilised since 2011. Water levels were still declining as of June 2017. Management and mitigation: As part of the transition to 120 GL per year allocation for the Integrated Water Supply Scheme 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 also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	**35.6**	**35.8**	**35.8**	**35.7**	**35.3**	**35.5**	**35.5**	**35.5**	**35.6**	**35.4**	**# 35.5**	
MT3S	61610745	43.0	Max	44.6	44.7	44.9	44.8	44.3	44.4	44.2	44.6	44.5	44.3	44.6	Compliance and trends: **Compliant with absolute summer minimum criterion.**
			Min	43.7	43.9	44.0	43.9	43.5	43.6	43.5	43.7	43.7	43.6	44.0	Water levels have generally declined since 1992 but seem to have stabilised since 2011.
NR6C	61610982	58.5	Max	59.7	59.7	60.0	60.1	59.9	59.7	59.3	59.7	59.5	59.1	59.5	Compliance: **Compliant with absolute summer minimum criterion.**
			Min	59.1	59.1	59.2	59.4	58.9	59.0	58.7	58.9	59.0	58.7	58.8	Water levels have generally declined since 1992 and the minimum levels in 2015–16 and 2016–17 were the lowest on record.
PM9	61610804	56.3	Max	56.4	56.3	56.1	55.9	55.9	55.0	54.8	55.0	54.7			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. Water levels were still declining as of June 2016. The bore is not currently being monitoring due to safety issues associated with its location in a rifle range. We are looking to resolve this issue by installing a logger at the bore and monitoring it remotely. Maintenance in 2016 also impacted on water levels recorded at the site. Management and mitigation: As part of the transition to 120 GL per year allocation for the Integrated Water Supply Scheme in 2012–13, the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to the crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area, including PM9. We also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	**56.0**	**55.8**	**55.6**	**55.4**	**54.9**	**54.8**	**54.4**	**54.3**	**54.1#**	**51.8**		
PM24	61610697	40.5	Max	42.4	42.7	43.0	42.5	42.1	42.4	42.0	42.1	42.3	42.1	42.2	Compliance: **Compliant with absolute summer minimum criterion.**
			Min	41.2	41.3	41.2	41.2	41.0	41.1	41.1	41.1	41.3	41.0	41.4	Water levels have generally declined since 1998 but have stabilised since 2011.

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)	Water levels (mAHD)											Comments on compliance during the reporting period (1 July 2016 – 30 June 2017)
				2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	
WM1	61610833	55.7	Max	55.6	55.6	55.7	55.4	54.8	54.8	54.4	54.7	54.4	54.5	55.1	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 transition to 120 GL per year allocation for the Integrated Water Supply Scheme in 2012–13, the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to the crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area, including WM1. We also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	**55.0**	**55.0**	**54.9**	**54.8**	**54.4**	**54.3**	**54.1**	**54.2**	**54.1**	**54.1**	**54.3**	
WM2	61610908	66.5	Max	67.6	67.5	67.6	67.5	66.9	66.8	66.4	66.7	66.5	66.6	67.2	Compliance and trends: **Compliant with absolute summer minimum criterion.** Water levels have been non-compliant since 2011–12. In 2013–14 recharge occurred at this site for the first time in two years. Management and mitigation: As part of the transition to 120 GL per year allocation for the Integrated Water Supply Scheme in 2012–13, the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to the crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area, including WM2. We also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	67.1	67.0	66.9	66.9	66.5	**66.4**	**66.1**	**66.2**	**66.1**	**66.3**	**66.4**	
WM8	61610983	64.8	Max	65.5	65.4	65.5	65.4	65.5	64.9	64.7	65.0	64.8	64.3	64.7	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. This site recorded no recharge in 2015–16. Water levels were still declining as of June 2017. Management and mitigation: As part of the transition to 120 GL per year allocation for the Integrated Water Supply Scheme in 2012–13, the department worked with the Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields located close to the crest of the Gnangara Mound. This aimed to reduce abstraction impacts at sites in the area, including WM8. We also review public water supply abstraction annually, considering water level trends and criteria compliance.
			Min	65.1	65.1	65.1	65.1	**64.7**	**64.7**	**64.4**	**64.7**	**64.3**	**64.1**	**64.1**	
MM12	61610989	42	Max	43	43	43	43	43	43	43	43	43	43	43	Compliance and trends: **Compliant with absolute summer minimum criterion.** Levels have risen since 2011.
			Min	42	42	43	43	42	42	43	43	43	43	43	
L30C	61611010	47.2	Max	48.4	48.6	48.7	48.9	48.1	48.2	47.8	47.9	48.0	47.7	47.9	Compliance: **Compliant with absolute summer minimum criterion.** Levels have generally fallen since 2005. The site received very little recharge in 2015–16. Water levels were still declining as of June 2017 and are approaching the minimum criteria.
			Min	48.0	48.0	48.2	48.1	48.0	47.7	47.5	47.5	47.7	47.3	# 47.3	
L110C	61611011	55.7	Max	57.8	57.7	57.8	57.7				57.4	57.6	57.4	57.6	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 because of a blockage. Water levels were still declining as of June 2017 and are approaching the minimum criteria.
			Min	57.3	57.2	57.5	57.5				57.1	57.3	57.1	# 57.1	
L220C	61611018	52.2	Max	53.7	53.7	53.5	53.6	52.8	53.2	52.8	53.1	53.9	53.4	53.8	Compliance: **Compliant with absolute summer minimum criterion.** Levels have generally fallen since 1991 and the 2015–16 was the lowest on record. Water levels were still declining as of June 2017 and are approaching the minimum criteria.
			Min	53.1	52.7	52.6	52.6	52.3	52.4	52.1	52.3	53.1	52.8	# 53.1	

The minimum water level reported is the minimum water level recorded during the 2015–16 water year. As of June 2016, water levels were still declining.

Note: 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.

Appendix B — Audit tables: Environmental conditions, procedures and commitments for the Gnangara groundwater resources

Proponent: Department of Water

Period: 1 July 2016 to 30 June 2017

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 most Ministerial conditions – refer to the 'status' column of this table. Further amendments are likely to be proposed in the next Gnangara groundwater 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 most proponent commitments – refer to the 'status' column of this table.
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.**

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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: • evidence of compliance with the conditions and commitments.	Detail in annual/triennial reports. Compliance report will include: evidence of compliance with the conditions and commitments.	Audit program	CEO		Overall	Annually	**Compliant.** Summarised in sections 5 and 6 of this report and the 'status' column of this table.
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: • the performance of the environmental management plans and programs.	Detail in annual/triennial reports. Compliance report will include: 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 second evaluation statement was recently completed (DoW 2015a). The statement evaluates the department's management of Gnangara groundwater resources and against the Gnangara plan objectives between 2011–2014. The evaluation statement is available on the department's website. 2. Work has started on the next Gnangara groundwater allocation plan which will include new strategies to work towards meeting the following objectives: • reduce the total volume of water abstracted from the Gnangara system towards a level that better reflects the recharge from rainfall under the drying climate • protect groundwater-dependent ecosystems from 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: • compliance with the conditions.	The performance review will address: 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 this table.
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: • the achievement of environmental objectives set for the proposal.	The performance review will address: 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 table.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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: • 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: 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 responded to issues raised by the public to finalise the plan and how we are working towards managing these issues in implementing the plan. Gnangara plan evaluation statements were completed in 2013 and 2015 (DoW 2013b; DoW 2015a). These statements evaluate the department's management of Gnangara groundwater resources against the Gnangara plan objectives since its release. The evaluation statements are 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: • proposed environmental management over the next three years to comply with conditions and environmental objectives set for the proposal.	The performance review will address: 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.** Sections 6.2 and 6.3 describes the management actions and research initiatives the department is doing to limit impacts of abstraction on groundwater-dependent ecosystems.
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 and Environmental Regulation 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 haven't been formally audited or commented on but 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 2013a) • 2012–13 annual (DoW 2014a) • 2013–14 annual (DoW 2014b) • 2012–15 triennial (DoW 2016) • 2015–16 annual (DoW 2017).
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 reports regularly to the OEPA on non-compliance with criteria water levels and other criteria.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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 department used the concept of sustainable yield and PRAMS modelling to calculate 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 because recharge has decreased since the plan was released. We will reassess allocation limits for Gnangara resources as part of the next Gnangara groundwater 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 department's water licensing policies are the 'basis for groundwater management decisions'. We regularly review these policies, which is detailed in the policies (e.g. state-wide policies are reviewed every 5 years). The *Gnangara groundwater areas allocation plan* provides the foundation for water allocation decisions on the Gnangara Mound. We have evaluated the Gnangara plan twice (DoW 2013b; DoW 2015a). These statement evaluate the department's management of Gnangara groundwater resources against the Gnangara plan objectives since its release. The evaluation statements are available on the department's website. The draft *Gnangara sustainability strategy* (Government of Western Australia 2009b) shows how other factors (e.g. land uses) relate to 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 haven't been formally audited or commented on but 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 2013a) • 2012–13 annual (DoW 2014a) • 2013–14 annual (DoW 2014b) • 2012–15 triennial (DoW 2016) • 2015–16 annual (DoW 2017).

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*, adding the Southern Seawater Desalination Plant to the Integrated Water Supply Scheme triggered a change in how we allocate groundwater for public water supply. 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 per year (from existing infrastructure). The Water Corporation is committed to achieving an average abstraction of 120 GL per year over the five year licence period from 2012–13 to 2016–17. The department works with the Water Corporation annually to distribute abstraction to limit impacts at groundwater-dependent ecosystems. We will also review public water supply allocations in developing 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*). Sections 6.2 and 6.3 describe the management and research initiatives the department is doing 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.dwer.wa.gov.au/maps-and-data/maps/water-register>
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.dwer.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.dwer.wa.gov.au/maps-and-data/maps/water-register>

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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.** Consistent with the *State Water Plan* (Department of Premier and Cabinet 2007), and after extensively consulting with the mining and irrigation industries and 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 do 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 work with the City of Wanneroo and developers to reduce planned water use in the North West Urban Growth Corridor and develop a water supply strategy (DoW 2014c). Section 6.2 discusses the department's approach to allocating groundwater for public water supply and other initiatives that aim to reduce demand on the Gnangara groundwater resources and increase water use efficiency.
819: M 10-1 1	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: 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. We have run a number of scenarios using future climate datasets (developed using the department's future climate tool), to examine the impact of the drying climate on groundwater levels. This work will inform our review of allocation limits as part of the next Gnangara allocation plan.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 10-12	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: improvement in the understanding of the relationship between groundwater levels and vegetation, including plantations.	Compliance report	Minister for the Environment	EPA/ DPaW	Overall		**Compliant.** As part of the Strategic Assessment for the Perth-Peel regions, the department has used the Perth Regional Aquifer Modelling System to simulate groundwater levels under various pines, land use and climate scenarios. The results informed the Draft Strategic Conservation Action Plan released for public comment in 2016. Through the Perth shallow groundwater system investigations we have improved our understanding of the interrelationships between wetlands and the Superficial aquifer and the complex, superimposed impacts of climate change, land use and abstraction. We are using the investigation's outcomes 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 for the next Gnangara allocation plan. Several other studies have improved our understanding of the relationships between groundwater levels and vegetation, including: • 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 10-13	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: 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.** The department is using PRAMS modelling to improve the understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gnangara system. Reductions to both public and private abstraction are being modelled to evaluate storage gains in the Superficial aquifer at 2030. These scenarios will inform an allocation limit review as part of the next Gnangara allocation plan. The department began the four-year Perth Regional Confined Aquifer Capacity project in 2012. The project is investigating the best locations and depth for sustainable abstraction from the Leederville and Yarragadee aquifers and for groundwater replenishment (or managed aquifer recharge). 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 the investigation's outcomes to limit abstraction impacts on groundwater-dependent ecosystems.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: M 10-14	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: 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 studies hydrogeology at a number of sites across the Gnangara Mound as part of the Perth shallow groundwater systems investigation. To date, ten 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 have been constructed and used for scenario modelling for the following areas: • 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 10-15	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: 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.** Water quality and macroinvertebrate monitoring in the Yanchep caves ceased in 2013–14 because of low water levels. Building on the work of the shallow groundwater system investigation, the department recently completed a study on the cause of rapidly declining levels in Loch McNess in Yanchep National Park (Kretschmer and Kelsey 2016). This study improved our understanding of the hydrogeology of Loch McNess and surrounding areas, including the nearby caves. We continue to monitor groundwater levels in relation to cave levels and have made management changes that aim to improve levels in the caves (see section 6).
819: M 10-16	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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: 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 is a prime responsibility of the DPAW. The department does 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 (Department of Water).
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 (Department of Water).

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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 was obtained as part of the comprehensive, interagency network that formed part of the draft *Gnangara Sustainability Strategy*. Also, both the DEC and FPC 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 The proponent's (Department of Water) 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 sites on the Gnangara Mound, 2000–2017.
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.** Gnangara plan evaluation statements were completed in 2013 and 2015 (DoW 2013b; DoW 2015a). These statement evaluate the department's management of Gnangara groundwater resources against the Gnangara plan objectives since its release. The evaluation statements are 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 2008c) and confirmed in *Ministerial Statement No. 819*. The department will review allocation limits of Gnangara resources for 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 most caves are now dry. Also, we can no longer gain access to a number of the caves above because of 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 study on the cause of rapidly declining levels in Loch McNess in Yanchep National Park (Kretschmer and Kelsey 2016). Working with DPAW, the department has reduced local abstraction in the Yanchep National Park and has also made changes to public water supply abstraction to limit impacts on the caves (see section 6).
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.** In 2009 the department finalised the Swan *Urban Growth Corridor drainage and water management plan* (DoW 2009e), which provide guidance on drainage management in the area. See the department's website for more information.

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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, together with research partners, is focussing management effort on the areas that will show the most benefit from changes to abstraction. This work will inform the next Gnangara allocation plan. • The department has updated the Perth Regional Aquifer Modelling System. • The department began the four-year Perth Regional Confined Aquifer Capacity project in 2012. The project is investigating the best locations and depth for sustainable abstraction from the Leederville and Yarragadee aquifers and for groundwater replenishment (or managed aquifer recharge). • The Perth shallow groundwater system investigation is complete with reports available on the department's website. These studies improved our 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 Gnangara allocation plan, we will use a tool developed by Edith Cowan University to assess the risk of impacts 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 that the commitment could be 'cleared' upon confirmation from the DEC.
819: P 5 2	Research and investigation program	Administrative	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, to promote the sustainable use of the groundwater resources of the Gnangara system.
819: P 5 3	Research and investigation program	To provide for ongoing up-to-date adaptive management.	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 modelling of climate, land use and abstraction scenarios using the Perth Regional Aquifer Modelling System and the Perth Regional Confined Aquifer Capacity project.
819: P 6 1	Environmental monitoring program	To enable evaluation of the environmental impact of groundwater abstraction from the Gnangara Mound (Superficial aquifer).	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 the 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 previous environmental monitoring program was produced and submitted to the EPA on 21 December 2005. It was detailed in Appendix 7 of the 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 this requirement has been satisfied technically (the monitoring program was prepared), the department does not seek a 'clearance' of this commitment as the program is constantly evolving and being modified.
819: P 6 2	Environmental monitoring program	Administrative	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)

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
819: P 6 3	Environmental monitoring program	To provide for ongoing up-to-date adaptive management.	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 completed in June 2009 with the ecologists who do the monitoring. We made a number of amendments. A letter was sent to the Director General of the DEC in December 2009, seeking advice and input on the amendments. To date, no response has been received. Although the action states that a review must be compiled 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. The department will review environmental objectives and monitoring as part of developing 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 that are referred to it from local and state government agencies.
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 no formal Gnangara Consultative Committee, the department continues to consult with a range of stakeholders on Gnangara as required. To develop the next Gnangara allocation plan, we've begun discussing with water users how to adjust to a drier climate, with the aim to rebalance the groundwater system by 2030.
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.** The department has classified the sensitivity of each public water supply bore based on proximity to environmentally sensitive areas. We use these classifications to distribute public supply abstraction to limit impacts at groundwater-dependent ecosystems. In 2012–13 the department 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).

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ Where	Status
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.** The department requires and review annual bore abstraction plans from the Water Corporation to ensure that abstraction was distributed to limit impacts on groundwater-dependent ecosystems. The Water Corporation also submits annual water monitoring summaries that report 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 the former Department of Environmental Protection's Environmental Audit Branch on 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 based on ecological significance, management issues and geomorphic setting. As part of the investigation, we redesigned and upgraded 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 discussed this issue with the Water Corporation. Consistent with the study on 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 Water Corporation have agreed to review and develop an environmental benefit program to offset the impacts seen on wetlands in the next phase of planning for the Gnangara Mound.

Appendix C – History of Ministerial statements for the Gnangara Mound

The importance of managing abstraction from the Gnangara Mound to protect groundwater-dependent ecosystems was formally recognised in the late 1980s. The Environmental Protection Authority (EPA) proposed conditions on Gnangara groundwater abstraction in 1986 when the *Gnangara Mound water resources environmental review and management program* was released (WAWA 1986). The conditions, released in March 1988 under Statement 021, included Ministerial water level criteria based on environmental knowledge at the time. These were considered reasonable by the former Water Authority of WA to maintain key elements of the environment. These Ministerial criteria accounted for expected groundwater abstraction for the region, expected land use changes, and historical rainfall variations.

In 1995, the WAWA reviewed Ministerial water level criteria (WAWA 1995). The review highlighted that climate was an important factor affecting groundwater levels, and the difficulty of predicting future groundwater levels given the uncertainty of future climatic conditions.

In 2001, in response to land-use changes 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 of Water (former 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).

In 2007, the Department of Water conducted a further review of Ministerial conditions and commitments on Gnangara (DoW 2008c). The purpose of this review was to refine Ministerial criteria to the sites with significant ecological value and 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* for Gnangara (Government of Western Australia 2009a) 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 overtaken by more recent investigations into the shallow groundwater systems and ecological responses to climate. We will use this work to focus management effort on areas that will show the most benefit from changes to abstraction. The intent of the stage two review will be covered by the next Gnangara groundwater allocation plan, which is expected to be released for public comment in 2018,.

Appendix D – 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\ C2207\0004\141118

Filename: C2207

Compilation date: November 2014

Disclaimer

This map is a product of the Department of Water, Water Allocation Planning Branch and was printed in November 2014.

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

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