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

Environmental management of groundwater from the Gnangara Mound groundwater resources

Annual compliance assessment report July 2022–June 2023

January 2024

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Contents

Figures

Tables

Summary

This report describes the Department of Water and Environmental Regulation's (the department) compliance with Ministerial conditions and commitments under *Ministerial Statement no. 819 – Gnangara Mound groundwater resources [including East Gnangara Shire of Swan]* (*Ministerial Statement no. 819*) (Government of Western Australia 2009) for the period 1 July 2022 to 30 June 2023, under Part IV of the *Environmental Protection Act 1986* (EP Act).

The report presents total licensed groundwater entitlements covered under the *Gnangara groundwater allocation plan* (DWER 2022a) from all aquifers of the Gnangara groundwater system (Table 1). The report also outlines environmental monitoring, management, research and consultation by the department to manage abstraction from the Gnangara groundwater system.

Under *Ministerial Statement no. 819*, the department must manage the groundwater system to comply with water level criteria set at 30 groundwater-dependent wetland and terrestrial vegetation sites across the Gnangara groundwater system. The number of sites where water levels were non-compliant with absolute minimum or peak water level criteria in 2022–23 was 14, the same as in 2021–22.

The rainfall at Perth Airport (Bureau of Meteorology [BoM] station no. 009021) of 758.0 mm over the reporting period was similar to the long-term (75 year) average of 756.0 mm and above the short-term (10 year) average of 664.4 mm (Table 1).

Public water supply entitlement volumes, licensed to Water Corporation primarily for the Integrated Water Supply Scheme (IWSS), remained similar in 2022–23 to the previous reporting period (Table 1). We continued to work with Water Corporation to distribute abstraction for the IWSS in response to groundwater level trends and to move abstraction away from environmentally sensitive and non-compliant sites.

Over the 2022–23 reporting period, the volume of water licensed as part of Water Corporation's groundwater replenishment scheme for the IWSS was the same as 2021–22. The volumes injected and abstracted slightly increased (Table 1).

Private licensed entitlements increased across all aquifers of the Gnangara groundwater system by 0.91 gigalitres (GL) compared with 2021–22 (Table 1).

The estimated volume of groundwater abstracted by exempt uses has been adjusted to reflect the change in the watering roster for garden bores from three to two days per week, which came into effect from 1 September 2022. The figure of 29.4 GL is consistent with the estimated exempt use at 2030 as published in the 2022 *Gnangara groundwater allocation plan*. It assumes a small amount of growth in garden bore numbers over time. See Section 3.3 for more information.

To rebalance the Gnangara groundwater system in response to climate change, in June 2022 the department released the *Gnangara groundwater allocation plan* (DWER 2022a). The plan, developed following extensive stakeholder consultation, provides water users with certainty of ongoing supply and will help ensure the long-term environmental sustainability of the Gnangara groundwater system.

The plan outlines strategies to reduce overall annual groundwater use from the Gnangara resources by 54 GL, or about 19 per cent. In so doing the plan aims to maintain or increase groundwater levels in important locations and reduce the rate of groundwater decline in other locations to avoid further impacts to the health of groundwater-dependent ecosystems. The plan also proposes changes to water level criteria at some sites, and the Environmental Protection Authority (EPA) is currently inquiring into whether these implementation conditions should be changed under section 46 of the EP Act.

Following the EPA's inquiry, the Minister for Environment will review its recommendations and if the Minister decides the implementation conditions should be changed, a new Ministerial Approval Statement will be issued. The department will continue to comply with monitoring and reporting requirements under *Ministerial Statement no. 819* until a new statement is issued.

Table 1 Rainfall, licensed entitlement totals from all aquifers, and compliance summary

	2021–22	2022–23
Rainfall[1]	688.8 mm	758.0 mm
Public water supply entitlements (IWSS baseline licences, Town of Woodridge [ToW] and Moore River South development [MRSD])[2]	111.47 GL	111.59 GL
Public water supply entitlements (IWSS groundwater replenishment)[3]	28.00 GL[4]	28.00 GL
Injected (actual)	*15.02 GL*	*17.32 GL*
Abstracted (actual)	*10.48 GL*	*15.53 GL*
Private licensed entitlements	129.52 GL	130.43 GL
Estimated garden bore and stock and domestic use[5]	36.0 GL	29.4 GL
No. of sites non-compliant with absolute minimum or peak water level criteria[6]	14 out of 30	14 out of 30

1 Rainfall figures are for July to June (water year) and are measured at Perth Airport (BoM station no. 009021).

2 In 2022–23 this consisted of 110.77 GL licensed to Water Corporation for the IWSS (including 0.78 GL) for bore MR17 which is located outside the Gnangara allocation plan boundary, but within the Perth South groundwater area), 0.13 GL for the ToW and 0.69 GL for the MRSD. The minor increase in IWSS licences from the Gnangara system was because of an operational licence transfer from Jandakot Yarragadee bore J07 because of water quality issues (high total dissolved solids) at the bore.

In 2021–22 this consisted of 110.65 GL licensed to Water Corporation for the IWSS (including 0.78 GL for bore MR17), 0.13 GL for the ToW and 0.69 GL for the MRSD.

3 For full details of IWSS groundwater replenishment entitlements, injection and abstraction see Section 3.1 and Table 2.

4 Volume corrected from 27.90 GL in the 2021–22 compliance report to include 0.1 GL licensed to bore MR17.

5 Garden bore and stock and domestic use is from the superficial aquifer only. It is estimated using data collected through surveys, data from the Australian Bureau of Statistics and records of household use from Water Corporation. See Section 3.3.

6 For full details of compliance with absolute minimum or peak water level criteria see Table 4 and Appendix A.

1 GL = 1,000,000 kilolitres. Figures have been rounded to two decimal places.

1 Background

1.1 Ministerial Statement no. 819

Ministerial Statement no. 819: Gnangara Mound groundwater resources [including East Gnangara Shire of Swan] (*Ministerial Statement no. 819*) (Government of Western Australia 2009) establishes the environmental conditions and commitments associated with the allocation of groundwater from the Gnangara groundwater resources for public and private use. The Department of Water and Environmental Regulation (the department) is the proponent for the Gnangara groundwater proposal and must comply with and report on the implementation conditions to the Environmental Protection Authority (EPA) each year.

The department was formed in July 2017 following the merger of the Office of the Environmental Protection Authority, the Department of Water and the Department of Environment Regulation. To ensure there is no possible apprehension of bias, the Director General of the department is not involved in monitoring compliance with *Ministerial Statement no. 819*. The Executive Director Compliance and Enforcement has been formally delegated to exercise the compliance duties under the *Environmental Protection Act 1986* (the EP Act).

Some of the key conditions in *Ministerial Statement no. 819* are environmental water provisions, set as minimum water level criteria at 30 representative sites across the Gnangara groundwater resources – 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. On the Swan Coastal Plain, native vegetation that occurs within 10.5 m depth to groundwater is considered likely to be phreatophytic.

Implementation conditions associated with the Gnangara groundwater resources proposal were first established in 1988 under Part IV of the EP Act. Since then, they have been revised several times to include additional criteria sites or to remove sites where environmental values had been lost because of causes other than abstraction (Appendix C). These causes include reduced rainfall because of climate change, land clearing and disturbance related to changing land use.

The water level criteria at the current 30 sites have been developed to protect the important environmental values of groundwater-dependent ecosystems from significant impact caused by water use from the Gnangara groundwater system.

The 2022 *Gnangara groundwater allocation plan* (DWER 2022a) proposes changes to some water level criteria. The EPA is inquiring into the proposed changes under section 46 of the EP Act. After reviewing the EPA's recommendations, if the Minister for Environment decides that implementation conditions in *Ministerial Statement no. 819* should be changed then a new Ministerial Approval Statement will be issued. The department will then comply with the implementation conditions in the new Statement.

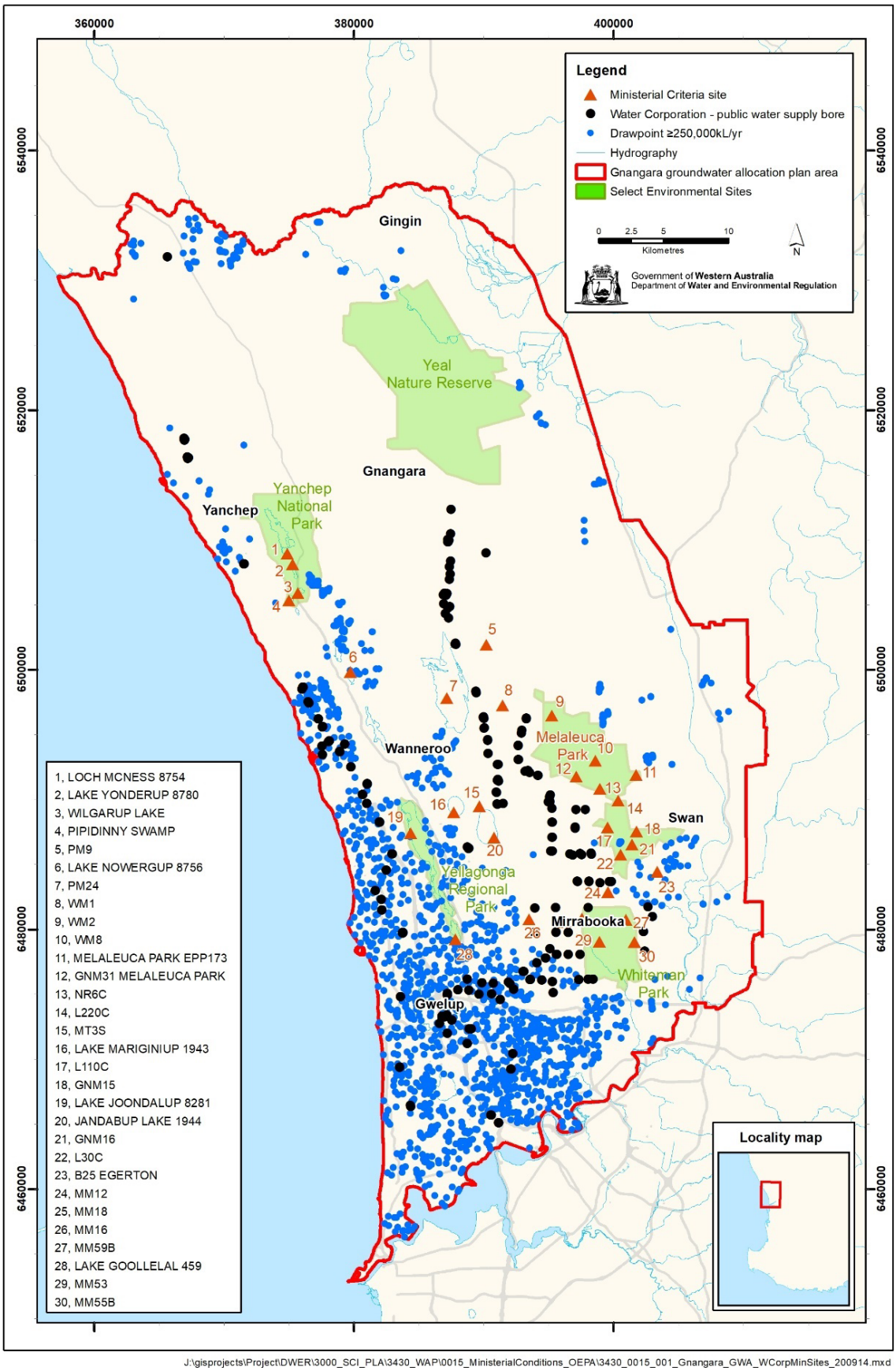

Figure 1 Location of Gnangara water level criteria sites, public water supply production bores and drawpoints of private licences with larger entitlements

1.2 The Gnangara groundwater system

The Gnangara groundwater system is located on the Swan Coastal Plain. It extends from the Swan River in the south to Moore River and Gingin Brook in the north, and from the coast to close to the Darling Scarp in the east. It covers an area of about 2,200 km^2 (Figure 1). The system comprises four main aquifers:

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

The Gnangara groundwater system is currently over-allocated and overused. A reduction in rainfall and an increase in groundwater use have contributed to water level declines over the past 40 years. These have, in turn, impacted on important wetlands and other groundwater-dependent ecosystems. Water level declines are the result of:

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

Environmental impacts to ecosystems from groundwater level decline can occur where those ecosystems are directly supported by the regional watertable. In the Gnangara area, the main watertable aquifer is the Superficial aquifer. Impacts can occur by pumping from the Superficial aquifer itself or through abstraction from deeper aquifers where they are directly or indirectly connected to the Superficial aquifer. Such connections exist in the northern half of the Gnangara plan area (Figure 2).

Private users of groundwater most often take water from the Superficial aquifer, while Water Corporation is the dominant user of the deeper Leederville and the Yarragadee aquifers for public water supply purposes.

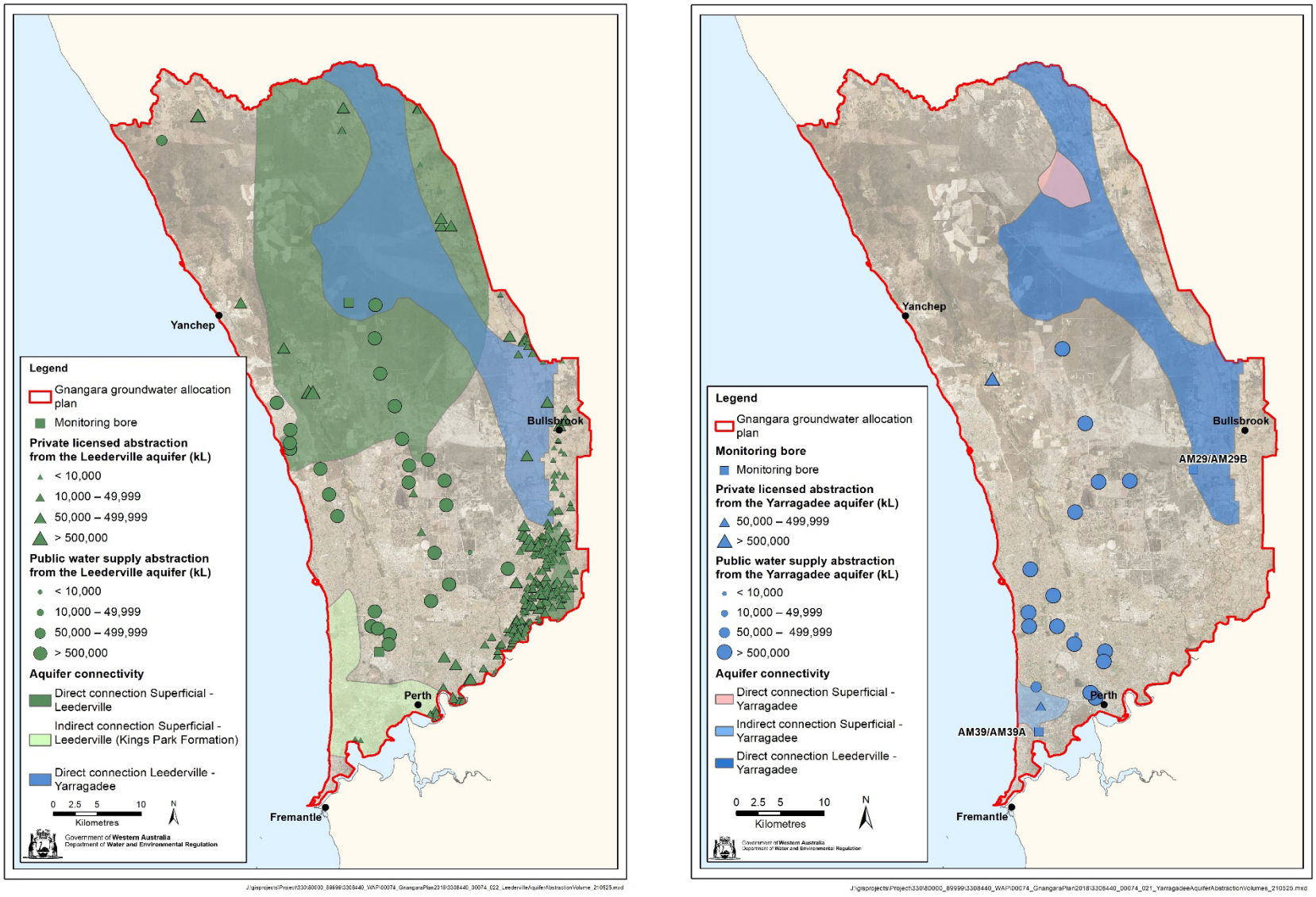

Figure 2 Groundwater connectivity of the Leederville (left) and Yarragadee (right) aquifers, with abstraction locations and volumes

1.3 Allocation limits and licensing

The department uses allocation limits, licensing of groundwater abstraction and monitoring of water levels, water quality and ecological values 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.

Groundwater abstracted as part of a managed aquifer recharge scheme (including Water Corporation's groundwater replenishment scheme – see Section 3.1) is licensed but accounted for outside the allocation limit as there is no net deficit to the groundwater resource.

Water allocated to the environment is not included as part of the allocation limit. Rather, it is the water that is left in the groundwater system to support environmental, cultural and community values. The water level criteria set at high value wetland and bushland sites on the Gnangara groundwater system in *Ministerial Statement no. 819* serve to restrict the volume of water that can be allocated from the system (the allocation limit). This helps ensure there is sufficient water left in the system to meet environmental needs. If criteria are not met this indicates that there is a risk of impacts to ecological values. Breaches, or impending breaches, of criteria trigger management actions, including further investigations or, ultimately, changes to groundwater management and reductions to groundwater use.

Ongoing breaches of water level criteria set in *Ministerial Statement no. 819* led to the development and release of the 2022 *Gnangara groundwater allocation plan* (DWER 2022a). The 2022 Gnangara plan reduces groundwater use by 54 gigalitres (GL) per year[1] and establishes new allocation limits for the Gnangara groundwater resources.

The new allocation limits were set following comprehensive assessments of the state of the Gnangara groundwater resources and risks of climate change and abstraction to the system, existing users and the environment. The department applied climate science, hydrogeological modelling and environmental assessments in setting the new allocation limits. See the *Gnangara groundwater allocation plan* (DWER 2022a) for a summary of the allocation limits and the *Gnangara groundwater allocation plan: Methods* (DWER 2022b) for more detailed information on how the allocation limits were determined.

[1] Reductions to groundwater use under the 2022 *Gnangara groundwater allocation plan* include a 30 GL/year reduction to baseline public water supply abstraction, a 10 GL/year reduction to private licensed use (10 per cent of licensed entitlements), and a 14 GL/year reduction to unlicensed (exempt) stock and domestic garden bore use. Reductions to licensed use will be implemented from 2028. Reductions to exempt use were implemented through a change to the garden bore roster (from three watering days to two days per week) on 1 September 2022.

2 Rainfall

Groundwater is recharged by rainfall. How much groundwater levels rise and fall each year is affected by the amount of rainfall that falls in the catchment, but also by how it falls (timing, pattern and intensity). Recharge is also affected by temperature – warmer weather will increase evaporation and allow less rainfall to reach the aquifer.

The climate across Western Australia is changing. Average temperatures across the whole of the state have risen 1.3°C since 1910, and in the south-west there has been a general trend of declining annual rainfall since the mid 1970s.

National climate projections data provided through the Climate Change in Australia website project that Western Australia will continue to get hotter into the future, the south-west of the state will continue to become drier and by mid-century, under a high-emissions scenario, the climate of Perth will be more like the current climate of Jurien (CSIRO and Bureau of Meteorology 2021).

Rainfall at Perth Airport (Bureau of Meteorology [BoM] station no. 009021) over the reporting period was 758.0 mm. This was similar to the long-term (75 year) average of 756.0 mm and above the short-term (10 year) average of 664.4 mm (Figure 3).

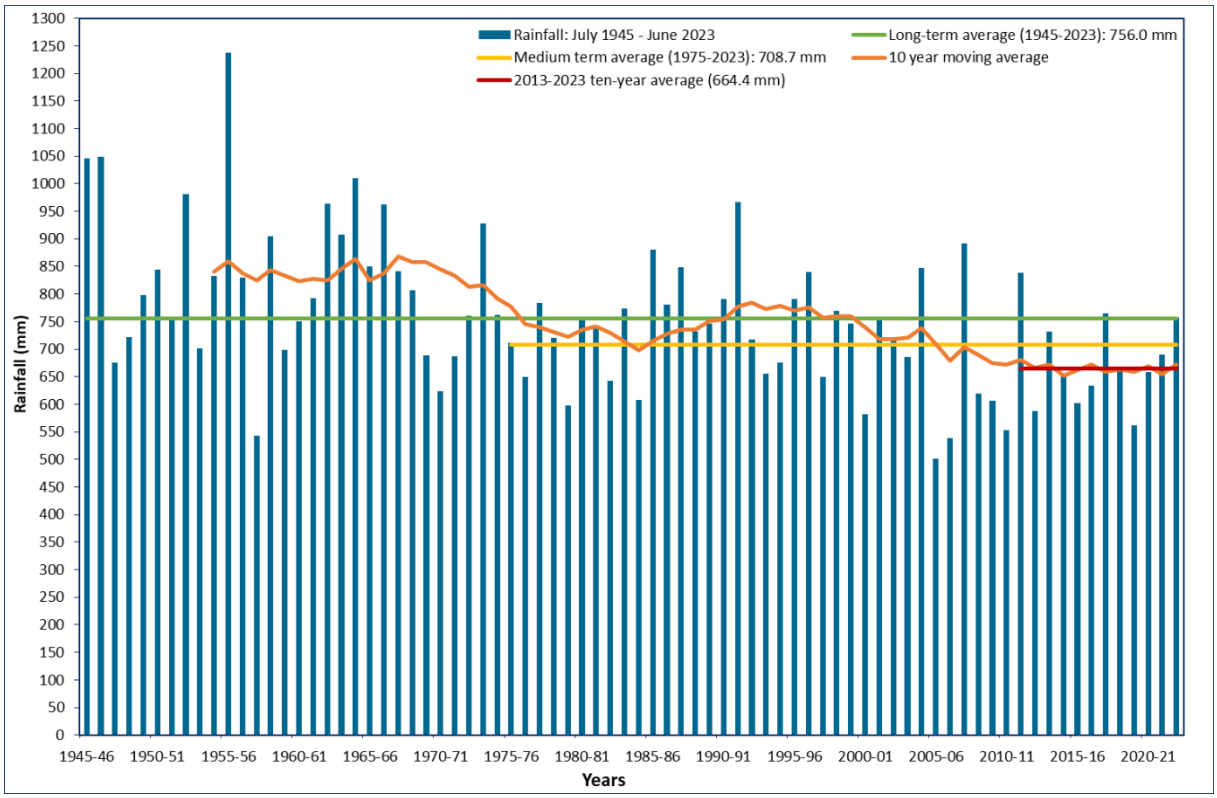

Figure 3 Annual and average water-year (July–June) rainfall at Perth Airport (BoM station no. 009021)

3 Groundwater use

The Gnangara groundwater system is the Perth region's largest source of easily accessible, low-cost, good-quality water. It provides almost half of Perth's public water supply as well as water for public open spaces, local horticulture and viticulture, and domestic garden bores.

This chapter summarises the licensed groundwater entitlements within the Gnangara groundwater allocation plan area for the reporting period, and describes the uses exempt from licensing and their estimated volumes.

3.1 Public water supply entitlements

The department licenses 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 (IWSS). Within the Gnangara groundwater system, there is also a small volume of groundwater licensed from the Leederville aquifer for the Town of Woodridge (ToW) water supply and for the Moore River South development (MRSD). These volumes do not form part of the IWSS and are licensed separately.

The volume of groundwater licensed for public and town water supply from all aquifers of the Gnangara groundwater resources was 111.59 GL in 2022–23 compared with 111.47 GL in 2021–22. See Table 2 for the distribution of licences by all aquifers and Table 3 for the distribution of licences across superficial aquifer subareas.

We continue to work with Water Corporation to distribute public water supply abstraction in response to groundwater level trends, and to move abstraction away from sites where levels are non-compliant with water level criteria in *Ministerial Statement no. 819*.

Groundwater replenishment scheme

The licensing of groundwater associated with Water Corporation's groundwater replenishment scheme (GWR) is managed outside the allocation limits set for the Gnangara groundwater system. Licensed volumes are reported separately from other volumes licensed for public water supply. Water abstracted is balanced by water injected.

Groundwater replenishment is a form of managed aquifer recharge. At Beenyup Wastewater Treatment Plant in Craigie, water is treated to drinking water quality standard and recharged (or injected) into the Leederville and Yarragadee aquifers. In 2022–23 17.31 GL was injected, compared with 15.02 GL in 2021–22.

An equivalent amount of water is then available for abstraction from aquifers across the Gnangara groundwater system, and from one Yarragadee bore (MR17) in the Perth South groundwater area, south of the Gnangara plan area. Abstraction is subject to a groundwater licence. The distribution of GWR licensing considers IWSS

operating constraints while aiming to limit overall impacts to groundwater-dependent ecosystems. In 2022–23 15.53 GL was abstracted, compared with 10.48 GL in 2021–22.

See Table 2 for the distribution of licences, GWR injection volumes and GWR abstraction by aquifer.

3.2 Private licensed entitlements

Groundwater licensed for private use from the Gnangara groundwater system mostly comes from the Superficial aquifer. It is mainly used for the purposes of irrigation of public open spaces, agriculture, industry and commercial uses.

Private licensed entitlements in 2022–23 increased across all aquifers of the Gnangara groundwater system by 0.91 GL compared with 2021–22 (Tables 2 and 3).

Subarea boundary changes

The Western Australian Planning Commission completed the final *Swan Valley Planning Scheme No. 1* (DPLH 2021) in August 2021. The final mapping for the scheme is marginally different to the draft mapping the department referenced when setting up the new Swan Valley subarea and groundwater area boundaries in the *Gnangara groundwater allocation plan* (DWER 2022a).

In September 2022, we adjusted the boundary of the Swan Valley subarea in the Swan groundwater area to reflect the final *Swan Valley Planning Scheme No. 1*. This has resulted in some minor cadastre and boundary changes to the neighbouring Karri (outside the plan area), Perth, and Mirrabooka groundwater areas and the subareas within the Swan groundwater area. The new Swan Valley subarea replaced the Central Swan subarea and includes parts of the North, South and East Swan subareas.

3.3 Use that is exempt from licensing

The department estimates and accounts for groundwater that is exempt from licensing. The main types of exempt water use from the Gnangara groundwater system are garden bores used in urban areas and stock and domestic bores used in rural areas where there is often no scheme water connection. As part of the 2022 *Gnangara groundwater allocation plan*, the number of watering days for garden bores in the Perth and Peel areas was reduced from three days per week to two days per week (effective 1 September 2022), bringing it into line with the roster for scheme water users. The estimate in the Gnangara plan of total groundwater use per year for domestic bores at 2030 under the two-day-per-week roster is 29.4 GL. This figure accounts for a small amount of growth in the number of garden bores between the plan release date and 2030. We will use the 29.4 GL estimate in compliance reports as the annual estimated annual volume of groundwater use for garden bores, until updated data is available.

As exempt uses are not subject to metering regulations, we use other methods, such as surveys, to estimate use volumes. Estimates are updated over time as we obtain better information on the rates of instalment and average water use by garden bores in urban and rural areas.

The department's most recent estimates of average groundwater use by domestic bores were obtained through a domestic bore metering project, which ran between 2009 and 2012. Results from this project revealed that after the three-day-per-week sprinkler roster and the winter sprinkler ban were introduced in 2010, average water use per bore decreased from about 800 to 430 kilolitres per year in urban areas.

Further information on the management of garden bores is contained in Section 5.2.

Table 2 Licensed entitlements and estimates of garden bore use from all aquifers in the Gnangara groundwater system

Aquifer	Public water supply entitlements[1] (GL)								Private licensed entitlements (GL)		Garden and stock/ domestic bore use exempt from licensing (GL)	
	IWSS + ToW + MRSD entitlements[2]		IWSS GWR									
			Entitlements		Injected		Abstracted					
	2021–22	2022–23	2021–22	2022–23	2021–22	2022–23	2021–22	2022–23	2021–22	2022–23	2021–22	2022–23[3]
Superficial	32.53	32.73	1.90	1.90	-	-	1.05	1.37	114.33	115.19	36.0	29.4
Mirrabooka	3.48	3.48	0.80	0.80	-	-	0.09	0.09	2.41	2.28	-	-
Leederville	32.32[4]	32.14	15.81	16.11	10.68	10.27	5.93	8.25	11.52	11.68	-	-
Yarragadee[5]	43.15	43.25	9.50	9.20	4.34	7.04	3.41	5.82	0.68	0.68	-	-
Fractured rock	-	-	-	-	-	-	-	-	0.58	0.59	-	-
Total	**111.47**	**111.59**	**28.00[6]**	**28.00**	**15.02**	**17.31**	**10.48**	**15.53**	**129.52**	**130.43**	**36.0**	**29.4**

1 Public water supply volumes include groundwater licensed to Water Corporation for the IWSS, the ToW and the MRSD.

2 In 2022–23 the IWSS baseline licence from the Gnangara groundwater system (including bore MR17) was 110.77 GL. In 2021–22 it was 110.65 GL. In both 2022–23 and 2021–22 the ToW entitlement was 0.13 GL and the MRSD entitlement was 0.69 GL (both from the Leederville aquifer). The minor increase in IWSS licences from the Gnangara system was because of an operational licence transfer from Jandakot Yarragadee bore J07 because of water quality issues (high total dissolved solids) at the bore.

3 Annual (estimated) volume of groundwater abstracted by exempt uses has been adjusted to reflect the change in the watering roster for garden bores from three to two days per week (in force from 1 September 2022). The figure of 29.4 GL is consistent with the estimated exempt use volume at 2030 published in the 2022 *Gnangara groundwater allocation plan*. The figure takes into account a small amount of growth in garden bore numbers over time.

4 Volume corrected from 31.50 GL in the 2021-22 compliance report.

5 Yarragadee public water supply entitlement volumes include: 0.78 GL in 2021–22 and 2022–23 from bore MR17 which is located outside of the Gnangara allocation plan boundary, but within the Perth South groundwater area. In both 2022–23 and 2021–22 GWR entitlements also include 0.10 GL from bore MR17.

6 Volume corrected from 27.90 GL in the 2021–22 compliance report to include 0.1 GL licensed to bore MR17.

1 GL = 1,000,000 kilolitres. Figures have been rounded to two decimal places (except for exempt use volumes, which are estimates).

Table 3 Licensed entitlements from the Superficial aquifer in subareas of the Gnangara groundwater system

Groundwater area	Subarea	Ministerial criteria site present?	Public water supply entitlements[1] (GL)				Private licensed entitlements[2] (GL)	
			IWSS + Town of Woodridge entitlements		Groundwater replenishment			
			2021–22	2022–23	2021–22	2022–23	2021–22	2022–23
Gingin	Beermullah Plain South	No	-	-	-		3.14	3.14
	Deepwater Lagoon South	No	-	-	-		2.88	2.84
	Guilderton South	No	-	-	-		9.78	9.67
	Lake Mungala	No	-	-	-		2.70	2.70
Total for Gingin Groundwater Area			**0.00**	**0.00**	**0.00**	**0.00**	**18.51**	**18.35**
Gnangara	Reserve	Yes	0.65	0.65	-	-	1.57	1.57
	Wanneroo Wellfield	Yes	6.10	6.28	-	-	2.11	2.23
Total for Gnangara Groundwater Area			**6.75**	**6.93**	**0.00**	**0.00**	**3.68**	**3.80**
Gwelup	Gwelup	No	3.50	3.50	0.10	0.10	1.10	1.14
Total for Gwelup Groundwater Area			**3.50**	**3.50**	**0.10**	**0.10**	**1.10**	**1.14**
Mirrabooka[3]	Ballajura	No	2.00	1.90	0.05	0.05	1.36	1.93
	Beechboro	No	-	-	-	-	0.65	0.69
	Henley Brook	No	0.45	0.27	-	-	0.30	0.49
	Improvement Plan 8	No	1.60	1.73	-	-	0.16	0.19
	Landsdale	Yes	-	-	-	-	0.34	0.32
	Plantation	No	-	-	-	-	0.36	0.32
	State Forest	No	-	-	-	-	1.12	1.04
	Whiteman Park	Yes	0.08	0.05	-	-	0.72	0.77
Total for Mirrabooka Groundwater Area			**4.13**	**3.95**	**0.05**	**0.05**	**5.01**	**5.74**
Perth[3]	City of Bayswater	No	-	-	-	-	2.50	2.39
	City of Fremantle North	No	-	-	-	-	0.05	0.05
	City of Nedlands	No	-	-	-	-	2.52	2.39
	City of Perth	No	-	-	-	-	1.49	1.60
	City of Stirling	No	2.80	2.80	0.30	0.30	7.83	8.80
	City of Subiaco	No	-	-	-	-	1.14	0.95
	Eglinton	No	-	-	-	-	3.39	3.33
	Quinns	No	11.05	10.85	0.25	0.25	3.49	3.52
	Shire of Peppermint Grove	No	-	-	-	-	0.08	0.08
	Shire of Swan North	No	-	-	-	-	0.73	0.67
	Town of Bassendean	No	-	-	-	-	0.37	0.37
	Town of Cambridge	No	-	-	-	-	2.33	2.33
	Town of Claremont	No	-	-	-	-	0.63	0.62
	Town of Cottesloe	No	-	-	-	-	0.28	0.28
	Town of Mosman Park	No	-	-	-	-	0.48	0.48
	Town of Vincent	No	-	-	-	-	0.72	0.75
	Whitfords	Yes	3.00	3.60	1.20	1.20	9.36	9.25
Total for Perth Groundwater Area			**16.85**	**17.25**	**1.75**	**1.75**	**37.38**	**37.85**
Swan[3]	Bandy Spring	No	-	-	-	-	0.33	0.32
	Central Swan[4]	No	-	N/A	-	N/A	1.27	N/A
	Cockman Bluff	No	-	-	-	-	0.85	0.85
	East Swan	No	-	-	-	-	0.80	0.25
	Neaves	No	-	-	-	-	3.23	3.42
	North Swan	Yes	-	-	-	-	2.66	2.53
	Radar	No	-	-	-	-	1.90	1.90
	South Swan	No	-	-	-	-	3.65	0.57
	Swan Valley	No	N/A	-	N/A	-	N/A	4.90
Total for Swan Groundwater Area			**0.00**	**0.00**	**0.00**	**0.00**	**14.68**	**14.75**
Wanneroo	Adams	Yes	-	-	-	-	1.04	1.00
	Carabooda	No	-	-	-	-	8.00	7.91
	Carramar	No	-	-	-	-	1.60	1.59
	Jandabup	No	-	-	-	-	0.18	0.18
	Joondalup	No	-	-	-	-	0.73	0.73
	Lake Gnangara	No	-	-	-	-	6.28	6.22
	Mariginiup	Yes	-	-	-	-	4.10	4.06
	Neerabup	No	-	-	-	-	2.52	2.47
	Nowergup	Yes	-	-	-	-	2.74	2.74
	Pinjar	Yes	-	-	-	-	0.58	0.58
Total for Wanneroo Groundwater Area			**0.00**	**0.00**	**0.00**	**0.00**	**27.76**	**27.47**
Yanchep	Yanchep	Yes	1.30	1.10	-	-	6.21	6.09
Total for Yanchep Groundwater Area			**1.30**	**1.10**	**0.00**	**0.00**	**6.21**	**6.09**
Total for Gnangara groundwater allocation plan area			**32.53**	**32.73**	**1.90**	**1.90**	**114.33**	**115.19**

1 Public water supply information is from the department's water licensing assessment and compliance monitoring platform, COMPASS, as well as annual reports submitted to the department as a condition of Water Corporation's licences.

2 The 2022–23 report was run on 1 July 2023. The 2021–22 report was run on 1 July 2022. All reports were run using COMPASS.

3 As part of finalising the Swan Valley subarea within the Swan groundwater area, minor boundary changes made to were to the Perth and Mirrabooka groundwater areas and subareas within Swan groundwater area.

4 The Central Swan subarea fell almost completely within the new Swan Valley subarea. The East Swan subarea boundaries were altered and a small number of licences from the northern portion of the Central Swan subarea are now in the East Swan subarea. The Central Swan subarea has now been abolished.

Up-to-date figures on water availability are available from the department's website or through the Swan–Avon regional office.

1 GL = 1,000,000 kilolitres. Figures have been rounded to two decimal places.

4 Compliance

The conditions and commitments in *Ministerial Statement no. 819* (Government of Western Australia 2009) that the department is required to comply with under Part IV of the EP Act are shown in Appendices A and B (the 'audit tables').

4.1 Compliance with water level criteria

Ministerial Statement no. 819 sets water level criteria at 30 sites across the Gnangara Mound. There are 14 wetland sites and 16 terrestrial (phreatophytic) vegetation sites. Some sites have more than one water level criterion and can therefore be non-compliant with multiple criteria. Water level criteria include:

- annual absolute minimum levels and minimum peak water levels
- annual preferred minimum water levels – set at some wetlands to allow water levels to fall between the 'preferred' level and the absolute minimum level in two out of six years (replicating natural drying cycles); preferred minimum water levels are referred to as 'other' water level criteria in this report.

The number of sites that were non-compliant with absolute minimum or minimum peak water level criteria in 2022–23 was 14, the same as 2021–22 (Table 4).

Management and mitigation actions implemented by the department in response to non-compliance are described in Section 5. Details for individual sites can be found in the audit tables in Appendix A.

Table 4 Summary of non-compliance with water level criteria for Gnangara groundwater resources for the reporting period

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**
2021–22				
Loch McNess Lake Yonderup Lake Jandabup Lake Nowergup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173	MM53 MM59B PM9 WM1 WM2 WM8	14 out of 30	Lake Mariginiup Lake Nowergup Lexia 86 Lexia 186 Melaleuca Park Dampland 78	5 out of 8
2022–23				
Loch McNess Lake Yonderup Lake Jandabup Lake Nowergup Lake Wilgarup Pipidinny Swamp Lexia 186 Melaleuca Park EPP173	MM53 MM59B PM9 WM1 WM2 WM8	14 out of 30	Lake Mariginiup Lake Nowergup Lexia 86 Lexia 186 Melaleuca Park Dampland 78	5 out of 8

1 In the event that a site is non-compliant with both absolute summer minimum and peak water level criteria within the same year, it is only counted as a single incidence of non-compliance (i.e. the site is not double-counted). See also Appendix A.

5 Environmental monitoring, management, research and consultation

5.1 Environmental monitoring

The ecological condition of groundwater-dependent ecosystems is affected by several factors of which the water regime is just one. Other factors include fire, insect attack, disease, weed invasion, pollution and disturbance from changing land use. Similarly, groundwater abstraction is just one of the factors that can affect the water regime of an ecosystem. Others include changes in rainfall patterns, fire, and land use changes such as urbanisation.

Expert environmental consultants undertake environmental monitoring of groundwater-dependent ecosystems for the department in line with the commitments in *Ministerial Statement no. 819* (Government of Western Australia 2009). This long-term monitoring program provides a representative indication of changes in the overall health of the Gnangara groundwater system over time and includes:

- wetland vegetation – paused in 2021–22 and 2022–23 for transect maintenance[2]
- wetland macroinvertebrates and water quality
- mound spring macroinvertebrates and water quality
- wetland frogs.

The department uses the results of environmental monitoring, carried out each spring in the reporting period, to continually improve our understanding of the relationship between water levels and ecological condition. The information is also used to manage public supply abstraction at priority locations, by reducing abstraction from production bores near environmental features where monitoring indicates there have been adverse changes in ecological condition (and water stress is a likely contributing factor).

The department is required to update the monitoring program every six years and submit it to the EPA. This is in line with commitment 6.3 in *Ministerial Statement no. 819* (Government of Western Australia 2009). The monitoring program is reviewed by the department each year. A formal update of the program was submitted to the EPA in 2022 as part of the proposed changes to implementation conditions prompted by the *Gnangara groundwater allocation plan* (DWER 2022a).

[2] Transect maintenance involves updating transect coordinates, re-staking transects and plots and tagging/re-tagging overstorey species.

Wetland macroinvertebrates and water quality

Over the reporting period, macroinvertebrates and water quality were monitored in spring to coincide with peak water levels at Loch McNess, Lake Yonderup, Lake Nowergup, Lake Joondalup, Lake Jandabup, Lake Mariginiup, Lake Goollelal, Melaleuca Park EPP173, Lake Gwelup and Lake Gnangara (Lette & Horwitz, 2023). The monitoring showed:

- There were higher water levels in many lakes because of higher winter rainfall, and a corresponding improvement in condition for several of the wetlands. However, water levels at Loch McNess and Lake Yonderup remained critically low, possibly influenced by increased transpiration from post-fire regeneration.
- As a result of acidification because of low water levels, Lake Mariginiup continues to develop characteristics similar to the acidified Lake Gnangara and remains at risk of undergoing another acidification episode because of low levels of alkalinity and high sulphate concentrations.
- Acidity indicators have increased at Lake Gwelup, putting it at risk of acidification if water levels decline, and Lake Gnangara remains in an acidified state despite higher water levels in 2022.
- Nutrient concentrations were stable at lakes Jandabup, Nowergup, Joondalup and Melaleuca Park EPP173, while nutrient levels were of some concern at lakes Gwelup, Yonderup and Goollelal. High nitrogen levels at lakes Mariginiup and Gnangara are mainly because of the acidity indicator, ammonium.
- There was habitat degradation, generally as a result of low water levels, at Loch McNess, Lake Yonderup, Lake Nowergup and Melaleuca Park EPP173. Habitat at the former two wetlands has also been negatively affected by a bushfire that burned through the area in December 2019.
- Of the ten wetlands sampled, seven had increases in family richness between 2021 and 2022, demonstrating the relationship between higher rainfall, higher water levels and increased size and diversity of macroinvertebrate habitats. Improved availability of habitat is assisting macroinvertebrate assemblage recovery at Lake Gnangara, which recorded its highest family richness (18 families) in 27 years.
- The two additional sites during 2020–22 at Lake Joondalup revealed that the absence of insects picked up in previous years' sampling is localised to the northern part of the lake.
- Melaleuca Park EPP173 macroinvertebrate assemblages appear to have changed after a sudden loss of surface water permanence in 2010 and are now characterised by low family richness. However, the Perthiid amphipod, previously thought to have been lost from the wetland because of drying, was recorded in 2022.

Mound spring macroinvertebrates and water quality

Five mound springs (Sue's Spring, Gaston Road Spring, Barnard Spring, Egerton Spring and Edgecombe Spring) along the eastern edge of the Gnangara groundwater allocation plan area were monitored for aquatic macroinvertebrates and water quality (SLR 2023).

Groundwater levels in monitoring bores B10 (near Edgecombe Spring), B25/B25A (near Egerton Spring) and LC160C (near Barnard Spring) have been relatively stable over the past 15 years and surface flow in both Egerton and Edgecombe springs was similar in 2022 to recent years.

Although surface flow in Sue's and Gaston Road springs was also comparable to previous years, water levels in nearby monitoring bore GN24 have been slowly declining since the 1990s, and if this trend continues it is foreseeable that the springs may cease to flow in the future. The GN24 hydrograph also shows significant fluctuations in water level over the past five years, giving rise to concern that surrounding land uses (horticulture, and more recently, the construction of the NorthLink highway) may be a threat to flows at Sue's and Gaston Road springs. The department will install a logger and telemetry in GN24 (and also in B25A near Egerton Spring) to help assess the influence of surrounding abstraction on local groundwater levels, particularly during the summer/autumn period, when levels are lowest and irrigation demand is highest.

Water quality at each of the mound springs was similar to recent years. 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 during the reporting period using head-torching, hand-capture and measurement, and aural surveys of calling males (Bamford & Bleby 2023).

Numbers of calling frogs varied greatly between sites, sampling periods and years (monitoring has occurred since 2002), but there were some patterns evident over the period. Some species declined and even disappeared, or at least stopped calling, at some sites.

Guenther's toadlet and the moaning frog appear sensitive to local extinction because of their reliance upon early winter rains, but both have an ability to persist and even to reappear after periods of absence. Despite this, Guenther's toadlet may have died out from some sites. While it was concluded in 2021 that the moaning frog was effectively lost from Lexia 86 and Lexia 186, results in 2022 indicate that it is still present even though it failed to breed. The source of calling adults at these two sites in autumn 2022 is unknown and could either be immigrants from another breeding site, or persistent animals that had metamorphosed at the Lexia sites (Bamford & Bleby 2023).

Monitoring data has previously generated concern that if current groundwater levels did not rise, the local distribution of some frog species would contract in the short term (three to five years), with the greatest declines in the middle and north of the Gnangara area, but with populations persisting in more reliable urban or supplemented wetlands in the south and west. Urban and near-urban wetlands are important for local frog populations as these wetlands tend to have more reliable hydroperiods (Bamford & Bleby 2023).

5.2 Management actions

In response to the changes described in Section 5.1 and the level of non-compliance identified in this and previous reports, the department is implementing strategies to reduce impacts on environmentally important sites. Many of these strategies are outlined in the 2022 *Gnangara groundwater areas allocation plan* (DWER 2022a).

The plan details how groundwater abstraction will be reduced by 54 GL per year from the Gnangara groundwater system over the next decade. The plan aims to stabilise or improve groundwater levels in key areas of environmental significance, and to reduce the rate of groundwater level decline in other areas where climate is driving the changes.

The plan includes adjustments to most licensed water users' entitlements that will better align the amount of groundwater abstracted with rainfall recharge under a drying climate. This will help ensure that Perth's groundwater-dependent environments are more resilient to climate change, and that the city's most important water source is secure and sustainable in the long term.

Managing public water supply use

Under the *Gnangara groundwater allocation plan* (DWER 2022a) Water Corporation's abstraction from the Gnangara groundwater system for the IWSS will be reduced by 30 GL per year in 2028. To offset this reduction, a third seawater desalination plant at Alkimos to the north of Perth is expected to be operational by 2028 and will provide an additional, long-term, climate-independent drinking water source for Perth.

To reduce risks to Loch McNess in Yanchep National Park, Water Corporation will step down abstraction from its bores west of the park before 2028, to reach a volume of 0.21 GL per year by 2025–26.

The department will review the abstraction for ToW water supply and MRSD in the Gnangara plan area's north and near the Gingin Brook in a new combined Gingin surface water and groundwater allocation plan.

Every year, the department reviews the distribution of Water Corporation's entitlements and wherever possible moves abstraction away from bores in the environmentally sensitive areas of the Superficial aquifer and from bores in the deeper Leederville and Yarragadee aquifers where they are connected to the Superficial aquifer. This is done to reduce the impact of Water Corporation's

abstraction on Ministerial sites where water levels are non-compliant or are at risk of becoming non-compliant with water level criteria.

Groundwater replenishment scheme

Recycling of Perth's wastewater is becoming a bigger part of the total public water supply mix, providing a climate-independent source to help meet our increasing water demands. Stages 1 and 2 of the groundwater replenishment scheme at Beenyup, with a combined capacity of 28 GL, have now been commissioned.

The locations of the injection bores constructed as part of Stage 2 were informed by the *Perth Regional Confined Aquifer Capacity study* (DWER 2021), completed by the department to help achieve sustainable use of Perth's deep aquifers. Because of the greater interconnectivity of the Superficial and deeper aquifers to the north of the Stage 2 injection points, water injected through Stage 2 of the groundwater replenishment scheme is projected to have broader benefits to the northern part of the Gnangara groundwater system, including to connected wetlands such as Lake Nowergup.

Managing private licensed use

The *Gnangara groundwater allocation plan* (DWER 2022a) will apply a reduction in groundwater use of 10 per cent to most private licence holders from 2028. The lead time before implementation of the reductions allows licensees time to improve their irrigation systems and/or adapt their business model so that the impact of the change on individuals and businesses is reduced. Schools, hospitals and commercial nurseries and tree farms are among the few exceptions to the 10 per cent reductions.

The department monitors private licensed use through on-ground compliance inspections, meter audits, water use surveys and standard checks as part of the licence renewal process. Through this work the department verifies that groundwater use is within licensed entitlements and that site activities are authorised.

The department conducts compliance monitoring checks across licences taking water from the Gnangara groundwater system. The department's response to any alleged non-compliance, including exceedance of annual water entitlements, ranges from educational letters and warning notices to statutory direction and infringement notices and, in some cases, legal action is taken.

When prioritising licence compliance and enforcement activities the department considers the conditions and commitments set in *Ministerial Statement no. 819*.

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

- local governments, urban developers, schools, golf clubs and other licensees that use large volumes, to improve water use efficiency, reduce their demand for groundwater, and assess future water needs and alternative water supply options

- Water Corporation to encourage community participation in a range of Waterwise programs, such as Waterwise Councils, Waterwise Schools, and Waterwise School Grounds
- the Department of Primary Industries and Regional Development, industry peak bodies, such as Irrigation Australia (WA), vegetablesWA, the Nursery & Garden Industry Western Australia, and Greenlife Industry Australia, as well as directly with horticulturalists to focus on improving water use efficiency in the agricultural sector, and options to reduce total groundwater use in the future.

Managing groundwater use exempt from licensing

The use of domestic garden bores is managed under the provisions of the *Water Agencies (Water Use) By-Laws 2010*. Permanent water efficiency measures are ongoing and cover most of the Gnangara groundwater allocation plan area. They include:

- a total winter sprinkler switch-off between 1 June and 31 August each year (unless delayed by the Minister because of low rainfall)
- a daytime sprinkler ban between the hours of 9am and 6pm
- sprinkler watering day rosters applying to scheme and domestic garden bore sprinkler use.

From 1 September 2022, the rostered watering days for domestic garden bore use changed from three days to two days per week, which is the same roster as scheme water users. The Government of Western Australia (State Government) is supporting garden bore users to adopt waterwise practices by promoting waterwise products and activities. For example, Water Corporation is providing a rebate for waterwise products, including smart irrigation controllers, and endorsing garden designers, landscapers, garden centres and nurseries that can assist households in watering efficiently and provide advice on waterwise plants.

Waterwise Perth action plan

The *Waterwise Perth action plan* was released in October 2019 to help transition Perth to a leading waterwise city by 2030 (Government of Western Australia 2019). The 2019 action plan involved eight government agencies coordinating on 38 actions with the aim of creating waterwise communities and helping Perth to stay beautiful, cool and liveable in the face of reducing water resources and rising temperatures as a result of climate change. The plan aims to achieve responsible and sustainable use of water from all sources, including groundwater, and well-designed private and public green spaces to make the most of the Perth and Peel region's limited water resources.

The second two-year plan, *Kep Katitjin – Gabi Kaadadjan – Waterwise Perth action plan 2*, was launched in October 2022 (Government of Western Australia 2022) and has broadened to include eleven agencies and 41 actions. The department continues

to work with local government, industry and the broader community to fulfil the following action plan commitments (among others):

- reduce Perth and Peel groundwater use by 10 per cent by 2030
- Waterwise Gold status achieved by all Perth and Peel councils[3]
- best practice waterwise policies integrated into all state urban water policies, guidelines and technical advice notes
- 100 per cent of irrigated open space audited and adopting waterwise management practices.

Gnangara horticulture water use efficiency grants program

Action 21 of *Kep Katitjin – Gabi Kaadadjan: Waterwise Perth action plan 2* (Kep Katitjin – Gabi Kaadadjan) is:

> Support horticultural water users in the Gnangara plan area to adjust to the effects of climate change and reductions in water licence allocations through best-management-practice water efficiency infrastructure, soil amelioration and technology programs.

Action 21 is being implemented via the Gnangara horticulture water use efficiency grants program, which has been running since November 2021 when the State Government committed $600,000 to support water use efficiency improvements for agricultural licensees in North Wanneroo. It was expanded in June 2022 to other horticultural licensees in the broader Gnangara plan area, and a further $1 million was committed by the State Government.

There are three arms to the grants program:

- grants to implement water use efficiency infrastructure
- grants to implement soil amelioration activities
- a voucher program to obtain expert advice on water use efficiency.

The Gnangara horticulture water use efficiency grants program is administered by the Department of Primary Industries and Regional Development.

Gnangara Waterwise Councils grants program

Action 22 of Kep Katitjin – Gabi Kaadadjan is:

> Support local governments, particularly those in the Gnangara plan area that are most impacted by the urban heat island effect, to develop a pathway to achieve reductions in their groundwater use.

Action 22 is being implemented via the Gnangara Waterwise Councils grants program that will provide up to a total of $4 million between 2022–23 and 2025–26 to nine eligible local governments. The program aims to support these local councils that are large groundwater users and most affected by urban heat to implement

[3] All local governments in Perth and Peel bar one (Shire of Waroona) are now endorsed Waterwise councils, and almost 90 per cent have achieved Gold status.

waterwise strategies and reduce their groundwater use, while keeping neighbourhoods cool and liveable.

The program is a joint initiative between the department and Water Corporation, with funding provided by Water Corporation.

Waterwise accreditation of garden nurseries and tree farms

Action 23 of Kep Katitjin – Gabi Kaadadjan is:

> Work with the commercial nursery and tree farming sector to agree on and adopt new waterwise standards.

The department is partnering with Nursery & Garden Industry Western Australia (NGIWA) to raise awareness of waterwise practices within the commercial nursery and tree farm sector and increase the number of operators obtaining waterwise accreditation and certification under the Australian Plant Production Standard (APPS) framework.

NGIWA will roll out activities such as targeted mailouts to nursery and tree farm licensees and the delivery of waterwise training with Greenlife Industry Australia (GIA) through 'Waterwork' irrigation workshops and technical training sessions for individual nursery and tree farms.

Be Groundwater Wise

The Be Groundwater Wise community education initiative was part of the 2019 *Waterwise Perth action plan* and continues in Kep Katitjin – Gabi Kaadadjan. In collaboration with Water Corporation, the department has developed the Be Groundwater Wise website (begroundwaterwise.wa.gov.au), which provides a central location for the community to learn about the importance of groundwater and how to use groundwater wisely, such as through developing waterwise gardens and through waterwise use of garden bores.

The initiative also includes regular social media campaigns at key points in the year, such as in spring when homeowners begin to switch on their irrigation systems after winter and plant out new gardens.

5.3 Research initiatives

The department, together with research partners, has completed several major projects that assist with planning for a drier future and focus management effort on the areas that will deliver the most benefit from changes to abstraction. Recent research initiatives have been outlined in previous compliance reports and are also documented in the *Gnangara groundwater allocation plan* (DWER 2022a) and the *Gnangara groundwater allocation plan: Methods* (DWER 2022b).

Projects currently underway that will contribute to the understanding and management of the Gnangara groundwater resources include:

- Development of updated climate science guidance using projections produced using global climate models from the Coupled Model Intercomparison Project Phase 5 (CMIP5).
- Testing of Perth Regional Aquifer Modelling System (PRAMS) version 3.6 through applying the updated climate science guidance.
- State telemetry program:
  - About half of the department's total monitoring bore network will undergo installation of telemetry systems between 2023–24 and 2026–27. This will provide a wealth of monitoring information that will be very useful for groundwater model development and evaluation, assessment of groundwater licence applications, monitoring of the effects of groundwater abstraction/injection, monitoring of rainfall and land use changes on the groundwater resource, and for improving the understanding of the connection between aquifers.
- Recharge Estimation Collaboration (REC):
  - REC is a partnership between the department, The University of Western Australia (UWA) and CSIRO to measure and model recharge to Perth's aquifers. As part of REC, the department and UWA have established seven research sites across the 12,000km^2 Swan Coastal Plain – near Dandaragan, Gingin, Gnangara, Whiteman Park and Myalup – where the movement, storage, potential, and quality of water through soils are observed on different land covers and land uses.
- North-East Corridor and Swan Valley groundwater investigation
  - The department is currently undertaking a detailed study of groundwater in the North-East Corridor and Swan Valley, which will improve our understanding of the increases in groundwater salinity in some bores in the Swan Valley and also show us where alternative water supplies, such as managed aquifer recharge, could be located.

5.4 Consultation

There was extensive stakeholder consultation ahead of the finalisation of the *Gnangara groundwater allocation plan* (DWER 2022a). The department focused on working with water users, their industry reference groups and other government agencies to identify a practical pathway to bring the system back into balance, prepare for a future with less groundwater availability and help build climate resilient organisations and businesses. The department received 197 submissions on the draft plan which were used to finalise the plan. The department's responses to the key issues raised are documented in the *Gnangara groundwater allocation plan: Statement of response* (DWER 2022c).

Following the release of the plan, the department has continued to collaborate and consult with State Government agencies, Water Corporation, local governments and industry peak bodies to deliver the plan implementation actions, such as those described in Section 5.2.

Appendices

Appendix A — Water level monitoring results for Ministerial sites for the Gnangara Mound groundwater resources for 2013–23

Bold text refers to compliance with water level and other criteria. **Black bold text** indicates sites compliant with water level and other criteria. **Red bold text** indicates sites non-compliant with water level criteria. **Blue bold text** indicates sites non-compliant with other criteria.

Table A1 Wetland sites

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum												
		Pref	Abs	Pref	Abs		2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Lake Goollelal	6162517			26.2*	26.0	Max	27.3	27.2	27.1	27.3	27.3	27.2	27.5	27.3	27.6	27.6
						Min	26.5	26.6	26.4	26.8	26.9	26.9	26.7	26.7	26.8	26.9

Compliance:

Compliant with absolute summer minimum and other criteria.

Since monitoring started, water levels at Lake Goollelal have never been non-compliant with the absolute summer minimum water level criterion.

Groundwater modelling projections for the 2022 *Gnangara groundwater allocation plan* (DWER 2022a) indicate that the ongoing urbanisation of East Wanneroo could lead to increases in the surface water levels of Lake Goollelal in the coming years.

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum												
		Pref	Abs	Pref	Abs		2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
Loch McNess	6162564				6.95	Max	6.39	6.25	6.25	6.25	6.25	6.25	6.02	6.03	6.01	5.90	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The lake has been non-compliant since 2002–03. Lake levels fell rapidly from 2006 with some easing in the rate of decline evident in recent years. The original staff gauge at the lake is no longer inundated and a new staff gauge was installed in a deeper part of the wetland in 2019. Water levels are now measured from the new staff gauge. Ecological condition: Long-term monitoring has shown declines in the health of *Melaleuca rhaphiophylla*; changes in species composition to more terrestrial species and increases in abundance of exotic species. A fire in December 2019 badly burnt the southern, western and northern parts of Loch McNess and considerable loss of organic soils occurred. Declines in groundwater levels have also contributed to the loss of the key wetland macrophyte *Baumea articulata* at the monitoring transect and the degradation and loss of aquatic habitat for macroinvertebrates. Sampling for macroinvertebrates has occurred on foot since 2020 because of the ongoing terrestrialisation of the lake. Macroinvertebrate family richness is still relatively high. In 2022 Carter's freshwater mussel (*Westralunio carterii*) was found at the lake (collected at the spring/culvert sampling site) for the first time. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation (DoW 2011a) 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 has not met the minimum groundwater requirement of wetland vegetation since 2006. Monitored peak and minimum levels in BH-LM2 still appear to be in a downward trend, although the rate of decline has been slower post-2015 than it was in the preceding decade. In 2016 the department completed a further 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. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of Yanchep National Park. This action should help to stabilise and slightly improve water levels at Loch McNess in coming years.
						Min	**6.25**	**6.25**	**6.07**	**6.25**	**6.25**	**6.25**	**5.89**	**5.94**	**5.85**	**5.81**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum												
		Pref	Abs	Pref	Abs		2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
Lake Yonderup	6162565				5.9	Max	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The lake has been non-compliant since 2007–08. Peak and minimum levels declined from about 2006, although peak levels were relatively stable from 2014 to 2021. The 2022 peak levels were lower than in 2021 but not as low as in 2020. Minimum levels have continued to decline, particularly from 2011 onwards, and this trend persisted over the reporting period. Ecological condition: In December 2019 Lake Yonderup was severely burnt in a large fire, resulting in near complete removal of vegetation to the lake edge. *Typha* sp. was seen at the wetland for the first time in 2017, and in 2022 more patches of *Typha* were present than in previous years. Nutrient levels increased in the lake in 2022, but it still remains a low-nutrient system when compared to the other monitored wetlands. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation (DoW 2011b) 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. The minimum groundwater level at this bore has remained more than one metre below this level for over a decade, including over the reporting period. Water levels in YDP_SC were stable from 2016 to 2021 but minima have dropped off in 2022 and 2023. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of Yanchep National Park. This action should help to stabilise and slightly improve water levels at Lake Yonderup in coming years.
						Min	**5.6**	**5.6**	**5.5**	**5.6**	**5.5**	**5.5**	**5.6**	**5.5**	**5.4**	**5.4**	
Lake Joondalup	6162572 (Staff 8281)			16.2*	15.8	Max	17.1	17.0	16.9	17.1	17.3	17.6	17.5	17.4	17.8	17.8	Compliance and trends: **Compliant with absolute summer minimum criterion.** **Compliant with other criterion.** Lake Joondalup is the largest of the monitored wetlands. Lake levels have been above the preferred minimum since 2016–17 and have risen in recent years. Groundwater modelling projects that water levels at Lake Joondalup are likely to rise further as result of the ongoing urbanisation of East Wanneroo. High water levels are having an impact on the health of fringing *Melaleuca rhaphiophylla* adjacent to the lake. For unknown reasons, in 2018 and 2019 macroinvertebrate richness was abnormally low for the lake, but with the addition of two more sampling sites in the southern part of the lake, recorded richness has increased to more typical levels. However, the low number of insect larvae remain of slight concern.
						Min	16.2 **4/6 yr**	16.3 **4/6 yr**	16.1 **4/6 yr**	16.5 **4/6 yr**	16.6 **4/6 yr**	16.8 **4/6 yr**	16.7	16.7	17.0	17.0	
	61610661 (Bore 8281)					Max	19.0	18.9	18.7	19.0	19.2	19.4	19.4	19.2	19.5	19.6	
						Min	18.2	18.3	18.1	18.5	18.6	18.7	18.6	18.6	18.8	18.9	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum			2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
		Pref	Abs	Pref	Abs												
Lake Mariginiup	6162577 (Staff 1943)	42.1*	41.5			Max	**41.3**	**41.3**	**41.1**	**41.4**	41.5	41.6	**41.4**	**41.3**	41.6	41.7	Compliance and trends: **Compliant with absolute minimum spring peak criterion.** Peak levels have shown an increasing trend over the past decade and this trend continued over the reporting period. Groundwater modelling projects that water levels at Lake Mariginiup are likely to rise in the future because of increasing urbanisation of the East Wanneroo area and a corresponding decrease in groundwater abstraction from agricultural land uses. **Non-compliant with other criterion.** Water levels have not reached the preferred spring peak since 1994. Ecological condition: Groundwater declines have contributed to the lake being one of the poorest sites in terms of vegetation health. Deteriorating water quality because of acidification has been a significant factor in the decline in the lake's ecological condition, and the extremely low alkalinity level indicates that the lake's capacity to buffer changes in pH is exhausted. Despite high acidity, Lake Mariginiup has relatively high macroinvertebrate richness. Lake Mariginiup's typically high nutrient levels decreased in 2022. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation (Searle et al. 2010a) 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 • bore MGP_C (AWRC ref. 61611440) should be used to relate changes in the watertable to wetland vegetation condition. The department is using MGP_C to better relate groundwater levels to the condition of wetland vegetation. Minimum levels at bores MS10 and MGP_C increased over the reporting period.
						Min	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**	41.0 **4/6 yr**	41.0 **4/6 yr**	41.0 **4/6 yr**	41.0 **4/6 yr**	
	61610685 (Bore MS10)					Max	41.0	41.2	40.8	41.1	41.1	41.2	41.1	40.9	41.2	41.3	
						Min	40.1	40.2	40.0	40.4	40.4	40.3	40.2	40.2	40.4	40.6	
Lake Jandabup	6162578 (Staff 1944)	44.7*	44.2		44.3	Max	44.7	44.7	44.6	44.7	44.8	45.0	44.8	44.6	44.9	44.9	Compliance and trends: **Compliant with absolute spring peak criterion.** **Non-compliant with absolute summer minimum criterion.** In 2020–21 and 2022–23 water levels were non-compliant with the absolute summer minimum criterion. Water Corporation supplements lake levels to meet the absolute spring peak water level criterion and to prevent the lakebed from drying and oxidising and causing acidification upon rewetting. Over the reporting periods 780 megalitres was supplemented into the lake. Recently, levels have been relatively stable, and the supplementation has been successful in preventing the lake from acidifying. Ecological condition: Long-term vegetation monitoring has shown declines in canopy condition, changes in species composition to more terrestrial species and increases in abundance of exotic species. The risk of acidification because of excessive drying of the lakebed is high if water levels decline and the lakebed is exposed. However, groundwater modelling projects that water levels at Lake Jandabup are likely to rise in the future because of increasing urbanisation of the East Wanneroo area and a corresponding decrease in groundwater abstraction from agricultural land uses. This should reduce the need for artificial supplementation of the lake. Management and mitigation: Work completed as part of the Perth shallow groundwater systems investigation found that bore JB12B (AWRC ref. 61610764) should be used to relate groundwater levels to the ecological condition of vegetation on the transect. There has been a rising trend in this bore since 2011.
						Min	**44.2**	**44.2**	**44.1**	44.3	**44.2**	44.3	44.3	**44.3**	**44.2**	**44.3**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum												
		Pref	Abs	Pref	Abs		2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
Lake Nowergup	6162567 (Staff) 616145 (telemetered site)	17.0*	16.8			Max	**16.0** **4/6 yr**	**16.0** **4/6 yr**	**16.0** **4/6 yr**	**16.0** **4/6 yr**	**16.0** **4/6 yr**	**15.7** **4/6 yr**	**15.6** **4/6 yr**	**15.6** **4/6 yr**	**15.7** **4/6 yr**	**15.9** **4/6 yr**	Compliance and trends: **Non-compliant with absolute spring peak criterion.** Lake levels have been non-compliant in most years since 1996 despite water levels being artificially maintained by the department. Since 2018 the department has used a telemetered site to monitor levels at the lake (AWRC ref. 616145). Levels recorded at the site have been relatively stable since 2018. **Non-compliant with other criterion.** Ecological condition: Many years of low water levels have led to the deaths of mature trees and declines in the abundance of the key wetland macrophyte *Baumea articulata*. Despite artificial supplementation, the lake is now reduced in size and vegetation changes mean that the original macroinvertebrate habitats where annual sampling occurred no longer exist and new sites are now used. Macroinvertebrate family richness has declined as a result of the loss of fringing macrophyte habitats. The lake retains sufficient buffering capacity at current levels and risk of acidification has subsided. Management and mitigation: From work completed as part of the Perth shallow groundwater systems investigation, Searle et al. (2010b) made the following recommendations: • the continuation of the supplementation regime • the use of groundwater levels at bore LN2-89 (AWRC ref. 61611247) to relate changes in the watertable to wetland vegetation condition. Minimum levels at bore LN2-89 declined from 2007 to 2016 but rose about 1.5 m in 2017–18. Water levels have been stable since then. The department investigated the causes of groundwater level declines at Lake Nowergup and results showed that local superficial aquifer use for horticulture had the greatest impact on lake levels, followed by reduced rainfall, then Leederville aquifer pumping from Quinns and Pinjar borefields (Global Groundwater 2015). The *Gnangara groundwater allocation plan* (DWER 2022a) includes reductions in both public and private licensed entitlements across Gnangara resources, including in the vicinity of Lake Nowergup, which modelling projects should, with continued supplementation, help to stabilise water levels at the lake and buffer the lake against the effects of climate change.
						Min	16.0	16.0	16.0	16.0	16.0	15.1	15.0	15.0	15.1	15.1	
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**	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. Ecological condition: Vegetation composition at Lake Wilgarup has shifted from one dominated by wetland species such as *Baumea articulata* to a terrestrial community dominated by *Eucalyptus gomocephala*. Bushfire events have also led to a significant loss of peat from the wetland. Management and mitigation: Given the location of Lake Wilgarup just to the east of Loch McNess, the department's management actions to improve water levels at Loch McNess also aim to benefit groundwater levels at Lake Wilgarup. However, groundwater modelling results indicate that the improvement in groundwater levels will not be sufficient to produce surface water at Lake Wilgarup and therefore the vegetation is likely to remain dominated by terrestrial species.
						Min											
	61618500 (Bore)					Max	4.41	4.29	4.21	4.34	4.29	3.64	3.43	3.32	3.58	3.58	
						Min	**3.82**	**3.79**	**3.66**	**3.88**	**3.75**	**2.99**	**2.86**	**2.83**	**2.90**	**2.94**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum			2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
		Pref	Abs	Pref	Abs												
Pipidinny Swamp	6162624 (Staff)	2.70	2.40		1.6	Max	**2.2**	**1.9**	**1.6**	**2.0**	**2.0**	**2.2**	**1.4**	**0.9**	**2.0**	**2.1**	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Levels at the swamp have been non-compliant since 2009–10. **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. 61611872) – 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. The 2022 spring peak level was the second-highest level recorded in the fourteen years of monitoring. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of Yanchep National Park. This action should help to stabilise and slightly improve water levels at Pipidinny Swamp in coming years.
						Min	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**<0.7**	**<0.7**	**<0.7**	**<0.7**	
Lexia 86 (GNM16)	61613215			47.3*	47.0	Max	47.8	47.7	47.3	47.7	47.9	48.2	48.2	47.8	47.9	48.1	Compliance and trends: **Compliant with absolute summer minimum criterion.** 2015–16 was the first and only year that the site was non-compliant with absolute summer minimum water levels. Groundwater levels declined from 1995 to 2016 and have then stabilised. **Non-compliant with other criterion.** Ecological condition: Long-term monitoring has shown reduced frog numbers, declines in canopy condition, changes in species composition to more terrestrial species and increases in abundance of exotic species. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields close to the crest of the Gnangara Mound with the intention of reducing abstraction impacts at sites in the area, including Lexia 86. The department also reviews public water supply abstraction annually, considering water level trends and criteria compliance. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of the Lexia wetlands. This action should help to maintain levels at Lexia 86.
						Min	47.0 **4/6 yr**	47.0 **4/6 yr**	**46.9** **4/6 yr**	47.1 **4/6 yr**	47.1 **4/6 yr**	47.3 **4/6 yr**	47.2 **4/6 yr**	47.1 **4/6 yr**	47.1 **4/6 yr**	47.2 **4/6 yr**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum												
		Pref	Abs	Pref	Abs		2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
Lexia 186 (GNM15)	61613214			47.5*	47.2	Max	47.2	47.1	46.7	47.0	47.3	47.5	47.6	47.3	47.6	47.7	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant with the absolute summer minimum criterion since 1997. The spring peak in 2015–16 was the lowest on record. Water levels have shown a general rising trend since 2015–16. **Non-compliant with other criterion.** Minimum water levels have not been above the preferred summer minimum criteria since 1995. Ecological condition: Long-term monitoring has shown reduced frog numbers, declines in canopy condition, changes in species composition to more terrestrial species and increases in abundance of exotic species. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields close to the crest of the Gnangara Mound with the intention of reducing abstraction impacts at sites in the area, including Lexia 186. The department also reviews public water supply abstraction annually, considering water level trends and criteria compliance. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of the Lexia wetlands. This action should help to maintain levels at Lexia 186.
						Min	**46.6** **4/6 yr**	**46.5** **4/6 yr**	**46.3** **4/6 yr**	**46.5** **4/6 yr**	**46.6** **4/6 yr**	**46.8** **4/6 yr**	**46.8** **4/6 yr**	**46.7** **4/6 yr**	**46.8** **4/6 yr**	**46.9** **4/6 yr**	
Melaleuca Park EPP173	6162628 (Staff)				50.2	Max	50.9	50.7	50.4	50.8	51.0	51.1	50.8	50.6	50.8	51.0	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Water levels have been non-compliant with the absolute summer minimum criterion since water level monitoring began in 1995. Minimum groundwater levels in monitoring bore GNM14 (AWRC ref. 61613213) are currently about 0.5 m lower than they were in the decade after monitoring began but have been relatively stable since 2017. The spring peak and summer minimum levels in 2022–23 were higher than in 2021–22. Ecological condition: Groundwater declines since the mid 2000s have contributed to the wetland species *Baumea articulata* and *Pericalymma ellipticum* almost disappearing from the transect. Despite lower water levels, *B. articulata* is still present in very low abundances. Other tree species remain in good health. Declines have also contributed to the degradation and loss of aquatic habitat for macroinvertebrates and a decline in macroinvertebrate richness. Richness in 2022 (18 families) has improved from a low of nine families in 2016, but is not as high as prior to 2009, when 23 to 26 families were recorded each year. It is presumed that the native fish *Galaxiella nigrostriata* is now locally extinct as the wetland dries up each year. The wetland is highly coloured and is the only wetland of all those in the sampling program to show organic acidity. Management and mitigation: Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of Melaleuca Park. Modelling indicates that this action should limit declines in groundwater levels at Melaleuca Park EPP173.
						Min	50.4	50.4	50.4	50.4	50.4	50.4	50.7	50.4	50.4	50.4	
	61613213 (Bore GNM14)					Max	50.3	50.1	49.3	50.2	50.3	50.8	50.1	49.8	50.3	50.4	
						Min	**48.8**	**48.7**	**48.5**	**49.0**	**48.8**	**48.7**	**48.7**	**48.6**	**48.8**	**48.8**	

Wetland	AWRC reference number	Water level criteria (mAHD)				Water level (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
		Spring peak		End of summer minimum			2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
		Pref	Abs	Pref	Abs												
Melaleuca Park Dampland 78 (GNM31)	61613231			65.4*	65.1	Max	65.3	65.2	64.9	65.1	65.2	65.4	65.5	65.4	65.6	65.9	Compliance and trends: **Compliant with absolute summer minimum criterion.** **Non-compliant with other criterion.** Minimum water levels have not been above the preferred summer minimum criteria since 2013–14. However, groundwater levels have been on a rising trend since 2016. Ecological condition: Long-term monitoring has shown reduced frog numbers, declines in tree health, changes in species composition to more terrestrial species and increases in abundance of exotic species. Management and mitigation: A cluster of bores was installed adjacent to GNM31 as part of the Perth shallow groundwater systems investigation (Searle 2009). Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of Melaleuca Park. Modelling indicates that this action should limit declines in groundwater levels at Melaleuca Park Dampland 78.
						Min	65.1 4/6 yr	64.9 4/6 yr	64.7 4/6 yr	64.7 4/6 yr	65.0 4/6 yr	65.2 4/6 yr	65.2 4/6 yr	65.1 4/6 yr	65.2 4/6 yr	65.3 4/6 yr	
Egerton Spring (B25)/ Egerton Spring (B25A)	61618607/ 61672233				39.29	Max	40.17	40.12	39.97	40.10	40.20	40.26	40.15	40.07	40.86	40.95	Compliance and trends: **Compliant with absolute summer minimum criterion.** Water levels have been compliant since 2003 and since then there has been a rising trend in response to increased localised recharge associated with the surrounding urban development. Additional information: The department was unable to continue monitoring at bore B25 because of access and safety issues. The department now uses B25A (AWRC ref. 61672233), located nearby, to measure water level criteria. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at Egerton Spring.
						Min	39.73	39.79	39.58	39.84	39.84	39.76	39.71	39.77	40.28	40.33	

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

Table A2 Terrestrial phreatophytic vegetation sites

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)		Water levels (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
				2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
MM16	61610835	38.8	Max	40.1	40.2	40.1	40.3	40.7	41.1	41.0	40.7	41.0	41.1	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at MM16.
			Min	39.2	39.5	39.3	39.5	39.8	40.0	40.0	40.0	40.1	40.2	
MM18	61610918	38.6	Max	39.9	40.0	39.6	40.0	40.2	40.6	40.6	40.2	40.5	40.5	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates that with the planned reductions to abstraction groundwater levels can be maintained at MM18.
			Min	38.6	39.2	39.1	39.2	39.4	39.6	39.6	39.5	39.6	39.5	
MM53	61610493	33.3	Max	34.0	34.0	33.5	33.7	34.0	34.3	34.1	33.7	34.1	34.1	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the Superficial aquifer from bores close to Whiteman Park, with the intention of reducing abstraction impacts at sites in the area, including MM53. The department reviews public water supply abstraction annually, considering water level trends and criteria compliance. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates that with the planned reductions to abstraction groundwater levels can be improved at MM53.
			Min	**32.8**	**33.1**	**32.9**	**33.1**	**33.1**	**33.3**	**33.2**	**33.1**	**33.2**	**33.2**	
MM55B	61610559	29.5	Max	30.5	30.5	30.3	30.4	30.6	30.8	30.7	30.2	30.7	30.7	Compliance and trends: **Compliant with absolute summer minimum criterion.** The site has been non-compliant with absolute summer minimum water level criteria in all years, except 2014–15, 2021–22 and 2022–23. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates that with the planned reductions to abstraction groundwater levels can be improved at MM55B.
			Min	**29.2**	29.7	**29.2**	**29.4**	**29.5**	**29.5**	**29.3**	**29.3**	29.5	29.6	
MM59B	61611025	36.3	Max	36.3	36.3	36.0	36.1	36.4	36.7	36.5	36.0	36.5	36.6	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the Superficial aquifer from bores close to Whiteman Park with the intention of reducing abstraction impacts at sites in the area, including MM59B. The department reviews public water supply abstraction annually, considering water level trends and criteria compliance. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates that with the planned reductions to abstraction groundwater levels can be improved at MM59B.
			Min	**35.5**	**35.6**	**35.4**	**35.5**	**35.6**	**35.8**	**35.6**	**35.5**	**35.6**	**35.7**	
MT3S	61610745	43.0	Max	44.6	44.5	44.3	44.6	44.9	45.0	44.8	44.5	44.9	45.1	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Groundwater modelling projections indicate that the ongoing urbanisation of East Wanneroo is likely to lead to increases in groundwater levels at MT3S in the coming years.
			Min	43.7	43.7	43.6	44.0	44.1	44.0	44.0	43.9	44.0	44.0	
NR6C	61610982	58.5	Max	59.7	59.5	59.1	59.5	60.0	59.9	59.7	59.5	59.6	59.9	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at NR6C.
			Min	58.9	59.0	58.7	58.8	59.0	59.0	59.0	58.8	58.9	59.0	

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)	Water levels (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
				2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
PM9	61610804	56.3	Max	55.0	54.7									Compliance and trends: **Non-compliant with absolute summer minimum criterion.** The bore is not currently being monitored because of safety issues associated with its location in a rifle range. Water levels at the site are now greater than 10.5 m depth to groundwater, and it is unlikely vegetation in the vicinity is accessing groundwater. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the Superficial aquifer in borefields close to the crest of the Gnangara Mound with the intention of reducing abstraction impacts at sites in the area, including PM9. The department reviews public water supply abstraction annually, considering water level trends and criteria compliance. Because of the likelihood that the surrounding vegetation is no longer groundwater-dependent, the department is proposing to remove the water level criteria at PM9. The Environmental Protection Authority is currently inquiring into this and other proposed changes to the proposal.
			Min	**54.3**	**54.1**	**51.8**								
PM24	61610697	40.5	Max	42.1	42.3	42.1	42.2	41.6	42.5	42.2	42.0	42.0	42.5	Compliance and trends: **Compliant with absolute summer minimum criterion.** Groundwater levels declined by about two metres at this site between the early 1980s until about 2011 and have been fairly stable since then. As commonly occurs at this site, monthly groundwater level measurements were not taken in September and October of the reporting period as the access track was inundated. As annual peak water level readings at this site have historically been recorded in September; the 2022 peak level would likely have been higher than the 42.5 mAHD reading (recorded in November). Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at PM24.
			Min	41.1	41.3	41.0	41.4	41.0	41.1	41.0	40.9	41.0	41.1	
WM1	61610833	55.7	Max	54.7	54.4	54.5	55.1	55.6	55.9	55.6	55.2	55.4	55.8	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Groundwater levels have fallen about four metres at this site since monitoring began in 1975 but bounced back slightly in 2017 and have been stable since then. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the superficial aquifer in borefields close to the crest of the Gnangara Mound, with the intention of reducing abstraction impacts at sites in the area, including WM1. The department reviews public water supply abstraction annually, considering water level trends and criteria compliance. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of WM1. Modelling indicates that this action should limit declines in groundwater levels at the site.
			Min	**54.2**	**54.1**	**54.1**	**54.3**	**54.7**	**54.9**	**54.9**	**54.6**	**54.6**	**54.7**	
WM2	61610908	66.5	Max	66.7	66.5	66.6	67.2	67.3	67.5	67.0	66.6	66.7	66.9	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Groundwater levels have fallen about three metres at this site since monitoring began in 1975 but have been relatively stable since 2012. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the aquifer in borefields close to the crest of the Gnangara Mound with the intention of reducing abstraction impacts at sites in the area, including WM2. The department also reviews public water supply abstraction annually, considering water level trends and criteria compliance. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of WM2. Modelling indicates that this action should limit declines in groundwater levels at the site.
			Min	**66.2**	**66.1**	**66.3**	**66.4**	66.7	66.7	66.5	**66.2**	**66.2**	**66.2**	

Groundwater monitoring bore	AWRC reference number	End of summer absolute minimum (mAHD)	Water levels (mAHD)										Status and comments on compliance during the 2022–23 annual reporting period
				2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	
WM8	61610983	64.8	Max	65.0	64.8	64.3	64.7	65.2	65.6	65.5	64.7	65.0	65.3	Compliance and trends: **Non-compliant with absolute summer minimum criterion.** Groundwater levels have fallen about four metres at this site since monitoring began in 1975 but have been relatively stable since 2012. Management and mitigation: The department has worked with Water Corporation to reduce groundwater abstraction from the aquifer in borefields close to the crest of the Gnangara Mound with the intention of reducing abstraction impacts at sites in the area, including WM8. The department also reviews public water supply abstraction annually, considering water level trends and criteria compliance. Under the *Gnangara groundwater allocation plan* (DWER 2022a), groundwater abstraction will be reduced in areas that are affecting Superficial aquifer levels in the vicinity of WM8. Modelling indicates that this action should limit declines in groundwater levels at the site.
			Min	**64.7**	**64.3**	**64.1**	**64.1**	64.9	65.0	**64.7**	**64.4**	**64.4**	**64.6**	
MM12	61610989	42	Max	43	43	43	43	43	44	44	43	44	44	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at MM12.
			Min	43	43	43	43	43	43	43	43	43	43	
L30C	61611010	47.2	Max	47.9	48.0	47.7	47.9	48.1	48.6	48.9	48.2	48.4	48.6	Compliance and trends: **Compliant with absolute summer minimum criterion.** Water levels in 2016 were the lowest on record. They have risen about 0.5 m since then and are currently stable. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at L30C.
			Min	47.5	47.7	47.3	47.3	47.6	48.0	48.0	47.8	47.8	47.9	
L110C	61611011	55.7	Max	57.4	57.6	57.4	57.6	57.8	57.9	57.7	57.3	57.5	57.7	Compliance and trends: **Compliant with absolute summer minimum criterion.** Minimum water levels have been stable in recent years. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at L110C.
			Min	57.1	57.3	57.1	57.1	57.3	57.3	57.2	57.0	57.0	57.1	
L220C	61611018	52.2	Max	53.1	53.9	53.4	53.8	54.1	54.4	54.3	54.1	54.5	54.7	Compliance and trends: **Compliant with absolute summer minimum criterion.** The minimum groundwater level in 2016 was the lowest on record. Minimum water levels have risen about 0.8 m since then. Modelling completed as part of the *Gnangara groundwater allocation plan* (DWER 2022a) indicates groundwater levels can be maintained at L220C.
			Min	52.3	53.1	52.8	53.1	53.2	53.3	53.3	53.2	53.4	53.6	

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 and Environmental Regulation (formerly Department of Water)

Period: 1 July 2022 to 30 June 2023

Table B1 Ministerial conditions and procedures

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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		**Non-compliant.** Strategies are implemented to reduce impacts on environmentally important sites. These include: • significantly reducing abstraction for public water supply • increasing licence compliance and enforcement activities • capping abstraction for private licensed water supply. Further reductions to both public supply, and private licensed groundwater abstraction will be implemented from 2028 as per the strategies outlined in the *Gnangara groundwater allocation plan* (DWER 2022a). Reductions to garden bore use through the garden bore roster change were implemented in September 2022. The 2022 Gnangara plan supports the targets of the State Government's 2019 *Waterwise Perth Action Plan* (Government of Western Australia 2019) and the *Kep Katitjin – Gabi Kaadadjan – Waterwise Perth action plan* 2 (Government of Western Australia 2022) to review groundwater allocation limits across Perth and Peel to ensure groundwater is used sustainably, in line with climate change.
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 *Ministerial 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		**Non-compliant.** Refer to the results given in Appendix A – Water level monitoring results for Ministerial sites for the Gnangara Mound groundwater resources for 2012–23. Several sites were non-compliant with the absolute minimum and/or peak water level criteria identified in Schedule 1 of *Ministerial Statement no. 819*. Fourteen sites were non-compliant in 2022–23, the same as in 2021–22.
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		**Not required at this time.** No change to proponent was made over the reporting period.
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 any change in proponent details.	Minister for the Environment		Overall		**Not required at this time.** No change to proponent was made over the reporting period.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
819: M 3-3	Proponent nomination and contact details	The nominated proponent shall notify the Chief Executive Officer of the EPA 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 any change in proponent details.	CEO		Overall	60 days of change	**Not required at this time.** No change to proponent was made over the reporting period.
819: M 4-1 1	Compliance audit and performance review	The proponent shall prepare an audit program and submit compliance reports to the EPA 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.** Performance and compliance with water level criteria, management activities and research initiatives are summarised in Sections 4 and 5 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 EPA 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.** The *Gnangara groundwater allocation plan* (DWER 2022a) includes strategies to work towards meeting the following objectives: • reducing the total volume of water abstracted from the Gnangara groundwater system towards a level that better reflects the recharge from rainfall because of climate change • protecting groundwater-dependent ecosystems from impacts associated with abstraction. It also proposes some changes to conditions in *Ministerial Statement no. 819*, which are being assessed by the EPA under section 46 of the EP Act. The department has prepared and submitted a Groundwater Monitoring and Management Plan as part of its proposed changes to implementation conditions. Until such time as a new Ministerial Approval Statement is issued, the Department of Water and Environmental Regulation (the department) continues to comply with the reporting requirements in *Ministerial Statement no. 819*.
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 EPA, 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 EPA, 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.
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 EPA, which address: • stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any ongoing 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 ongoing concerns being expressed.	Compliance report	CEO		Overall	By 1 December each year and more detailed reports by 1 February every three years.	**Compliant.** The *Gnangara groundwater allocation plan* (DWER 2022a) was finalised and released in June 2022. The accompanying *Gnangara groundwater allocation plan: Statement of response* (DWER 2022c) 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 2022 plan. Prior to the release of the 2022 plan, evaluation statements were completed in 2013 and 2015 for the 2009 Gnangara plan (DoW 2013a; DoW 2015). The 2009 and 2022 allocation plans, evaluation statements, and statement of response (DWER 2022c) are published on the department's website.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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 EPA, 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.** The department submits annual and triennial compliance reports that are performance review reports on compliance with water level criteria, management activities and research initiatives. In addition to the contents of this report, the 2022 *Gnangara groundwater allocation plan* and the Gnangara Groundwater Monitoring and Management Plan (submitted to the EPA early in 2023) set out the department's proposed environmental management program and commitments related to the Gnangara groundwater resources for the coming years.
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 EPA.	Available on website.	Reports made available on the Department of Water's website.	CEO		Overall	After EPA Acknowledge-ement letter being received. Department website.	**Compliant.** Gnangara annual and triennial compliance reports are available on the department's website.
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 immediately it becomes evident to the proponent.	Report in regular summaries sent to the Chief Executive Officer.	Letter to the Chief Executive Officer reporting non compliances with water level and other criteria as required. Compliance report.	CEO		Overall	Immediately as it becomes evident.	**Compliant.** The department reports annually to the EPA on non-compliance with water level and other criteria.
819: M 5-1	Management of the water resource	The proponent shall base decisions affecting the management of groundwater resources of the Gnangara Mound on the concept of sustainable yield of resources and maintenance of ecological systems in accordance with the objectives of *A State Conservation Strategy for Western Australia* (1987).	Base decision on the concept of sustainable yield of resources and maintenance of ecological systems in accordance with the *A State Conservation Strategy for Western Australia* (1987). Present relevant material in annual/triennial compliance reports.	Compliance report	Minister for the Environment		Overall		**Compliant.** The department recognises that sustainable yield of Gnangara groundwater has diminished because rainfall recharge has decreased. The department has reassessed future allocation of Gnangara resources based on reduced rainfall recharge in line with climate change as part of the development of the 2022 *Gnangara groundwater allocation plan* (DWER 2022a). The *Gnangara groundwater allocation plan: Methods* (DWER 2022b) report contains additional information on the science other information that informed the management decisions in the 2022 Gnangara 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 EPA on advice of Department of Biodiversity, Conservation and Attractions (DBCA, formerly Department of Parks and Wildlife [DPaW]).	Present relevant material in annual/triennial reports. Refer draft groundwater management planning reports to the EPA and the DBCA for comment. Make compliance reports publicly available (on the Department of Water and Environmental Regulation's website).	Compliance report. Draft groundwater management documents sent to DBCA/EPA for comment. Reports made available on Department of Water (now Department of Water and Environmental Regulation) website.	EPA	DBCA	Overall	Subject to regular review every three years.	**Compliant.** The *Gnangara groundwater allocation plan: Statement of response* (DWER 2022c) sets out our response to issues raised by stakeholders, including DBCA, in finalising the 2022 Gnangara plan. The department consults with DBCA routinely on groundwater-related management issues that either concern lands under its management, such as Yanchep National Park and Yellagonga Regional Park, or protected flora and fauna or Threatened Ecological Communities.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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		**Non-compliant.** The addition of the Perth and Southern desalination plants, and the Groundwater replenishment scheme to the Integrated Water Supply Scheme has reduced the pressure on the Gnangara groundwater system for public water supply. From 2012–13 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 department recognises that it remains non-compliant with about half of the environmental water provision criteria for the Gnangara groundwater resources proposal. The *Gnangara groundwater allocation plan* (DWER 2022a) outlines additional reductions to licensed groundwater entitlements and domestic garden bore use along with other strategies to help bring Gnangara groundwater resources back into balance. However, groundwater modelling conducted for the plan showed that even with significant reductions in groundwater abstraction, many existing environmental water provisions (water level criteria) could not be met under projected dry climate conditions. Changes to water level criteria were proposed in the Gnangara plan and the EPA is currently inquiring into the proposed changes under section 46 of the *Environmental Protection Act 1986*.
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 EPA and the DBCA (formerly 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/ DBCA	Overall		**Non-compliant.** Section 6.1 and Appendix C describe the department's environmental monitoring program (in line with the commitments in *Ministerial Statement no. 819*). The department undertakes management and research initiatives 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 (now Department of Water and Environmental Regulation) website.	Allocation limits made available on the Department of Water (now Department of Water and Environmental Regulation) website. Current water availability figures can be obtained from the department's Swan Avon regional office or through the department's water register.	Minister for the Environment		Overall	End of October each year	**Compliant.** Water availability figures are constantly changing. Up-to-date figures are available by contacting the department's Swan–Avon regional office or through the 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 and Environmental Regulation's website.	Allocation limits made available on the now Department of Water and Environmental Regulation website. Current water availability figures can be obtained from Swan Avon regional office or through the department's water register.	Minister for the Environment		Overall	End of October each year	**Compliant.** Water availability figures are constantly changing. Up-to-date figures are available by contacting the department's Swan Avon regional office or through the water register.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
819: M 9-1	Water conservation	The proponent shall actively encourage further reduction in public and private water demand in accordance with the *Securing our water future: A State Water Strategy for Western Australia* (2003) and other water conservation initiatives.	Engage in activity that supports water conservation.	Compliance report	Minister for the Environment		Overall		**Compliant.** The department has worked with local governments to investigate conceptual water supply and demand management options for North East Corridor urban expansion and Swan Valley agriculture, North Wanneroo agriculture and Western Suburbs Regional Organisation of Councils greenspaces. In 2019 the cross-agency *Waterwise Perth Action Plan* (Government of Western Australia 2019) was initiated to help transition Perth to become a leading waterwise city by 2030. It was a two-year plan overseen by the department and contained 31 actions to be delivered by eight agencies across a range of scales from households and buildings to city and urban. In 2022 the second two-year plan *Kep Katitjin – Gabi Kaadadjan Waterwise Perth action plan 2* (Government of Western Australia 2022) was released and it contains an expanded program of 41 actions to be delivered by eleven agencies. Action 7 of the Waterwise Perth action plan 2 is the implementation of the Be Groundwater Wise initiatives, which in 2022–23 included social media campaigns using well-known gardening expert Sabrina Hahn to raise awareness of the importance of using water-saving principles in the garden. September 2022 saw the implementation of the two-day-a-week sprinkler roster for garden bore owners, bringing them into line with scheme water users. Actions 9 to 13 focus on the implementation of Waterwise Councils, Waterwise Schools, Waterwise School Grounds, Waterwise Golf and Waterwise Business programs. Actions 21 and 22 specifically target water use efficiency improvements and reducing the reliance on groundwater in the agricultural and local government sectors in the Gnangara allocation plan area. Action 23 aims to improve the uptake of waterwise accreditation and certification programs in the nursery and tree farm sectors in the Gnangara allocation plan area.
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 EPA and the DBCA (formerly 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/ DBCA	Overall		**Compliant.** The *Gnangara groundwater allocation plan* (DWER 2022a) and the *Gnangara groundwater allocation plan: Methods* (DWER 2022b) contain information on a range of research and investigation programs that have been carried out in recent years by the department to improve the understanding of the Gnangara groundwater system. The PRAMS groundwater model has also recently been updated with the latest global climate model information.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
819: M 10-1 2	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 DBCA (formerly 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/ DBCA	Overall		**Compliant.** As part of the development of the *Gnangara groundwater allocation plan* (DWER 2022a), the department used PRAMS modelling to simulate groundwater levels under various pines, land use and climate scenarios. 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 conceptual model for determining ecological risk to groundwater-dependent vegetation across the Gnangara groundwater system as the climate changes (Sommer & Froend 2010). The model is based on 30 years of ecological and hydrological monitoring data. It has been an important management tool for assessing the impact of future land and water-use scenarios and for reviewing allocation limits for the Gnangara plan.
819: M 10-1 3	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 DBCA (formerly 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/ DBCA	Overall		**Compliant.** The department is using PRAMS modelling to improve understanding of the relationship between groundwater level and abstraction from unconfined and confined aquifers of the Gnangara system. The Perth Regional Confined Aquifer Capacity (PRCAC) study used robust and established science coupled with innovative research to improve our understanding of the deep Leederville and Yarragadee aquifers in the Perth region. 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.
819: M 10-1 4	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 DBCA (formerly 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/ DBCA	Overall		**Compliant.** The department has studied hydrogeology at several sites across the Gnangara groundwater system as part of the Perth shallow groundwater systems investigation. To date, 10 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. The department has engaged Edith Cowan University to examine the possibility of developing water quality trigger criteria at several monitored wetlands.

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
819: M 10-1 5	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 DBCA (formerly 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/ DBCA	Overall		**Compliant.** Water quality and macroinvertebrate monitoring in the Yanchep Caves ceased in 2013–14 because of low water levels and cave safety issues. Water loggers have been installed in some caves to monitor water levels. As water levels in caves reflect the surrounding groundwater levels, the department uses nearby monitoring bores to monitor cave water levels. The department has a good understanding of the relationship between groundwater levels and cave 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 at 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. We have worked with Water Corporation to reduce public water supply abstraction near the Yanchep National Park and further reductions are proposed. Reductions in abstraction, both public and private, and removal of pine plantations to the east will assist in improving groundwater levels in the vicinity of the Yanchep Caves.
819: M 10-1 6	Research and monitoring	The proponent shall participate in and undertake research and monitoring on the Gnangara Mound which includes: • 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 DBCA (formerly 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/ DBCA	Overall		**Compliant.** The conservation value of wetlands is a prime responsibility of DBCA (formerly 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, now Department of Water and Environmental Regulation).		Minister for the Environment		Overall		**Non-compliant.** Not the responsibility of the Proponent (Department of Water and Environmental Regulation).
819: M Proced-ure 2		The EPA may seek advice from other agencies or organisations, as required, to provide its advice.	The EPA to seek advice as required.		EPA	Other agencies as required.	Overall		**Non-compliant.** Not the responsibility of the Proponent (Department of Water and Environmental Regulation).

Audit code	Subject	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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 EPA.	Department of Water and Environmental Regulation 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: • **819: M 2, M 4, M 6, M 8** and **M 21** = DBCA (formerly the Department of Environment and Conservation [DEC]) • **819: M 21** = Forest Products Commission (FPC). Both the FPC and the then DEC made public submissions to the *Gnangara groundwater areas water management plan: draft for public comment* (DoW 2008a), which dealt with similar issues as the conditions. The department is working directly with these two advisory bodies on future management of the Gnangara, Pinjar and Yanchep pine plantations given the multiple objectives of the area – pine harvesting, Carnaby's cockatoo conservation and groundwater recharge. The department routinely works with DBCA on any groundwater management-related issues within its managed lands (such as Yanchep National Park and Yellagonga Regional Park), or in connection with threatened ecological communities or flora and fauna of conservation significance.

Table B2 The proponent's (Department of Water, now Department of Water and Environmental Regulation) environmental management conditions

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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		**Non-compliant.** Refer to the results given in Appendix A – Water level monitoring results for Ministerial sites for the Gnangara Mound groundwater resources for 2012–23. Several sites were non-compliant with the absolute minimum and/or peak water level criteria identified in Schedule 1 of *Ministerial Statement no. 819*. Fourteen sites were non-compliant in 2022–23, the same as in 2021–22.
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	DBCA	Overall		**Compliant.** The department reviewed the management objectives and allocation limits of Gnangara resources as part of the development of the 2022 *Gnangara groundwater allocation plan* (DWER 2022a). The plan proposes some changes to environmental conditions and water level criteria, which the EPA is inquiring into under section 46 of the *Environmental Protection Act 1986*. Gnangara plan evaluation statements were completed in 2013 and 2015 (DoW 2013a; DoW 2015). These statements evaluated the department's management of Gnangara groundwater resources against the objectives in the previous (2009) *Gnangara groundwater areas allocation plan* (DoW 2009a). The evaluation statements are available on the department's website. The most recent completed review of Ministerial conditions and commitments for the Gnangara mound is the 2007 *Review of Ministerial Conditions on the groundwater resources of the Gnangara Mound* (DoW 2008b) and confirmed in *Ministerial Statement no. 819*.
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 the Department of Water and Environmental Regulation's Gnangara Mound monitoring program.	Compliance report	Minister for the Environment	DBCA	Overall		**Non-compliant.** Water levels in Yanchep Caves have been declining for many years and accessible caves are now dry. We can no longer gain access to several caves because of safety concerns. This informed the decision to discontinue macroinvertebrate and water quality monitoring at the Yanchep Caves. Monitoring of surrounding Superficial aquifer groundwater bores is ongoing. We have also installed loggers in some of the bores in the caves to monitor cave water levels (Boomerang Gorge, Water Cave, Carpark Cave). Building on the work of the shallow groundwater system investigation, the department completed a study on the cause of rapidly declining levels in Loch McNess in Yanchep National Park (Kretschmer and Kelsey 2016). Working with DBCA, the department has reduced local abstraction in Yanchep National Park. It has also made changes to public water supply abstraction to limit impacts on the caves and adjoining Loch McNess. There have been reductions to some northern Superficial and Leederville licence entitlements in line with the recommendations in Kretschmer and Kelsey (2016). Further reductions in licensed groundwater entitlements are outlined in the *Gnangara groundwater allocation plan* (DWER 202a2), which also aim to improve groundwater levels in the vicinity of Yanchep National Park and the Yanchep Caves.

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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.** The department assesses water management strategies and plans against our legislation, policies and guidelines to ensure that: • water management opportunities and issues are addressed at the appropriate planning and design stages of urban development • proposed urban development does not result in adverse impacts to water resources and the environment. The department worked with the Department of Planning, Lands and Heritage (DPLH), City of Wanneroo and Urbaqua to complete the District Water Management Strategy for East Wanneroo. The existing environmental conditions set on lakes Mariginiup and Jandabup are important considerations for the establishment of Controlled Groundwater Levels and overall drainage designs for future urban development in the East Wanneroo area.
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 Statement nos. 438* and *496*.	Prepare a research and investigation program.	Submit research and investigation program to the EPA for approval. Compliance report.	EPA	DBCA	Overall	Within four months of a revised statement being issued following the 2004 Stage 1 section 46 review	**Compliant.** 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 (now DBCA). The department, together with research partners, is focusing management effort on the areas that will show the most benefit from changes to abstraction. This work has informed the *Gnangara groundwater allocation plan* (DWER 2022a) and includes: • updates to PRAMS • completion of the Perth Regional Confined Aquifer Capacity (PRCAC) studies that investigated the best locations and depth for sustainable abstraction from the Leederville and Yarragadee aquifers and for groundwater replenishment (or managed aquifer recharge) • completion of the Perth shallow groundwater system investigations (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 • a conceptual model of vegetation water requirements developed by Edith Cowan University, which was used in the draft plan, to assess the risk of impacts to groundwater-dependent vegetation under different water, land use and climate scenarios.
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	DBCA	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 six-year intervals.	Triennial compliance report	EPA	DBCA	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 PRAMS.

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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	DBCA	Overall	Within four months of a revised statement being issued following the 2004 Stage 1 section 46 review	**Compliant.** A Groundwater Monitoring and Management Program was submitted to the EPA in early 2023 to support its inquiry into the proposed changes to implementation conditions of the Gnangara groundwater resources proposal.
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	DBCA	Overall		**Compliant.** (See **819: P 6 1**)
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 six-year intervals.	Triennial compliance report	EPA	DBCA	Overall	Every six years (coincide with triennial report)	**Compliant.** Although the action states that a review must be compiled in triennial reports every six years, the EMP undergoes regular revisions as required. Recent revisions were made in 2010 and 2013 and have been previously reported. We assess the monitoring program each year to ensure that the right sites are being monitored based on water level and ecological condition trends. The department has also reviewed environmental objectives and monitoring as part of developing the *Gnangara groundwater allocation plan* (DWER 2022a) and has submitted a Groundwater Monitoring and Management Plan to the EPA for review as part of its request to change some of the implementation conditions in *Ministerial Statement no. 819* under the EP Act.
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, DPLH (formerly Department of Planning and Infrastructure), DBCA (formerly DEC) and other relevant agencies on the impact of land use on groundwater resources.	Liaise with the City of Wanneroo, the DPLH, DBCA and other relevant agencies.	Compliance report	Minister for the Environment	City of Wanneroo, DBCA 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		**Not required at this time.** (See **819: P 9**)

Audit code	Subject	Objective	Action	How	Evidence	Require-ment of	On advice from	Phase	When/ where	Status and further information for the 2022–23 annual reporting period
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		**Not required at this time.** The Gnangara Consultative Committee at the time of the Gnangara Sustainability Study provided a cross-government approach to the sustainable management of Gnangara groundwater resources. While it hasn't been reinstated, the department continues to consult with a range of stakeholders on sustainable use of Gnangara groundwater. To develop the *Gnangara groundwater allocation plan* (DWER 2022a) we consulted extensively with water users on how to adjust to climate change.
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 its proximity to environmentally sensitive areas and uses these classifications to distribute public supply abstraction to limit impacts at groundwater-dependent ecosystems.
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 of water levels continues to occur at Lake Nowergup all year round, but water levels continue to be non-compliant.
819: P 12	Reporting	Assessment of environmental impact(s) from groundwater abstraction for public water supply.	Require 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 reviews annual bore abstraction plans from Water Corporation to ensure that abstraction is distributed to limit impacts on groundwater-dependent ecosystems. Water Corporation also submits annual water monitoring summaries that report on compliance with environmental commitments made in its 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		**Compliant.** A similar commitment from previous *Ministerial Statement no. 438*: P 2 was stated as 'cleared' by the then 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 monitoring and management issues facing 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. Under the department's new four-year telemetry program, most of the monitoring bores in the Gnangara groundwater allocation plan area will be connected to telemetry systems by 2025.
819: P 14	East Gnangara wetlands	Offset environmental impact with environmental benefit.	Require Water Corporation to implement its 2001 wetland mitigation strategy and subsequent approved revision and report to the then DoW (now Department of Water and Environmental Regulation) 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 commissioning of the Lexia scheme	**Partially compliant.** Water Corporation has developed a wetland offset strategy, but it has not been fully finalised or implemented. Production from the Lexia borefield never reached full capacity because of environmental concerns and under the *Gnangara groundwater allocation plan* (DWER 2022a), abstraction from the borefield is likely to be reduced further or ceased altogether. The department has proposed a change to this implementation condition as part of its request for changes to implementation conditions under section 46 of the EP Act. The EPA is inquiring into the proposed changes.

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 no. 021, included Ministerial water level criteria based on environmental knowledge at the time. These were considered reasonable by the then Water Authority of Western Australia (WAWA) 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.

After further research on wetland water requirements, WAWA reviewed the Ministerial water level criteria in 1995 (WAWA 1995). The review highlighted that climate was an important factor affecting groundwater levels, and it was difficult to predict future groundwater levels given the uncertainty of future climatic conditions. Following the release of this report in 1996 the water service provision and water management arms of WAWA were separated to form Water Corporation and the Water and Rivers Commission. A new Ministerial statement (statement no. 438) with revised conditions was issued to the Water and Rivers Commission in 1997. With the addition of Water Corporation's new Lexia Borefield in the late 1990s another set of Ministerial conditions were established on the Water and Rivers Commission for the East Gnangara area in 1999 (*Ministerial Statement no. 496*).

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, East Gnangara and Jandakot mounds under section 46 of the *Environmental Protection Act 1986* (EP Act). The first stage of the review led to *Ministerial Statement no. 687* for Gnangara/East Gnangara (Government of Western Australia 2005a) and *Ministerial 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 2008b). Its purpose was to remove Ministerial criteria from sites where ecological values had been lost because of reasons other than groundwater level change, and from sites where analysis showed that abstraction was not the main factor influencing groundwater levels. This review eventually led to a revised *Ministerial Statement no. 819* being released in 2009, which as of December 2021 is the current set of environmental conditions under which the Gnangara groundwater resources are managed (Government of Western Australia 2009).

The second stage of the section 46 review proposed in 2001 was meant to be 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 was overtaken by more recent investigations into the shallow groundwater systems and ecological responses to climate. The results of these and other investigations has been used to develop the new *Gnangara groundwater allocation plan* (DWER 2022a). The plan was finalised in June 2022 after a three-month public comment period. The plan also proposes changes to water level criteria at some sites that will require assessment by the EPA under the EP Act and so a section 46 review process has been initiated. If the Minister for Environment, after reviewing the EPA's recommendations, determines that the implementation conditions should be changed, a new Ministerial Approval Statement will be issued, and an addendum will be added to the plan.

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