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

Gingin

groundwater and surface water allocation plans:

2024 evaluation statement

The Gingin area's groundwater and surface water resources interact in complex ways. Many of its streams feature large sections of perennial flow supported by groundwater discharge. Its aquatic systems sustain diverse communities of flora and fauna, with the species richness of fish and crayfish among the highest in south-west Western Australia.

The Gingin area is also one of Australia's premier agricultural regions, supporting 10 to 12 per cent of the state's horticultural production, with an estimated value of $152 million.

Along with the rest of south-west Western Australia, Gingin is facing challenges associated with climate change, such as the marked drying trend in rainfall since 1970. Climate projections for this area indicate rainfall will continue to decline into the future. This presents both a challenge and an opportunity for water users to maintain security of supply and improve their climate resilience by adopting smart and efficient farming and water use practices.

Acknowledgement of Country

The Department of Water and Environmental Regulation (the department) acknowledges the Yued and Whadjuk Noongar people as the Traditional Owners and custodians of the lands and waters covered by this evaluation statement, and their deep and continuing connection to the land and waters of the region.

We pay our respects to their Elders past, present and emerging, and to all members of the Aboriginal communities in the Gingin area and their cultures. We acknowledge that Traditional Owners have been custodians of Country for countless generations and that water is integral to life.

We recognise that Aboriginal people and their cultures across the Gingin area are diverse and that continued custodianship of the land and water is fundamental to their health, spirit, culture and community.

We embrace the spirit of reconciliation, and we seek to listen, learn, and build strong partnerships with genuine opportunities for Aboriginal people throughout our business.

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Water management in the Gingin area has a long history: its surface water resources were proclaimed in 1950, 1962 and 1970[1] and its groundwater resources in 1975.

In 2011, our predecessor agency – the Department of Water – released the *Gingin surface water allocation plan* (surface water plan). The plan sought to maximise the reliability of supply for existing water users and to minimise risks to the riverine environment.

In 2015, the Department of Water released the *Gingin groundwater allocation plan* (groundwater plan) to manage the area's groundwater in the context of high demand and a drying climate. The groundwater plan was developed in consultation with licensees, local government, the Gingin Water Group and West Koojan-Gillingara Land Care District Committee.

Both the groundwater and surface water plans specified the water resource objectives, water allocation limits and licensing policies to achieve the desired plan outcomes and objectives. We periodically evaluate the performance of water allocation plans as part of our ongoing adaptive management approach. These evaluations allow us to continually review and improve how we manage water resources under the plans.

In 2013, the Department of Water published an evaluation statement for the surface water plan. The statement acknowledged that declining rainfall and streamflow was a significant issue and recommended adaptive management actions focused on efficient water use and maintaining the values of the surface water resources. Furthermore, it identified additional management responses, including recouping unused entitlements and bringing allocation limits down to more sustainable volumes.

The 2022 *Gnangara groundwater allocation plan* (Gnangara plan) signalled this department's intent to reduce groundwater abstraction in the Gingin area, and to replace both the groundwater and surface water plans with a new, combined Gingin water allocation plan. We intend for the combined plan to capture the complex groundwater/surface water interactions throughout the Gingin area and to outline a consistent approach to managing groundwater resources to the north and south of Gingin Brook and Moore River estuary.

As a precursor to the new, combined plan, this statement evaluates both the existing groundwater and surface water plans. It is the first published evaluation of the groundwater plan and the second of the surface water plan. It identifies where management action is needed and outlines key considerations for the future objectives, management strategies and performance indicators for the new plan.

In addition, the department is developing a Gingin numerical groundwater model to support the new allocation plan. This will simulate the responses of the complex groundwater/surface water interactions in the area to changes in climate and water use (see 8.1 The next water allocation plan). We anticipate that a draft Gingin water allocation plan will be ready for public consultation in 2028. This is a change from the estimated timeframe of 2025 given in the 2022 Gnangara plan to allow for development of the new numerical groundwater model using the latest climate projections.

[1] Three separately proclaimed areas under the *Rights in Water and Irrigation Act 1914* (WA) are within the Gingin surface water planning boundary:

- Gingin Brook catchment area, 1962
- Moore River and certain tributaries, 1950
- Swan River system, 1970.

The Gingin surface water plan area includes the entire Gingin Brook catchment and its tributaries, and overlaps parts of the Gingin groundwater plan area and the Gnangara plan area (Figure 1).

The Gingin groundwater plan area is about 6,000 km^2 and extends north of Gingin Brook between Guilderton and Bindoon to Grey and Moora (Figure 1). It includes the northern part of the proclaimed Gingin groundwater area. The southern boundary of the plan area generally follows Gingin Brook and Moore River.

The new Gingin water allocation plan will include revised plan boundaries to include subareas south of Gingin Brook (that currently fall within the Gnangara groundwater allocation plan boundary). This change will allow the new Gingin plan to set a consistent management approach for groundwater abstraction to the north and south of Gingin Brook as groundwater on both sides of the brook influences the flow and health of the surface water system. The new plan will set revised allocation limits for these subareas and will more closely align them with the proclaimed Gingin groundwater area (Figure 1).

For ease of reference, we will refer to the area covered by the Gingin groundwater and surface water plans as the ‘Gingin area’ throughout this evaluation statement.

Figure 1 Map of the Gingin area showing the areas covered by the proclaimed Gingin groundwater area, the Gingin groundwater and surface water plans, and the northern portion of the Gnangara groundwater allocation plan

Contents

1. Updated management arrangements

Evaluation of the Gingin groundwater and surface water plans has found several ongoing risks to the groundwater and surface water resources in the southern part of the proclaimed Gingin groundwater area (Figure 1). This is an area of concentrated abstraction from connected groundwater and surface water resources at full allocation. It has high ecological values but climate change and abstraction have led to long-term declines in groundwater levels and streamflow, and several groundwater plan objectives have only partially been met (see 2. Status of Gingin water resources and 6. Evaluation of water resource objectives in the Gingin groundwater plan).

To help prevent further declines in these water resources, and reduce the risk of impacts on water users and the environment, the department has made four key changes to the Gingin groundwater and surface water allocation plans (see below) as an interim management step until the new Gingin water allocation plan is published[2].

Note that under the *Rights in Water and Irrigation Act 1914* (WA), the Minister (or their delegate) has the discretion to determine licence applications or amendments. When exercising that discretion, they will take into account the matters set out in clause 7(2) of Schedule 1 of that Act, this evaluation statement, the Gingin groundwater and surface water plans and other relevant considerations.

1.1 Surficial allocation limits capped at licensed entitlements

We have capped the allocation limits of surficial aquifer resources in the Gingin groundwater allocation plan area at current licensed entitlements.

Surficial resources are typically minor, discontinuous, low-yielding aquifer resources located adjacent to rivers and wetlands where proximal abstraction impacts and a drying climate are a concern for sustainability. These resources are often hydraulically connected to regional aquifers such as the Mirrabooka or Leederville-Parmelia which are generally fully allocated. Additional water licensed to a surficial resource may disproportionately impact on these regional aquifers or – as has been common in the past – surficial resources are mistaken for a regional aquifer where no surficial resource is present (with subsequent water take putting further pressure on the regional aquifers).

Capping the allocation limits of these resources sets a more realistic expectation of water availability across the Dandaragan Plateau (Figure 1). Furthermore, it prevents the issue of additional water entitlements that may further affect the connected regional aquifers and their dependent values, such as local rivers and wetlands.

If we are able to recoup any unused water entitlements before the new Gingin water allocation plan is published, we may reduce the allocation limits further to retire this recouped water, to help prevent an increase in abstraction from the resource.

In the new water allocation plan, we may decide to manage surficial aquifer resources as part of the regional aquifers where they are connected.

[2] The changes do not affect water use that is exempt from licensing

1.2 Updated groundwater licence and trade policy for Gingin watercourses

To better manage the connected systems impacted by climate change and water use in the southern part of the proclaimed Gingin groundwater area, we have updated local licensing policy 1.2 in the groundwater plan (see new policy 1.2a in Table 1 below). Policy 1.2a applies to the watercourses within the exclusion zones shown in Figure 2. Policy 1.2 in the groundwater plan will continue to apply to the watercourses of Gingin Brook and Moore River outside of the exclusion zones.

The new policy:

- Creates a 600 m 'exclusion zone' preventing new groundwater licences to take water and groundwater licence transactions (water trades) around certain watercourses. We defined the exclusion zone after considering land tenure and groundwater/surface water interactions (Figure 2). The 600 m exclusion zone is measured from the edge of the stream bank or connected wetland. We determined the width of the exclusion zone based on hydrogeological studies of the southern Dandaragan Plateau showing that cumulative abstraction within 600 m of a perennial watercourse can impact river baseflows (Johnson 2000).
- Considers the impacts of the drying climate and abstraction on streamflow outlined in this evaluation statement, and aligns with the objectives and actions of both the Gingin groundwater and surface water allocation plans.
- Applies until it is superseded by publication of the new Gingin water allocation plan.

Table 1 Gingin groundwater allocation plan local licensing policy 1.2a

Policy		Policy detail – what the department will do
1.2a	Managing licence and trade applications in resources surrounding groundwater-dependent watercourses in Gingin	• We will apply a 600 m exclusion zone in the areas where groundwater supports streamflow (see Figure 2). • We will not approve any new groundwater licence applications to take water or any applications which increase the entitlement of an existing licence within the exclusion zone. • We may approve applications to trade groundwater entitlements from within the exclusion zone to outside the exclusion zone. • We will not approve applications to trade groundwater entitlements from outside the exclusion zone to inside the exclusion zone. • We may not approve applications to trade groundwater entitlements from one location within the exclusion zone to another location within the exclusion zone. • We will not approve like-for-like swaps between surface water entitlements and groundwater entitlements within the exclusion zone.

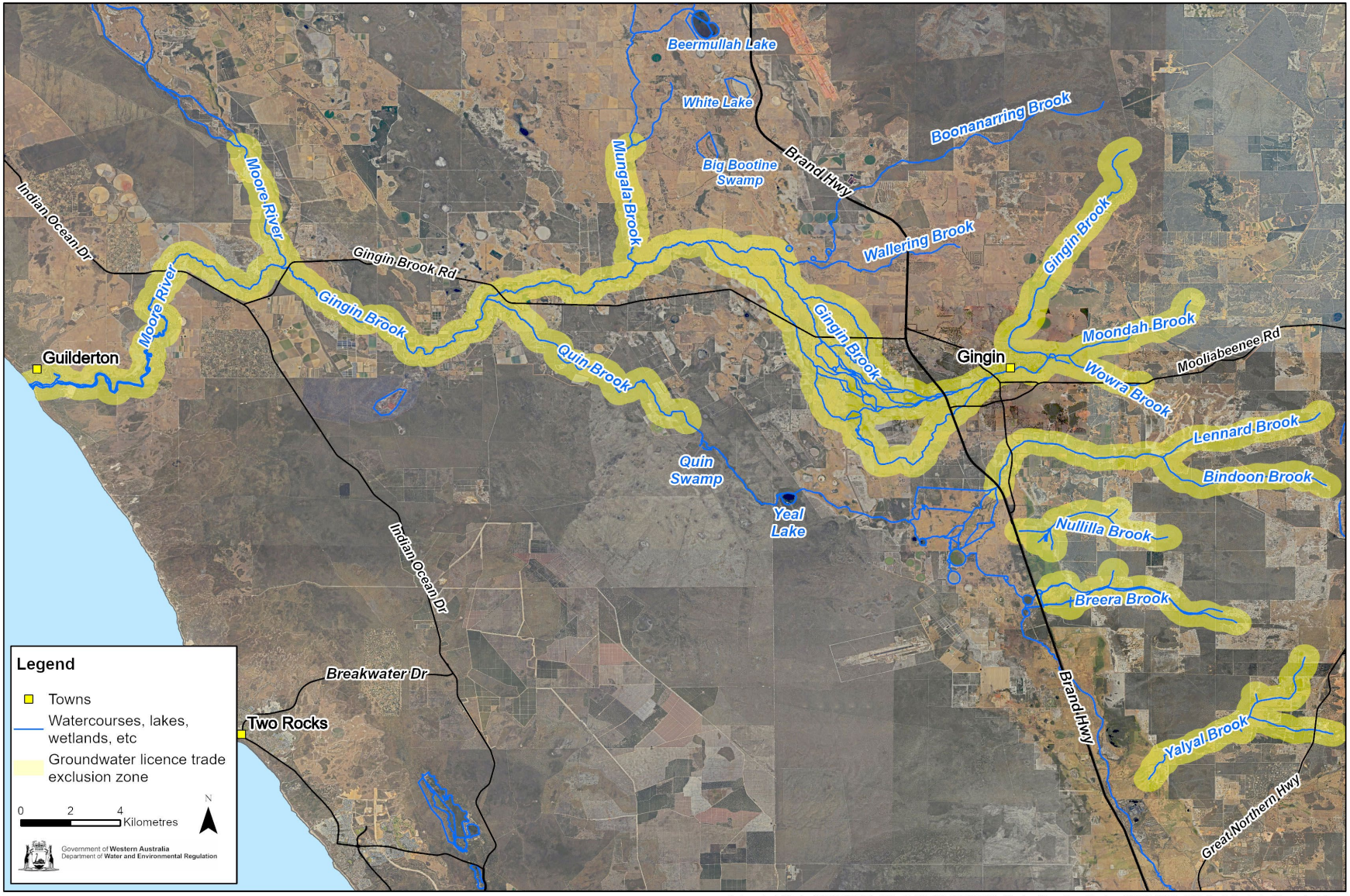


Figure 2 Groundwater licence and trade exclusion zones

1.3 Updated Cowalla subarea trading rules

We have updated local licensing policy 1.4 in the groundwater plan to disallow the trading of licences from the Leederville-Parmelia aquifer within trading zone 3 of the Cowalla subarea in the southern portion of the Dandaragan Plateau (Table 2 and Figure 3).

Policy 1.4 in the groundwater plan outlines the trading rules for the Leederville-Parmelia aquifer in the Cowalla subarea. The policy intent was to establish a trading market that encouraged trade northwards. It was designed to alleviate abstraction pressure in the Leederville-Parmelia aquifer in the southern part of the subarea and reduce the risk to groundwater-dependent ecosystems such as Gingin and Lennard brooks.

Under the previous trading rules that allowed trading within zone 3, there was a risk that unused entitlements could be traded and activated, potentially leading to a doubling of abstraction from the Leederville-Parmelia aquifer in the southern part of the Cowalla subarea – an increase of about 3.4 GL/year. This had the potential to cause further declines in groundwater levels and impacts on connected aquifers and surface water features such as Gingin and Lennard brooks.

To reduce this risk while we develop the new Gingin water allocation plan, we will no longer permit trading within zone 3 (see Table 2 below, which supersedes Table 6 in the groundwater plan).

Table 2 Revised trading rules (indicated in bold) between and within trading zones for the Cowalla Leederville-Parmelia resource

		Trading to		
		Zone 1	Zone 2	Zone 3
Trading from	Zone 1	Trading is permitted	Trading is not permitted	Trading is not permitted
	Zone 2	Trading is permitted	Trading is permitted	Trading is not permitted
	Zone 3	Trading is permitted	Trading is permitted	**Trading is not permitted**

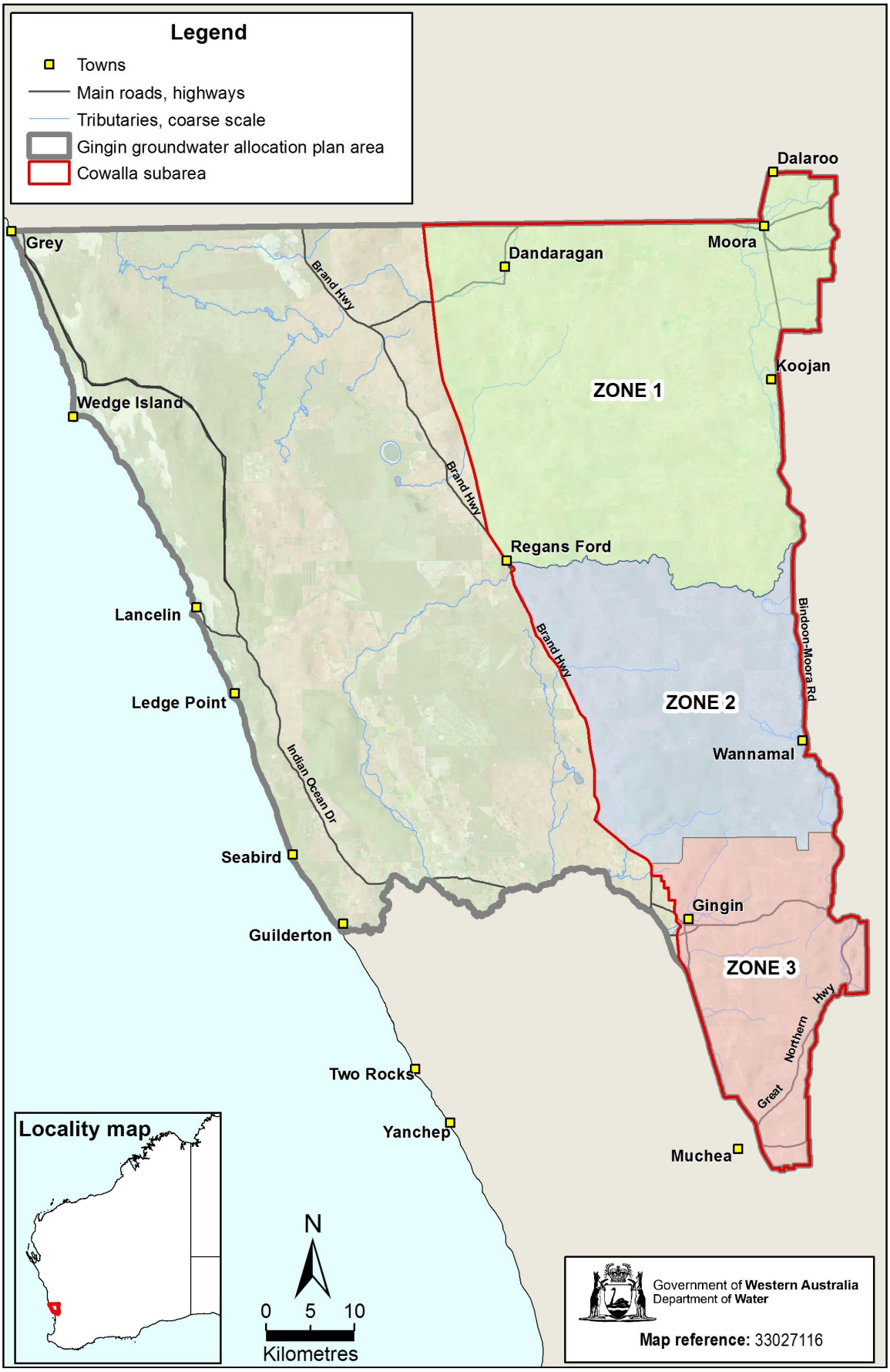


Figure 3 Trading zones in the Cowalla subarea

1.4 Revised low-flow thresholds

We have revised the low-flow thresholds in the 2011 surface water plan. The revisions are based on data from dry season monitoring of water quality and aquatic fauna in key refuge habitats collected since the plan was released. The refuges are near the Gingin gauging station (AWRC ref. 617058) on Gingin Brook and Molecap Hill gauging station (AWRC ref. 617165) on Lennard Brook (Table 3). This change is in line with Action 7 of the plan which states we may 'improve the critical low-flow thresholds to inform management of summer flows'.

The 2011 surface water plan includes critical low-flow thresholds for daily streamflow at the Gingin and Molecap Hill gauging stations as performance indicators against the plan's objectives. We updated the thresholds in the *Gingin surface water allocation plan: Evaluation statement 2011–2012* based on ecological investigations of Gingin Brook (Galvin & Storer 2012a) and Lennard Brook (Galvin & Storer 2012b).

We have further updated the thresholds in this evaluation statement based on an analysis of the monitoring data collected since 2013 (Table 3). Continued monitoring and ecological investigations have improved our understanding of the streamflow rates at the gauging stations, below which there is a potential risk to the aquatic ecosystem, through changes in water quality, stream connectivity and habitat availability. These changes do not reflect the point at which there is an immediate ecological impact, rather they are a trigger for us to conduct further investigations when lower flows occur. Thus we now refer to them as low-flow thresholds rather than 'critical' low-flow thresholds.

Table 3 Previous critical low-flow thresholds and revised low-flow thresholds (indicated in bold) for Gingin Brook and Lennard Brook

Stream and gauging station location	Low-flow thresholds from 2013 evaluation statement	Revised low-flow thresholds
Gingin Brook at Gingin gauging station (AWRC ref. 617058)	8 ML/day	**5 ML/day**
Lennard Brook at Molecap Hill gauging station (AWRC ref. 617165)	6.6 ML/day	**5.1 ML/day**

Gingin's water-dependent ecosystems

The Gingin area is home to a highly diverse and important network of waterways and wetlands, including rare and unique ecotypes. Many of these ecosystems are strongly connected to groundwater and supported by a reliable flow of high-quality water, even during periods of no rainfall. Several are relatively shallow with complex habitat – a particularly important feature for protecting the small-bodied fish and crayfish species that are endemic to south-west Western Australia. For many species, this area is near the northernmost extent of their range, which is likely a function of it being close to the northernmost extent of perennial flowing waterways in southern Western Australia.

In the south-eastern portion of the proclaimed Gingin groundwater area there are three unique internally draining systems (i.e. not connected to the ocean): Nullilla, Breera and Yalyal brooks (Figure 5).

Notably, across several aquatic species, some of the largest individuals in the south-west have been detected in Gingin waterways, including the threatened Carter's freshwater mussel (*Westralunio carteri*), which is listed as vulnerable under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and state *Biodiversity Conservation Act 2016* (BC Act). This suggests that these waterways have supported populations for many years.

In particular, Gingin and Lennard brooks have some of the highest diversities of native fish and crayfish in the southern half of the state, with 12 species known from these catchments alone. Three species of conservation significance have previously been found in the Gingin area: the Balston's pygmy perch (*Nannatherina balstoni*) (listed as vulnerable under the EPBC Act and BC Act), western mud minnow (*Galaxiella munda*) (listed as vulnerable under the BC Act) and Carter's freshwater mussel. Beermullah Lake is also a potential nursery ground for an inland population of western hardyhead (*Leptatherina wallacei*), which is typically an estuarine species.

Native aquatic species depend on the presence of good-quality permanent water and habitat. In a drying climate, it will be increasingly important to protect and enhance these permanent water habitats if we are to conserve biodiversity and the range of benefits that a healthy ecosystem provides us.

Gingin's stream and wetland ecosystems are naturally most vulnerable during the dry season, when water levels and streamflow are maintained predominantly by groundwater discharge. At this time, habitat availability is reduced, species congregate in smaller areas and water quality conditions can approach the limits of species' tolerances. This is also the time when demand for irrigation water is at its highest, and periods of hot weather often coincide with an increase in water use. This compounds the pressure on Gingin's water-dependent ecosystems during this vulnerable period, when along with higher water temperatures, critical drops in water level and dissolved oxygen can occur.

2. Status of Gingin water resources

Like other areas in south-west Western Australia, groundwater levels and streamflow in the Gingin area are being impacted by reduced rainfall due to climate change. The south-west has experienced declining rainfall since the 1970s, particularly in autumn and early winter. Rainfall decline in this region has been larger than anywhere else in Australia. Mean temperatures have also increased by about 1.1°C since 1910, with the rate of warming higher since 1960 (DWER 2021).

Average annual rainfall in Gingin since 2011 has been about nine per cent lower than the period 1975 to 2010. Seasonal rainfall patterns are also changing. Rainfall volumes over the winter wet season are lower, with peak rainfall occurring later in the season, and more rainfall occurring over the dry season (Figure 4).

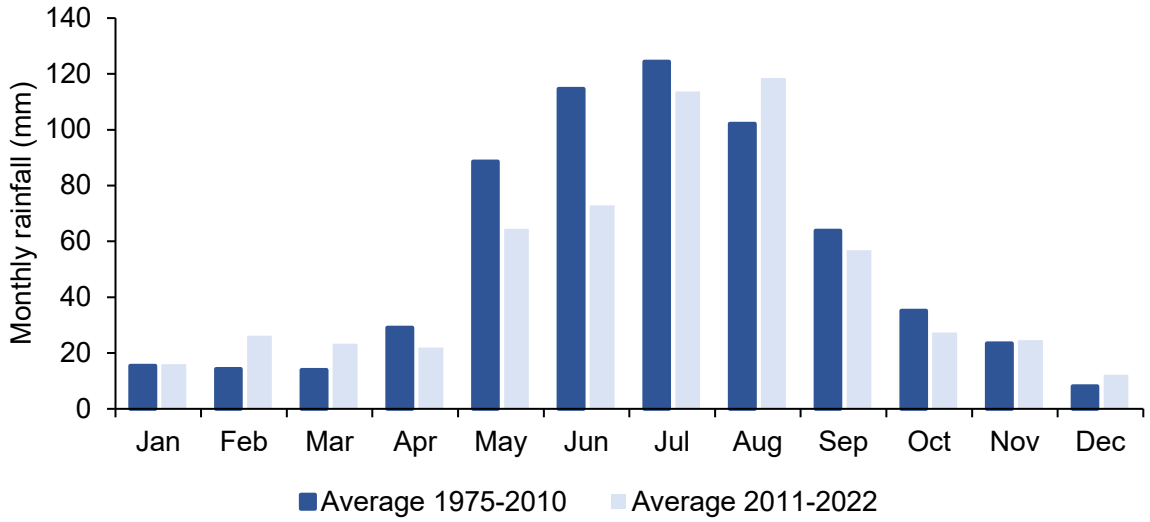


Figure 4 Average monthly rainfall at Gingin weather station (9018)

The effect of declining rainfall on the region's groundwater-dependent streams is exacerbated by the connectivity between surface water and groundwater resources. Streamflow has declined in Gingin and Lennard brooks not only because of reduced runoff, but also in response to reduced groundwater recharge and diminishing groundwater discharge to the streams. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has listed Gingin Brook and aquifers on the Dandaragan Plateau as one of the water resources most affected by climate change in south-western Australia (CSIRO 2009).

2.1 Groundwater resources

The department maintains a network of about 200 monitoring bores across the Gingin groundwater plan area to inform our understanding of the region's groundwater resources. Some of these are shown in Figure 5 and appendices A–C. Many of these bores have been installed since the groundwater plan was published in 2015, including more than 50 for the department's East Midlands groundwater investigation, which is improving our understanding of the hydrogeology of the Dandaragan Plateau.

The Gingin groundwater plan divided the plan area into 25 groundwater resource subareas for administrative purposes. Figures 2 to 5 across pages 8 to 11 in the groundwater plan show where the aquifers and subareas are located. We used 39 monitoring bores across the five major aquifers in the plan area to evaluate the performance of the plan's water resource objectives (see Figure 5). As part of this evaluation, we analysed groundwater level trends at these bores (see 6. Evaluation of water resource objectives in the Gingin groundwater plan). See appendices A–C for the hydrographs of these bores, together with 27 additional bores located along Gingin Brook for monitoring groundwater/surface water interaction. Groundwater levels from these bores show varying trends across the plan area. Trends are influenced by rainfall recharge, abstraction and aquifer connectivity. See 6. Evaluation of water resource objectives in the Gingin groundwater plan for a detailed analysis of groundwater trends across the groundwater plan area.

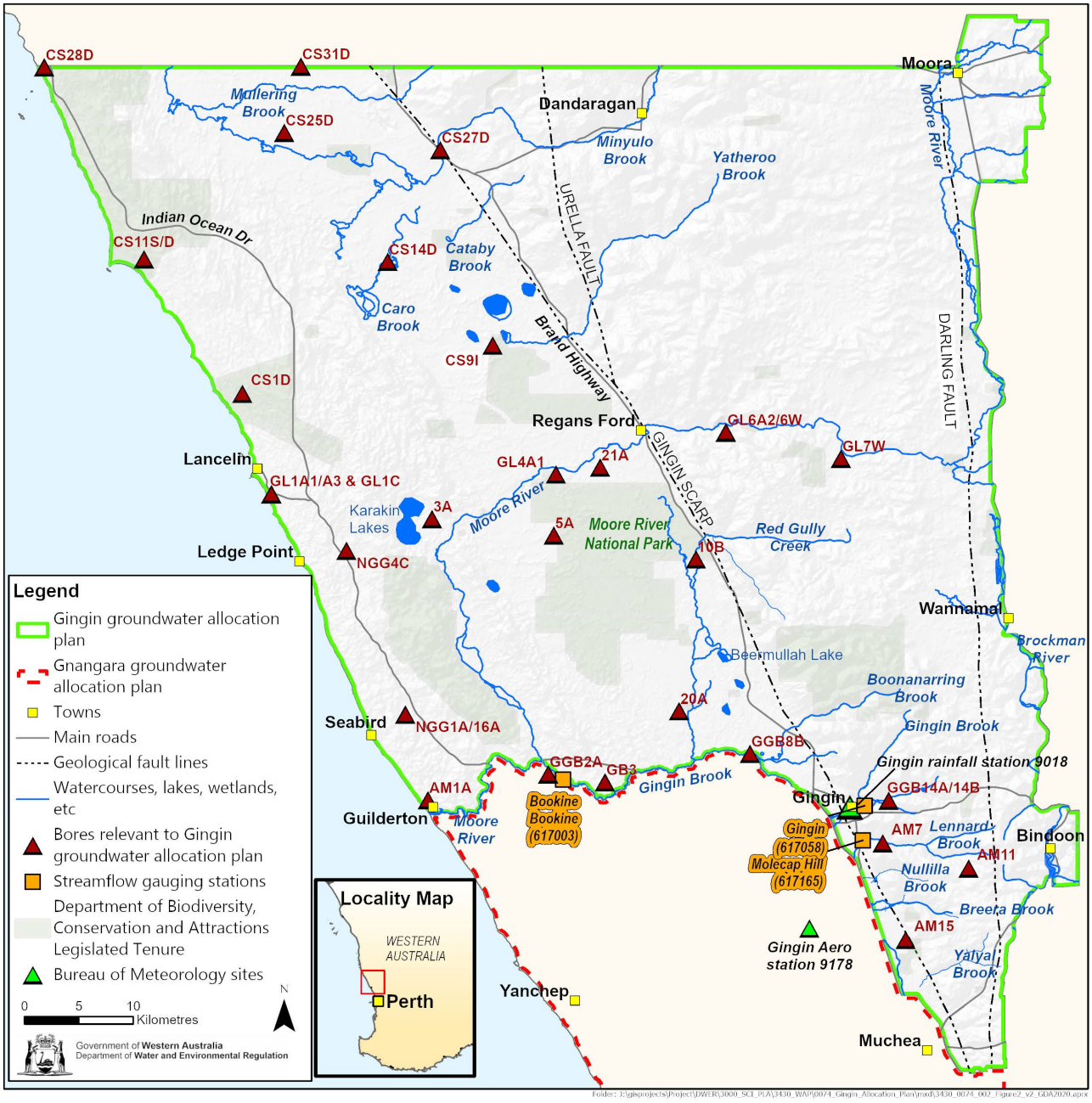


Figure 5 Monitoring bore, streamflow gauging and meteorological station locations in the Gingin area to which we refer in this evaluation statement

The trends are particularly concerning in an area of the Leederville-Parmelia aquifer in the southern part of the Cowalla subarea (southern portion of the Dandaragan Plateau), which supports shallow groundwater and dry season streamflow in several brooks (Figure 6).

Hydrographs for the Leederville-Parmelia aquifer in this area show 10 metre declines in groundwater levels since the 1990s because of reduced rainfall recharge and cumulative abstraction. Since 2010, some stabilisation in levels is evident, likely because no new licences have been granted and annual abstraction volumes have remained the same (Figure 6).

It is important to reduce the likelihood of an increase in abstraction from the Leederville-Parmelia aquifer in the southern part of the Cowalla subarea, not only to regain aquifer equilibrium but also to protect the ecosystems supported by shallow groundwater and dry season streamflow in the area.

We have updated local licensing policy 1.4 from the Gingin groundwater plan to prevent trading of groundwater entitlements from the Leederville-Parmelia aquifer within trading zone 3 of the Cowalla subarea (see 1. Updated management arrangements). This action will help to protect dependent ecosystems while the new Gingin water allocation plan is being developed.

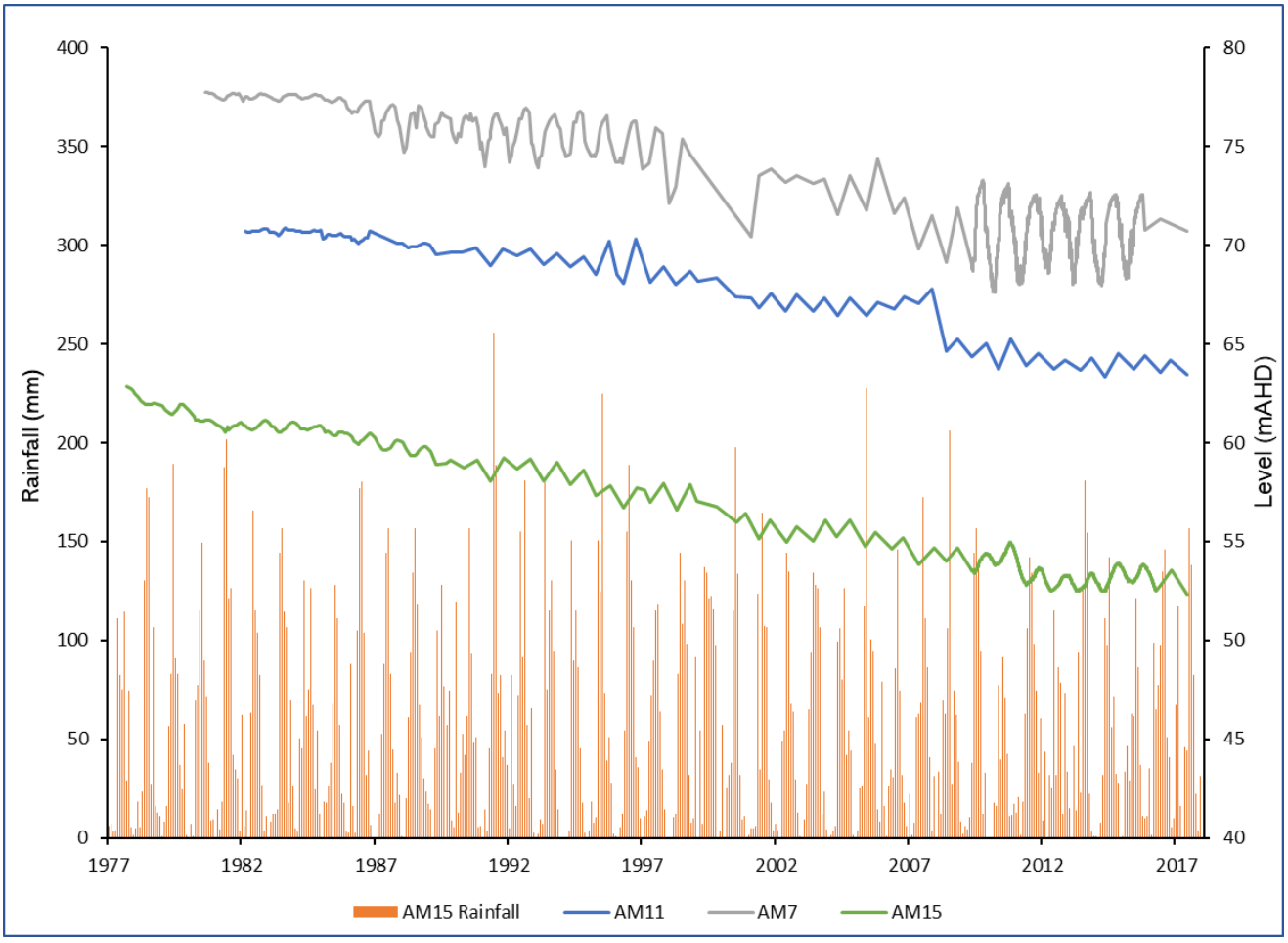


Figure 6 Groundwater level trends in the southern Leederville-Parmelia aquifer (see Figure 5 for monitoring bore locations)

2.2 Surface water resources

The department monitors the status of key surface water resources under the Gingin surface water plan using the gauging stations Gingin (AWRC ref. 617058) for Gingin Brook and Molecap Hill (AWRC ref. 617165) for Lennard Brook (Figure 5).

We first saw consistently lower dry season streamflow volumes (when flow is needed to support irrigated agriculture) at the Gingin and Molecap Hill gauging stations from around 2008 (Figure 7). Since 2011, dry season flow volumes at both gauging stations have been lower but relatively stable (Figure 7). Dry season streamflow in these sections of the brooks is driven by groundwater discharge east of the Gingin Scarp. The relatively stable dry season flows since 2011 indicate groundwater discharge has also been relatively stable over this time.

Of note, Leederville-Parmelia aquifer levels have also stabilised since around 2011 (Figure 6) and these may be supporting stable dry season flow volumes at the Gingin and Molecap Hill gauging stations over the same period.

Both average annual and dry season streamflow is much lower in the period since 2011 when the surface water plan was released (Table 4).

Table 4 Percentage change in average annual and dry season streamflow before and after the Gingin surface water plan was released (1975–2010 compared with 2011–2022)

Change in streamflow volumes between 1975–2010 and 2011–22	Gingin Brook at Gingin (AWRC ref. 617058)*	Lennard Brook at Molecap Hill (AWRC ref. 617165)
Average annual streamflow change	-27%	-17%
Average dry season streamflow change (November–April)	-34%	-16%

* 2022 data not included for Gingin Brook due to measurement issues

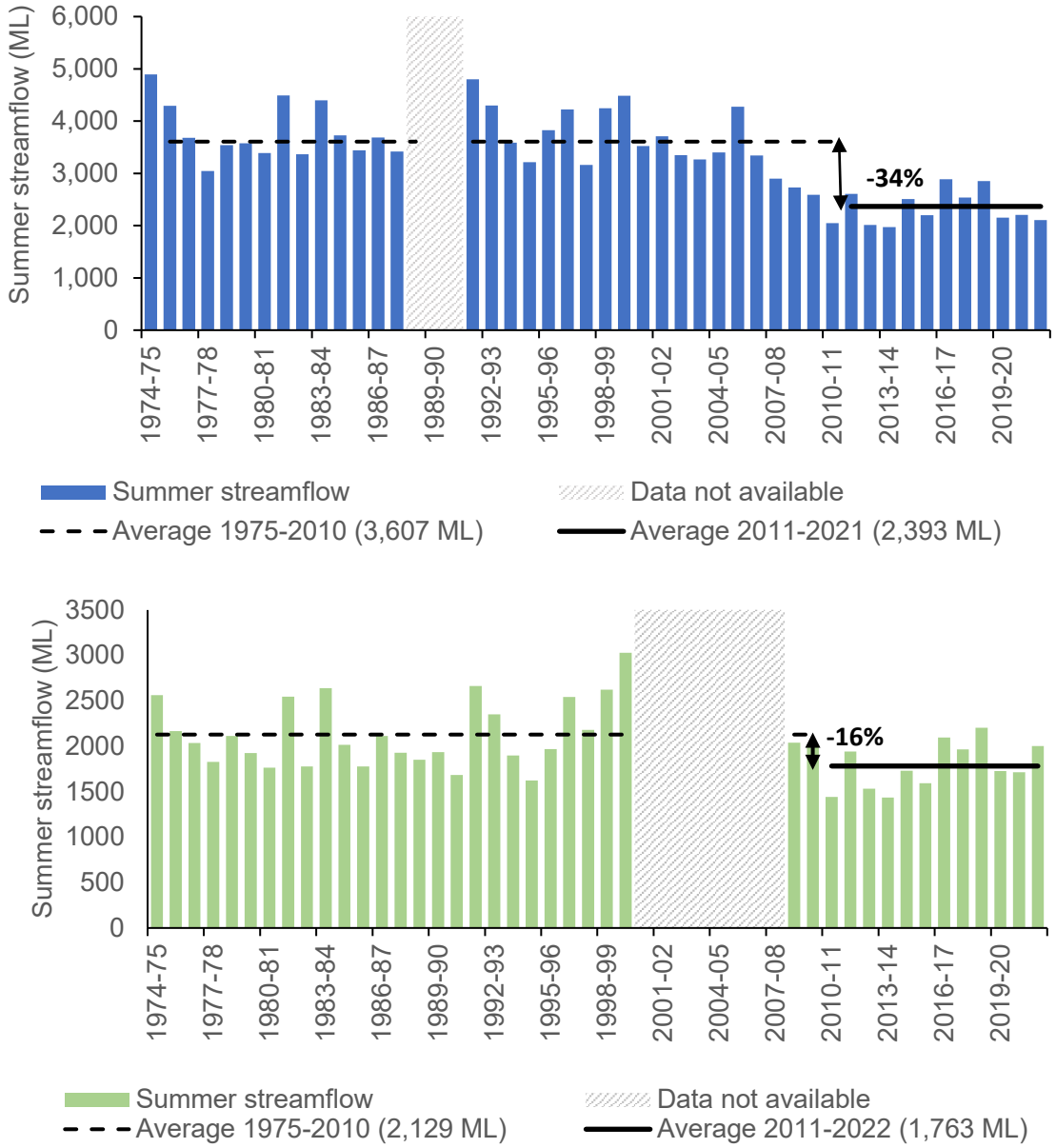


Figure 7 Declines in dry season (November–April) streamflow observed since 2011 in Gingin Brook at Gingin gauging station (top, blue) and Lennard Brook at Molecap Hill gauging station (bottom, green) (see Figure 5 for locations)

3. Status of groundwater use

3.1 Groundwater availability

Since the Gingin groundwater plan was published in 2015, the number of fully allocated groundwater resources has increased from six to 10 of the 35 resources. A further eight surficial resources have been capped at current licensed entitlements as part of this evaluation (see 1. Updated management arrangements), bringing the total to 18 fully allocated groundwater resources. In five additional resources, the remaining available water is reserved for future public water supply.

Since 2015, groundwater resources have reached full allocation because of:

- the uptake of available groundwater
- the approval of licence applications that were pending with the department at the time the plan was published
- updates to licences when new hydrogeological information became available (resulting in a change to the groundwater resource the licence was issued against)
- the granting of temporary licences for mining proposals.

The volume of groundwater available for licensing has decreased from 68 gigalitres in 2015 to the current availability of 20 gigalitres. Capping of surficial resources accounts for 14 gigalitres of the total decrease, while 34 gigalitres in licensed groundwater entitlements that have been granted since 2015 accounts for the rest.

Groundwater is currently available from four of the five major aquifers and spread out across the plan area. However, no water is available from the Leederville-Parmelia aquifer across the Dandaragan Plateau (Figure 1), the Cataby Yarragadee aquifer resource in the northern half of the plan area, or from the shallow Mirrabooka, Superficial and Leederville aquifer resources in the south in areas surrounding environmentally sensitive surface water features. Access to available water may be restricted by land tenure, proximity to groundwater-dependent ecosystems, drilling costs to access deep aquifers, and aquifer water quality in some areas.

Note that water availability changes daily as licences expire or are relinquished, unused entitlements are recouped, or new or amended licences are granted. Contact our Swan Avon regional office to confirm groundwater availability.

3.2 Trends in groundwater use

Irrigated agriculture and horticulture remain the dominant water uses throughout the Gingin area. We have received applications for large entitlements in the northern half of the area, with ‘economies of scale’ supporting operations that are a greater distance from markets and ports. Large growers have also accumulated substantial water entitlements to secure sufficient water supplies for future expansion. Finite, typically 10-year mineral sand mining operations are responsible for the temporary full allocation of the northern Yarragadee aquifer resources.

We also receive regular enquiries and applications for surficial resources which are typically unreliable and low yielding. The large volumes of surficial water showing as available on our water register has led to unrealistic expectations of water availability across the Dandaragan Plateau and contributed to our decision to cap surficial allocations at current licensed entitlements (see 1. Updated management arrangements).

3.3 Recoup of unused licensed groundwater entitlements

When the Gingin groundwater plan was released in 2015, we intentionally set allocation limits for certain resources below the level of licensed entitlements. This aimed to trigger recovery of these resources through the recouping of unused groundwater entitlements. As a result, some unused water has been recouped in the fully allocated Central Coastal Leederville aquifer resource, and the Eclipse Hill, Lancelin and Guilderton North Superficial aquifer resources. These resources remain fully allocated and, in line with the plan's recovery strategy, the recouped water will not be made available for licensing.

We will continue seeking to recoup unused licensed entitlements when assessing applications to renew groundwater and surface water licences, consistent with our *Policy – Management of unused licensed water entitlements*.

We recognise an ongoing risk that licensees may activate unused groundwater entitlements and therefore further increase abstraction in fully allocated, environmentally sensitive areas. We have updated local licensing policy to address the plan areas most susceptible to this issue (see 1. Updated management arrangements).

3.4 Groundwater use and trading from the Cowalla Leederville-Parmelia aquifer resource

When the Gingin groundwater plan was published in 2015, we allowed the trading of Leederville-Parmelia aquifer licences within trading zone 3 (see Figure 3) under local licensing policy 1.4 of the plan. The policy did not allow trading between trading zones in a southerly direction. Its intent was to alleviate abstraction pressure in the Leederville-Parmelia aquifer in the southern part of the subarea by encouraging trades in a northerly direction.

In 2020 we estimated the volume of water being abstracted from the Leederville-Parmelia aquifer across the Dandaragan Plateau. This work showed that only half of the licensed entitlements in trading zone 3 (southern part of the Cowalla subarea) were being used. Since 2015 there have been 19 trades or transactions from the resource totalling about 3.5 gigalitres, with most occurring within trading zone 3. A single trade shifted 0.03 gigalitres of water out of trading zone 3. Continuing to allow trading of Leederville-Parmelia licensed entitlements within trading zone 3 will increase the risk of activating unused entitlements and thus of further depressurizing the aquifer and causing impacts to groundwater-dependent ecosystems and baseflows.

To reduce this risk while we develop the new Gingin water allocation plan, we will no longer permit trading within zone 3 (see Table 2 and 1. Updated management arrangements).

4. Status of surface water use

4.1 Surface water availability

All surface water resources in the Gingin surface water plan area have remained fully allocated since the plan was released and no new water is available for licensing.

There is a need to reduce surface water allocations from Gingin and Lennard brooks because of:

- long-term declines in streamflow due to climate change
- less groundwater discharge to the brooks, resulting in fewer/shorter river reaches with permanent flow
- an increasing risk to future supply for existing water users and the environment as flows decrease.

Therefore, our focus for surface water management is on ensuring existing water users have security of supply and that the regionally significant environmental values of the brooks are protected as rainfall declines into the future.

4.2 Recoup of unused surface water entitlements

To help achieve security of supply for existing water users and protect the significant values of Gingin and Lennard brooks, we have been recouping unused licensed entitlements and lowering surface water allocation limits (Table 5). By way of this work, the volume of surface water allocated in the surface water plan area has decreased by 68 per cent (3.1 gigalitres) (Table 5). This has reduced the risk of increased take from the brooks in the years to come and increased the likelihood of meeting minimum dry season flow requirements.

The activation of unused licensed entitlements poses an ongoing threat to surface water resources. More water taken from the brooks for use, particularly in times of lower flow, may eventually lead to stream disconnection and deterioration in water quality, which in turn can adversely affect ecological health and negatively impact security of supply for water users.

Over time we have reduced the surface water allocation limits in line with the surface water plan's recovery strategy. Through this work no licensed surface water abstraction in the Gingin Brook catchment now exists west of the Brand Highway on the Swan coastal plain (Figure 4 and Table 5). Smaller-scale riparian users, who are exempt from licensing, still access surface water from Gingin Brook in the area.

Table 5 Change in licensed surface water entitlements since the release of the Gingin surface water plan

Stream section	Licensed surface water entitlements (kL/yr)	
	April 2011	September 2023
Gingin Brook and tributaries east of Brand Highway	1,599,000	748,000
Gingin Brook west of Brand Highway	603,000	0
Lennard Brook	2,409,000	722,000
Total	**4,611,000**	**1,470,000**

4.3 Low-flow thresholds to protect stream ecology

To monitor and communicate how dry season streamflow is supporting stream health in areas of high water use, we use low-flow thresholds (Table 3).

The low-flow thresholds (5 ML/day for Gingin Brook and 5.1 ML/day for Lennard Brook) apply to the sections of Gingin and Lennard brooks upstream of the Brand Highway (Figure 1). They indicate a flow rate at the Gingin and Molecap Hill gauging stations, below which there is a potential risk to aquatic species through changes in water quality, stream connectivity and habitat availability.

They are a useful guide for landholders along the brooks when checking streamflow data from the department's gauging stations, particularly during the dry season and periods of hot weather, when the brooks are under the most pressure. Streamflow data can be accessed via our River level monitoring webpage (use Figure 5 to locate a gauging station in your area of interest).

We monitor daily streamflow relative to the low-flow thresholds during the dry season. Flows that fall below the low-flow thresholds for more than two days trigger further investigation on our part and may lead to restrictions on pumping if there is a risk to other users or the environment. Where there is a risk of flows approaching the low-flow thresholds (e.g. following a dry year or consecutive dry years), we will conduct biological and water quality monitoring investigations to determine the risk to stream health and any response required.

The streamflow information can help landholders identify times of low flow that may pose a risk to downstream water users and the environment. Landholders may wish to consider how they might adapt their groundwater or surface water use to preserve flow during these times (see 7. Evaluation of water resource objectives in the Gingin surface water plan and Appendix D).

Surface water use and short-term pumping impacts

Permanent streamflow in the Gingin and Lennard brooks east of the Brand Highway provides water for licensed surface water use. Since 2010, dry season flow in the brooks has been approaching the low-flow thresholds. If flow falls below these thresholds there is a potential risk to the aquatic ecosystem, through changes in water quality, stream connectivity and habitat availability.

Summer is a high stress period when low rainfall, high temperatures and high evapotranspiration combine with peak periods of pumping for irrigation purposes, resulting in high volumes of water loss from the brooks. These cumulative impacts are regularly observed in monitoring data during the peak of summer. See Figure 8 for an example of this at Gingin Brook.

After weekends or spells of hot weather, reductions in brook flows lasting one to two days followed by a recovery several days later, are often observed (Figure 9). These patterns of fluctuation in surface water flow can be linked to the effects of surface water pumping, as licensees take advantage of off-peak electricity rates at night and over weekends or increase irrigation rates in hot weather.

A sustained low-flow period may affect the ability of downstream water users to access a sufficient quantity or quality of water for supply. Low-flow periods can also negatively affect the ecology of the brooks by reducing water levels and restricting the access of aquatic fauna to important habitat. They can also cause less water to circulate in river pools, which leads to insufficient dissolved oxygen levels for fauna. Water users should be aware of these impacts and consider their water use needs accordingly.

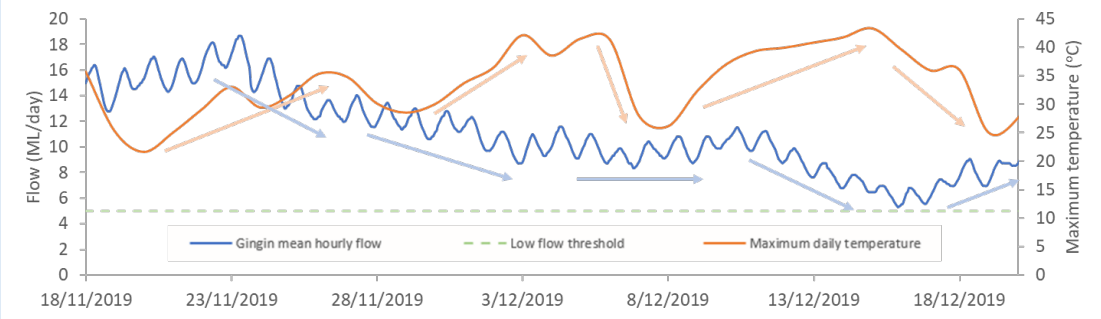


Figure 8 Hourly streamflow at Gingin gauging station and maximum daily air temperature at Gingin Aero meteorological station 9178 (Figure 5). The graph shows the relationship between hot weather periods and streamflow leading into the dry season (mid-November to mid-December 2019)

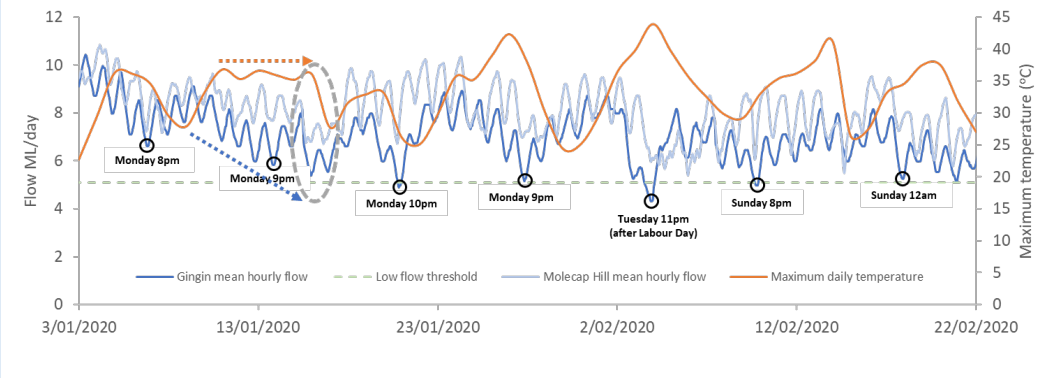


Figure 9 Hourly streamflow at Gingin (upper Gingin Brook) and Molecap Hill (Lennard Brook) gauging stations, and maximum daily air temperature at Gingin Aero meteorological station 9178 during January and February 2020. The graph shows how sustained periods of hot weather and water use over weekends is contributing to low-flow events

We have been pro-active about communicating the risks of summer low flows to the community. We provide advice on how groundwater and surface water users can help reduce impacts on stream levels. To date, this has included:

- making phone calls and sending emails and bulk mailouts to landholders along the brooks
- publishing the *Protecting Gingin Brook factsheet*, which featured on the Gingin Shire's website and Facebook page, and was cited in the *Northern Valley News, North Coast Times, The Advocate* and the Shire of Gingin's *Council to Community* newsletter (see Appendix D)
- presenting to the Gingin Shire, Gingin Water Group, Chittering Landcare and broader community
- providing information and advice to media outlets to spread the message as widely as possible – this has led to a variety of published articles being made available for the Gingin community to access.

5. Status of ecological values

Under the department's Healthy Rivers program, we make standardised assessments of river health in strategic locations across south-west Western Australia, including in the Gingin area. The program collects and interprets biological, water quality and habitat data on rivers and their catchments to support the development of strategies to best protect the environment.

We have conducted periodic river health assessments in the upstream catchment of Gingin Brook and in Lennard Brook since 2011. These assessments have sought to understand how the ecology of the brooks may be responding to changing flow and water quality conditions. The assessments indicate that even though lower streamflow has prevailed since the release of the Gingin surface water plan, it has been enough to maintain water quality, as well as fish and crayfish communities in the brook's catchments east of the Brand Highway.

This assessment was based on:

- key water quality parameters remaining within ranges suitable to support the lifecycles of native fish and crayfish, measured within important refuge habitats throughout the dry season
- maintenance of habitat availability and complexity
- the richness, abundance and age distribution of fish and crayfish species in 2017, 2019 and 2023 being consistent with those sampled in 2011 – suggesting that flows since 2011 were sufficient to provide for aquatic biota lifecycles.

Gingin and Lennard brooks continue to be some of the most diverse and ecologically important streams in south-west Western Australia.

Streamflow during the dry season assessment periods remained above the current low-flow thresholds of 5 ML/day for Gingin Brook (Gingin gauging station) and 5.1 ML/day for Lennard Brook (Molecap Hill gauging station).

To prepare for the new Gingin water allocation plan, we expanded our coverage of river health assessments through the Gingin area in 2019 to include new sites on Moore River, Red Gully Creek, lower Gingin Brook, Nullilla Brook, Breera Brook and Yalyal Brook (see Figure 1 for locations of these sites). Repeat assessments of all sites were conducted during the 2022–23 dry season. All these systems were shown to support healthy populations of native freshwater fish and crayfish, with Red Gully Creek and Breera Brook appearing to be key nursery areas for several native species. As internally draining systems, with strong connections to groundwater and complex habitat, Nullilla and Yalyal brooks are a particularly high priority for protection given their potential for resilience to the drying climate.

In addition, we have partnered with Edith Cowan University to better understand ecosystem values through stream sections and connected wetlands within the broader Gingin Brook catchment, particularly on the Swan coastal plain.

The information generated will help us to better understand the ecological value of other groundwater-dependent streams and wetlands in the region and to identify potential climate-resilient habitats and priority areas to maintain or restore. We will consider this information in setting objectives and management strategies for the new Gingin water allocation plan to help protect Gingin's diverse aquatic ecology. Repeat assessments of all sites were conducted during the 2022–23 dry season (Figure 10).

Figure 10 Fish and crayfish sampling in Lennard Brook (left) and Breera Brook (right)

6. Evaluation of water resource objectives in the Gingin groundwater plan

Table 8 in the Gingin groundwater plan (pages 39 to 41 of the plan) outlines the performance indicators, monitoring bores and streamflow gauging stations we use to evaluate whether the plan is achieving its water resource objectives.

We have analysed the hydrographs of these bores (appendices A–C) to assess whether the resource objectives for the major aquifers in the plan area have been met. Where the monitoring bores and/or assessment methods are no longer considered suitable for assessing the plan's objectives, we have recommended replacement bores and alternative methods in 'future planning considerations' (see below).

Superficial aquifer		
Objective A	Groundwater levels or pressure heads are consistent with rainfall trends	**Met**

- North of Regans Ford and Lancelin, groundwater levels are generally stable and largely controlled by rainfall recharge (Appendix A).
- In the central part of the plan area, groundwater levels are relatively stable and consistent with rainfall recharge. Groundwater levels in bore 3A (Appendix A) are an exception to this, declining by about 3 m from 2000 to 2016 before stabilising. Bores 5A and 21A, 10 to 15 km to the east, are located near a gaining section of the Moore River and show more stable groundwater levels consistent with rainfall recharge.
- In the south of the plan area, groundwater levels have remained relatively stable during the past 10 years and are consistent with rainfall recharge. Bore GGB2A near the confluence of Gingin Brook and Moore River is an exception, showing a 0.8 m decline in groundwater levels since 2018. We have worked with a nearby licensee to redistribute their abstraction from the Superficial aquifer in the area and this is expected to have a positive response on local groundwater levels. The GGB2A logger (providing daily automated measurements) failed in February 2021 and a recent manual dip measurement in January 2023 (Appendix A) is not enough evidence on its own to confirm groundwater levels have recovered. A new logger is being installed and we will continue to monitor the bore to understand the impact of climate and abstraction on groundwater levels and the contribution of groundwater to Gingin Brook flows in the area.

Superficial aquifer		
Objective B	Maintain groundwater levels or pressure heads within a target range to avoid impacts to groundwater-dependent ecosystems and/or baseflow in the Gingin Brook and Moore River	**Partially met**

- Analysis of hydrographs along Gingin Brook indicates that the gaining and losing sections of Gingin Brook remain relatively unchanged from how they were mapped in Tuffs (2011) (Appendix B).
- Groundwater levels at GGB2A remained stable and within the target range, above the base of Gingin Brook, until 2018. Since 2018, groundwater levels declined by 0.8 m and were outside the target range, below the base of the brook, for several months in early 2019 and for almost all of 2020. As mentioned in Objective A above, we have worked with a nearby licensee to redistribute their abstraction from the Superficial aquifer and this may allow groundwater levels to recover to pre-2019 levels.
- Bore GGB8B is located adjacent to a losing section of Gingin Brook where groundwater levels are below the base of the brook (Tuffs 2011). Since 2008, groundwater levels at GGB8B have been predominantly outside the target range, below the base of the brook, with no clear trend over the 14 years of monitoring. Maximum groundwater levels in GGB8B are within the target range, above the base of the brook, for brief periods in winter in most years. Bore GGB7A and GGB7B, 3 km to the west, have groundwater levels permanently within the target range, above the base of the brook. This indicates that GGB8B is located in a transitional area of gaining and losing flow for the brook.

Future planning (Objective B)

- We will continue to conduct hydrograph analysis of Superficial aquifer bores along Gingin Brook to review water levels relative to base-of-brook heights to confirm whether sections of groundwater discharge are being maintained.
- In developing the new Gingin water allocation plan, we will aim to maintain the discharge of groundwater into the identified gaining reaches of the brook. We will use hydrograph analysis relative to surveyed stream-bed heights and a new groundwater model to assess this objective.

Superficial aquifer		
Objective C	There is sufficient groundwater throughflow in coastal aquifers to reduce the risk of seawater intrusion	**Met**

- The plan performance indicator for this objective suggests using the Perth Regional Aquifer Modelling System (PRAMS)[3] to indicate whether groundwater flow is in a westerly direction. However, PRAMS is not well calibrated in the Gingin area, so we used groundwater level contour mapping to conduct the assessment. Analysis of a contour map of 2022 Superficial aquifer groundwater levels showed that groundwater flow direction is generally to the west-southwest across the plan area, which is similar to the flow direction when it was previously mapped in 2010.
- A Tuffs (2019) study found the Superficial aquifer seawater interface was likely to be significantly onshore in the subareas of Guilderton North, Seabird, Lancelin and Wedge Island. Guilderton North and Seabird are likely to have a seawater interface about 3 to 4 km inland from the coast. The seawater interface in the northern coastal subareas of Lancelin and Wedge Island is closer to the coast at about 1 km inland.
- The 2019 study recommended six new coastal Superficial aquifer bores and that target groundwater levels be maintained to prevent the seawater interface from being 'theoretically present' (calculated from local hydrograph data) at the base of the aquifer at each location. Since the release of the Gingin groundwater plan in 2015, groundwater levels have increased and are above the target needed to maintain the seawater interface in five of the six bores.
- We will consider using the proposed new Gingin numerical groundwater model to assess scenarios against this objective as part of developing the next Gingin plan.

Future planning (Objective C)

- In developing performance indicators for a seawater intrusion objective for the Superficial aquifer in the new Gingin water allocation plan, we will:
  - use the monitoring bores and target groundwater levels recommended in Tuffs (2019)
  - use the new Gingin numerical groundwater model to test scenarios against the objective.

[3] PRAMS is a numerical groundwater flow model that simulates the responses of aquifers in the Perth region to changes in climate, land use and abstraction. We used the model to support development of the 2022 *Gnangara groundwater allocation plan.*

Mirrabooka aquifer		
Objective A	Groundwater levels or pressure heads are consistent with rainfall trends	**Met**

- Manual dipped measurements of bore GL7W since 2000, together with logged levels since 2018, indicate that groundwater levels are relatively stable (Appendix C). Bore GL7W is in the centre of the Dandaragan Plateau, adjacent to and just south of the Moore River. This is an unconfined area of the aquifer, close to a section of the Moore River that receives groundwater discharge (Stelfox 2001).

Objective B	Maintain groundwater levels or pressure heads within a target range to avoid impacts to groundwater-dependent ecosystems and/or baseflow in the Gingin Brook and Moore River	**Partially met**

- Bore GGB14B is screened in a local sand lens (discrete perched aquifer) and is not in direct connection with Gingin Brook, or representative of the regional aquifer. Bore GGB12B is 1.9 km away, adjacent to Gingin Brook, and is a suitable replacement location for monitoring Mirrabooka aquifer levels relative to Gingin Brook. Groundwater levels in GGB12B showed a slight decline between 2008 and 2015 before stabilising within the target range at about 1.5 m above the base of Gingin Brook.
- Streamflow fell below the target range – namely the low-flow threshold for Gingin Brook (5 ML/day) – for more than two consecutive days in the years 2013, 2021 and 2022. Water quality monitoring and aquatic biota sampling in Moore River, Gingin Brook and Lennard Brook during this timeframe found that baseflows were sufficient to maintain these groundwater-dependent ecosystems (see 5. Status of ecological values).
- Our analysis of hydrographs along Gingin Brook relative to base-of-brook levels showed the gaining and losing sections of Gingin Brook remained relatively unchanged from Tuffs (2011) (Appendix B).

Future planning (Objective B)

- We will use bore GGB12B for ongoing Mirrabooka resource evaluations in place of GGB14B.
- We will continue to assess hydrographs of the Mirrabooka aquifer bores along the Gingin Brook relative to base-of-brook heights to confirm whether groundwater discharge to the brook is being maintained in sections where it is known to occur.

Leederville and Leederville Parmelia aquifers		
Objective A	Groundwater levels or pressure heads are consistent with rainfall trends	**Partially met**

- Monitoring bores on the coast near the Moore River estuary (AM1/AM1A) and Lancelin (GL1A1) indicate that Leederville aquifer groundwater levels are in slow decline, based on records going back 30 years and given they have fallen 0.5 m since the release of the 2015 Gingin groundwater plan (Appendix C). The Leederville aquifer is confined at these locations so we would expect a more muted relationship with changes in annual rainfall.
- On the Swan coastal plain, in the northern unconfined area of the Leederville aquifer, bore CS14D showed a declining trend until 2015, but groundwater levels are now stable and consistent with rainfall recharge.
- Where Moore River crosses the Dandaragan Plateau, east of the Brand Highway, bore GL6W shows groundwater levels steadily increasing – a 7 m rise since 1982. This is an unconfined area of the aquifer where it receives direct rainfall recharge and the trend at the bore is likely influenced by historical clearing in the region.
- On the southern Dandaragan Plateau (southern portion of the Cowalla subarea) there are long-term declines in Leederville-Parmelia aquifer levels (see 2.1 Groundwater resources). Performance indicator bore GGB14A appears to be mostly influenced by rainfall recharge (Appendix C). There was a slight decline in groundwater levels from 2008 before some stabilisation in annual maximum groundwater levels from 2015. Minimum annual groundwater levels have declined by up to 1.5 m from 2019, with measurements in 2022 unreliable, likely due to logger failure. The decrease in minimum groundwater levels in 2019 corresponds with an increase in licensed abstraction near GGB14A. To reduce the risk of further increases in abstraction, resulting from trade of unused water entitlements and leading to declines in groundwater levels and surface water flows, we will no longer permit trading within trading zone 3 (see 1. Updated management arrangements).

Leederville and Leederville Parmelia aquifers		
Objective B	Maintain groundwater levels or pressure heads within a target range to avoid impacts to groundwater-dependent ecosystems and/or baseflow in the Gingin Brook and Moore River	**Partially met**

- Leederville-Parmelia aquifer levels in bore GGB14A have been within the target range and above the base of Moondah Brook for most of each year since 2008 (Appendix B). Maximum groundwater levels have been stable since 2015 but minimum groundwater levels fell below the target range and base of the brook for much of the summer period in 2020 and 2021, which may have reduced summer flows in the brook. With annual groundwater level fluctuations very close to the base of the brook, any decline in levels will likely mean that minimum levels will again fall below the base of the brook in summer. The close relationship between groundwater levels in GGB14A and the base of Moondah Brook makes it a suitable site for ongoing monitoring, as well as for informing the objectives in the next Gingin plan for maintaining discharge to the brook. The logger in bore GGB14A appears to have failed recently and so we have scheduled its replacement.
- Water quality monitoring and aquatic biota sampling in Moore River, Gingin Brook and Lennard Brook since the release of the Gingin groundwater plan show that baseflows have been sufficient during this period to maintain the ecological values of these groundwater-dependent ecosystems (see 5. Status of ecological values).
- Our analysis of water level data from monitoring bores along Gingin Brook show that water levels have been reasonably stable relative to base-of-brook levels, indicating that gaining and losing sections of Gingin Brook remain relatively unchanged from Tuffs (2011) (Appendix B).

Future planning (Objective B)

- We will consider bore GGB14A as a potential site for setting and monitoring objectives and management triggers for the Leederville-Parmelia aquifer under the new Gingin plan.
- We will continue to assess water level data from the Leederville and Leederville-Parmelia aquifer bores along Gingin Brook relative to base-of-brook heights to confirm whether known sections of groundwater discharge are being maintained.

Yarragadee aquifer		
Objective A	Groundwater levels or pressure heads are consistent with rainfall trends	**Partially met**

- In the north of the plan area on the Swan coastal plain, bore CS25D shows Yarragadee aquifer levels have declined by 2 m since 2000, with levels relatively stable after 2015 (Appendix C).
- Yarragadee aquifer levels on the coast near Lancelin at bore GL1A3 have varied by up to 10 m since 2000. The lowest groundwater levels were reached between 2012 and 2017. Since then, levels have risen about 6 m and appear stable.
- Further east on the Swan coastal plain, where Moore River runs west, bore GL4A1 shows Yarragadee aquifer levels have declined by 3 m since 2000.
- East of the Brand Highway, where the Moore River crosses the Dandaragan Plateau, Yarragadee aquifer levels at bore GL6A2 have declined by 4 m since 2002.

Future planning (Objective A)

- A new Gingin numerical groundwater model will help us assess objectives for the Yarragadee aquifer as part of developing the new allocation plan.

Objective C	There is sufficient groundwater throughflow in coastal aquifers to reduce the risk of seawater intrusion	**Met**

- A 2016 investigation by our predecessor department found the seawater interface in confined aquifers was likely to be 10 to 15 km offshore (DoW 2016). The report concluded there was no immediate risk of seawater intrusion in the confined aquifers, even under a high abstraction regime, and recommended that groundwater levels in confined aquifers be maintained at a minimum of 3 m Australian Height Datum (mAHD) at the coast.
- Performance indicator bore AM1A near the Moore River estuary is screened in the Leederville aquifer and therefore we have not assessed it for this objective. Bore NGG1A, located 9.4 km north of AM1A and 3.7 km from the coast near Seabird, is screened in the Yarragadee aquifer and is the best replacement bore for assessing the risk of seawater intrusion in place of AM1A. Groundwater levels in NGG1A have declined by 0.3 m since 2018 to about 8.7 mAHD. There is currently little risk of seawater intrusion in the area.
- Dipped manual measurements at bore GL1A3 on the coast near Lancelin showed highly variable groundwater levels, indicating the bore had failed (Appendix C). Bore GL1A3 was decommissioned in November 2022 and replaced with bore GL1C, which will now be used to assess the performance indicator for the Yarragadee aquifer. Both bores are artesian with groundwater levels above the ground surface. However, water levels in GL1C have only been measured since 2021. There is currently little risk of seawater intrusion in the area.

Yarragadee aquifer

Future planning (Objective C)

- We will explore options to assess the risk of seawater intrusion in the Yarragadee aquifer in the south of the plan area, as bore AM1A is screened in the Leederville aquifer and unsuitable for monitoring the Yarragadee. Bore NGG1A, 9.3 km to the north near Seabird, is the closest replacement option. Maintaining groundwater levels above 3 mAHD at NGG1A is suggested as a suitable performance indicator for seawater intrusion risk in the Yarragadee aquifer in this area.
- Bore GL1C will replace GL1A3 as a performance indicator for the Yarragadee aquifer. A minimum groundwater level of 3 mAHD at GL1C should be used to assess the risk of seawater intrusion in the area.

7. Evaluation of water resource objectives in the Gingin surface water plan

Table 8 in the Gingin surface water plan (page 21 of the plan) outlines the performance indicators we use to measure the performance of the plan against its objectives (page 8).

While all four surface water plan objectives have been assessed as met or partially met to 2022, ongoing challenges are posed by future climate change, the way surface water is taken (typically direct pumping from streams), and the dependence on groundwater levels to maintain brook baseflows over the dry season to facilitate surface water irrigation practices.

We have included future planning considerations to address these challenges below. We will consider these as part of developing the new Gingin water allocation plan.

Water resource objectives		
Objective A	Maintain the capacity of the resources to supply water for use	**Met**

- We have been recouping unused licensed entitlements and lowering allocation limits to reduce the risk of increased water use and streamflow decline in the future and to protect the reliability of supply for existing users.
- We monitor streamflow at the Gingin and Molecap Hill gauging stations during the dry season and advise landholders along Gingin and Lennard brooks about periods of low flow. We encourage them to work together to share the limited water equitably and to use water in a way that will minimise cumulative impacts to streamflow (see Appendix D).
- We have begun targeted groundwater investigations as a part of the East Midlands groundwater investigation. We have installed new monitoring bores and so far the investigation is improving our understanding of the groundwater system to help us manage the limited surface water and groundwater resources in the Gingin Brook catchment.

Future planning (Objective A)

- For the next water allocation plan, use the new Gingin numerical groundwater model to help develop management strategies for maintaining groundwater discharge in areas of surface water use.
- We will consult with water users on alternative approaches to managing surface water take to reduce short-term declines in flow rate and water levels caused by surface water use (which can impact on the supply of downstream users).

Water resource objectives		
Objective B	Maintain sufficient flow regimes (summer and winter) in a changing climate to minimise risk to the riverine environment	**Partially met**

- We have been monitoring flow, water quality and fish and crayfish populations in important refuge pools through the Gingin Brook and Lennard Brook catchments since 2011. We used this science to revise the low-flow thresholds in the plan.
- We monitor data from our three telemetered gauging stations in the Gingin surface water plan area. We use the Gingin and Molecap Hill gauging stations to monitor daily streamflow against the low-flow thresholds during the dry season. We write to surface water users to let them know how they can help reduce impacts to stream levels (see Appendix D) when we believe there is a risk of low flows impacting on the ecology of the brooks.
- Flows in Gingin Brook at the Gingin gauging station dropped below the 5 ML/day low-flow threshold for short periods in the 2012–13, 2020–21 and 2021–22 dry seasons, while flows in Lennard Brook at Molecap Hill gauging station dropped below the 5.1 ML/day low-flow threshold for short periods in the 2012–13 and 2015–16 dry seasons.
- At key refuge pools near the two gauging stations, our long-term water quality loggers and our periodic assessments of aquatic fauna indicate the lower flows that have occurred since the release of the Gingin surface water plan have been sufficient to maintain water quality and fish and crayfish communities in the brook catchments east of the Brand Highway and to support licensed surface water use.
- We have implemented a communications strategy using various media platforms and stakeholder forums to increase engagement with the community about the regionally significant ecological values of Gingin and Lennard brooks, and the role of surface water and groundwater users in protecting permanently flowing stream sections during the dry season.

Future planning (Objective B)

- Develop groundwater level triggers linked to low-flow thresholds.
- Consider alternative approaches to licensing surface water take that reduce short-term declines in flow that can impact water levels and water quality.

Water allocation management objectives		
Objective C	Recover over-allocated resources to within the allocation limit	**Met**

- Recouping unused entitlements has been a priority action in the Gingin surface water plan area due to the risk to users and the environment from declining streamflow and future climate projections.
- We have recouped 1,687,000 kL from Lennard Brook, 435,000 kL from Moondah Brook and 257,000 kL from Gingin Brook. As the water was recouped, we lowered the allocation limits in these areas to protect existing users and stream health as the climate continues to dry.
- We reduced the allocation limits in the Gingin Brook 6 and Gingin Brook 7 subareas in the lower catchment to zero because flows were insufficient to support licensed use.
- The recovery strategy for surface water is ongoing and will reduce the risk of unused licensed entitlements being activated to prevent impacts on streamflow and reliability of supply to current water users.

Objective D	Increase efficient use of the limited water available during low-flow periods	**Met**

- We have been educating the community about the importance of smart and efficient water use during the summer low-flow period (see 4. Status of surface water use).
- Between April and July 2022, we undertook works to upgrade the Gingin gauging station. The station was built in 1957 and had deteriorated in quality. It is now one of the state's most accurate gauging stations, being able to measure most flows to within two per cent accuracy. This accuracy will be important for the department and landholders monitoring flows during the dry season, particularly when flows approach the low-flow threshold and landholders are asked to implement prudent water use practices to protect water-dependent ecosystems and supply to downstream users.

Future planning (Objective D)

- Consider licence conditions for groundwater and surface water that will help prevent abstraction from exacerbating low-flow events during hot weather periods or following a dry winter, to reduce the risk of impacts on the environment or downstream surface water users.

8. Our response and future planning

The *2015 Gingin groundwater allocation plan* and *2011 Gingin surface water allocation plan* remain effective tools for managing groundwater and surface water use throughout most of the Gingin area.

In this evaluation statement, we identified some opportunities to improve the implementation of the Gingin groundwater plan. In line with this, we have updated two local licensing policies and capped licensed allocations for surficial aquifer resources as an interim management step until the new Gingin water allocation plan is ready (see 1. Updated management arrangements).

8.1 The next water allocation plan

Due to complex groundwater/surface water interactions throughout the Gingin area (particularly where surface water is licensed) and the ongoing impact of climate change, it is crucial that we consider the management of groundwater and surface water resources together. To support this approach, we are developing a Gingin numerical groundwater model to inform development of the new Gingin water allocation plan for the region's groundwater and surface water resources. The new plan will include surface water resources in the proclaimed Breera and Yalyal brooks to the south of Lennard Brook and the Superficial and Leederville aquifer resources to the south of Gingin Brook on the Swan coastal plain (Figure 11).

We are aiming to release a draft of the Gingin water allocation plan for public comment by 2028. The plan will revise allocation limits and licensing strategies for Gingin's groundwater and surface water resources using contemporary climate change information. This work will include assessing the proposed 10 per cent reductions to licensed groundwater use from the Superficial and Leederville aquifers in subareas to the north and south of Gingin Brook and the Moore River estuary, as communicated in the 2022 *Gnangara groundwater allocation plan*. We will also consider the need for licence reduction scenarios in other areas, particularly the southern parts of the Gingin area on the Dandaragan Plateau.

We will consult with the community, Traditional Owners and industry to develop the new plan's objectives and to understand the implications of any proposed management strategies.

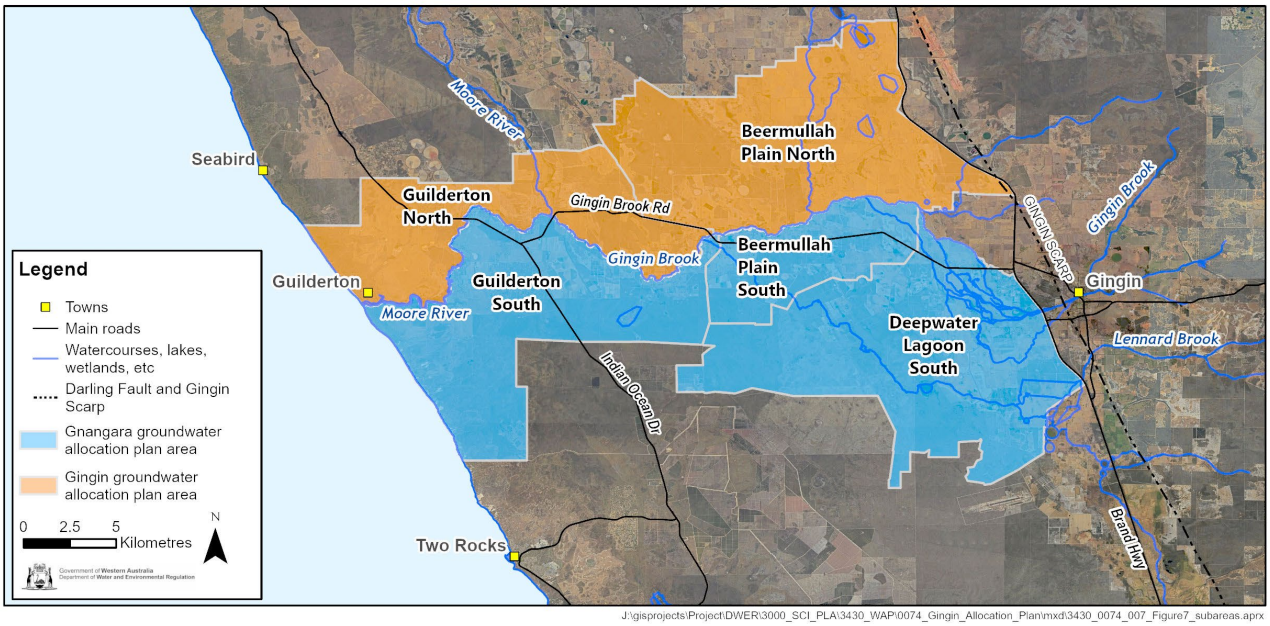


Figure 11 Subareas to the north and south of Gingin Brook that are currently managed under two separate groundwater allocation plans will be managed together under a new Gingin water allocation plan

8.2 New climate change projections

Global climate models have been developed by many organisations around the world to investigate how the global climate will respond to greenhouse gas concentrations in the atmosphere. These models represent our understanding of what drives climate change, how and why it changed in the past, and what the climate may look like in the future.

The Bureau of Meteorology has developed future climate projections based on global climate models from the World Climate Research Programme's Coupled Model Intercomparison Project 5 (CMIP5). We are collaborating with the Bureau of Meteorology to update our guidance for using future climate projections to assess risks from climate change to inform water resource decision-making.

The recent climate projections for the Gingin area show that:

- rainfall and water availability are very likely to continue decreasing
- the magnitude of change is expected to be within a certain range, with a greater change projected under a future without effective climate change mitigation (a high greenhouse gas concentration pathway).

The 2015 Gingin groundwater plan projected a nine per cent reduction in rainfall under a future dry climate scenario to 2020 and a 16 per cent reduction on average by 2030, compared with historical averages. Observed rainfall and recent climate projections for the Gingin Townsite weather station (station 9018) are broadly in line with these projections and show that rainfall and water availability are very likely to continue to decrease (Figure 12).

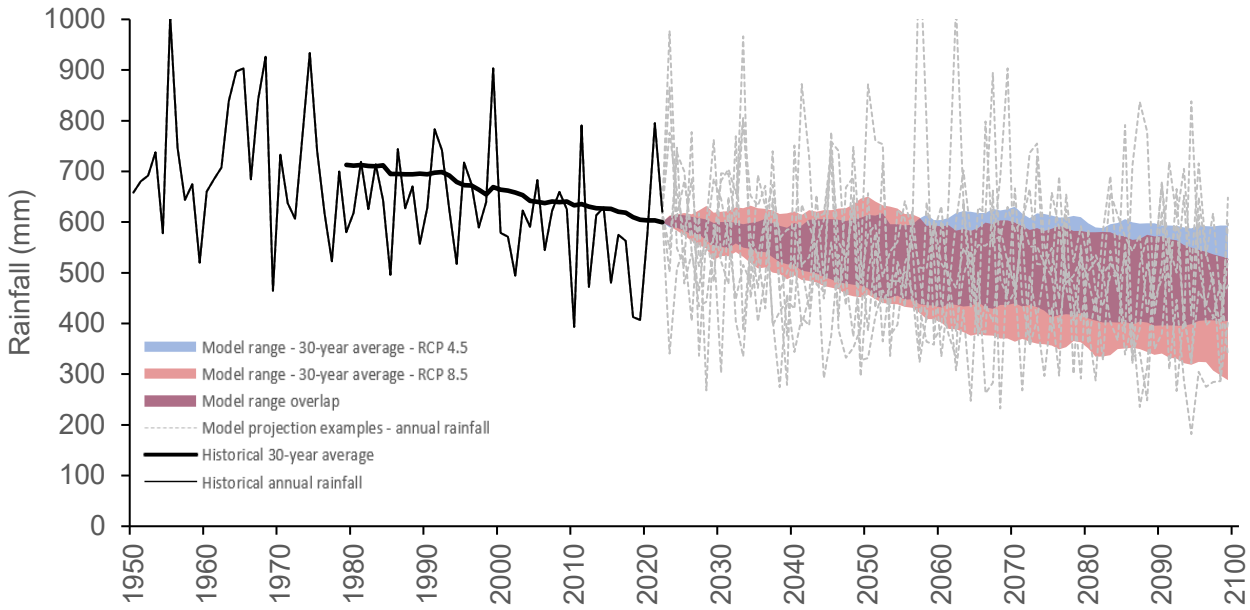


Figure 12 Historical and projected rainfall at the Gingin 9018 rainfall station

8.3 Traditional Owners

There have been many important state determinations and strategies relevant to Traditional Owners in south-west Western Australia.

The Noongar people are formally recognised as the Traditional Owners of the south-west region of Western Australia. The *Noongar (Koorah, Nitja, Boordahwan) (Past, Present, Future) Recognition Act 2016*, proclaimed on 6 June 2016 to coincide with Western Australia Day, recognises the Noongar peoples' important relationship with the Noongar lands, and their significant and unique contribution to the heritage, cultural identity, community and economy of Western Australia (Department of Premier and Cabinet 2020).

Our *Innovate reconciliation action plan 2022–2024* focuses on the key principles of reconciliation – unity, race relations, historical acceptance, institutional integrity, equality and equity – to strengthen our partnerships, collaboration and understanding to empower Aboriginal and Torres Strait Islander peoples and communities. We will ensure engagement with Traditional Owners on our next water allocation plan is built around these principles.

8.4 Further information

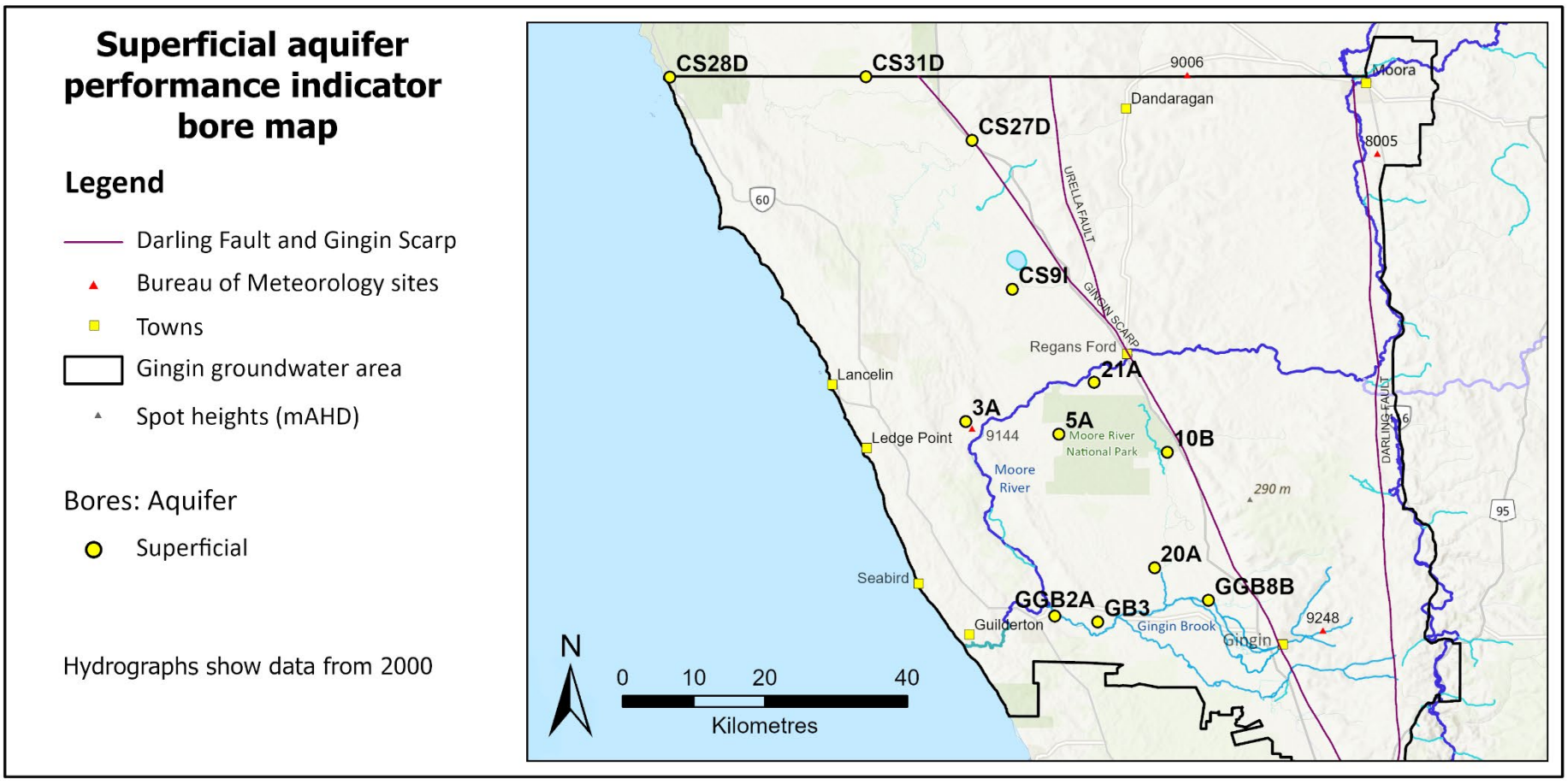
For further information on the Gingin groundwater and surface water allocation plans and this evaluation statement, contact us using the details provided below.

Subject	Responsible area	Contact details
Enquiries concerning the Gingin region	Swan Avon regional office	Phone: (08) 6250 8000 Email: ellam.reception@dwer.wa.gov.au
General licensing enquiries	Business Support Unit (Water)	Phone: 1800 508 885 Email: licence.enquiry@dwer.wa.gov.au
General water allocation planning enquiries	Water Allocation Planning	Email: allocation.planning@dwer.wa.gov.au
All other matters	As applicable	Phone: (08) 6364 7000 Email: info@dwer.wa.gov.au

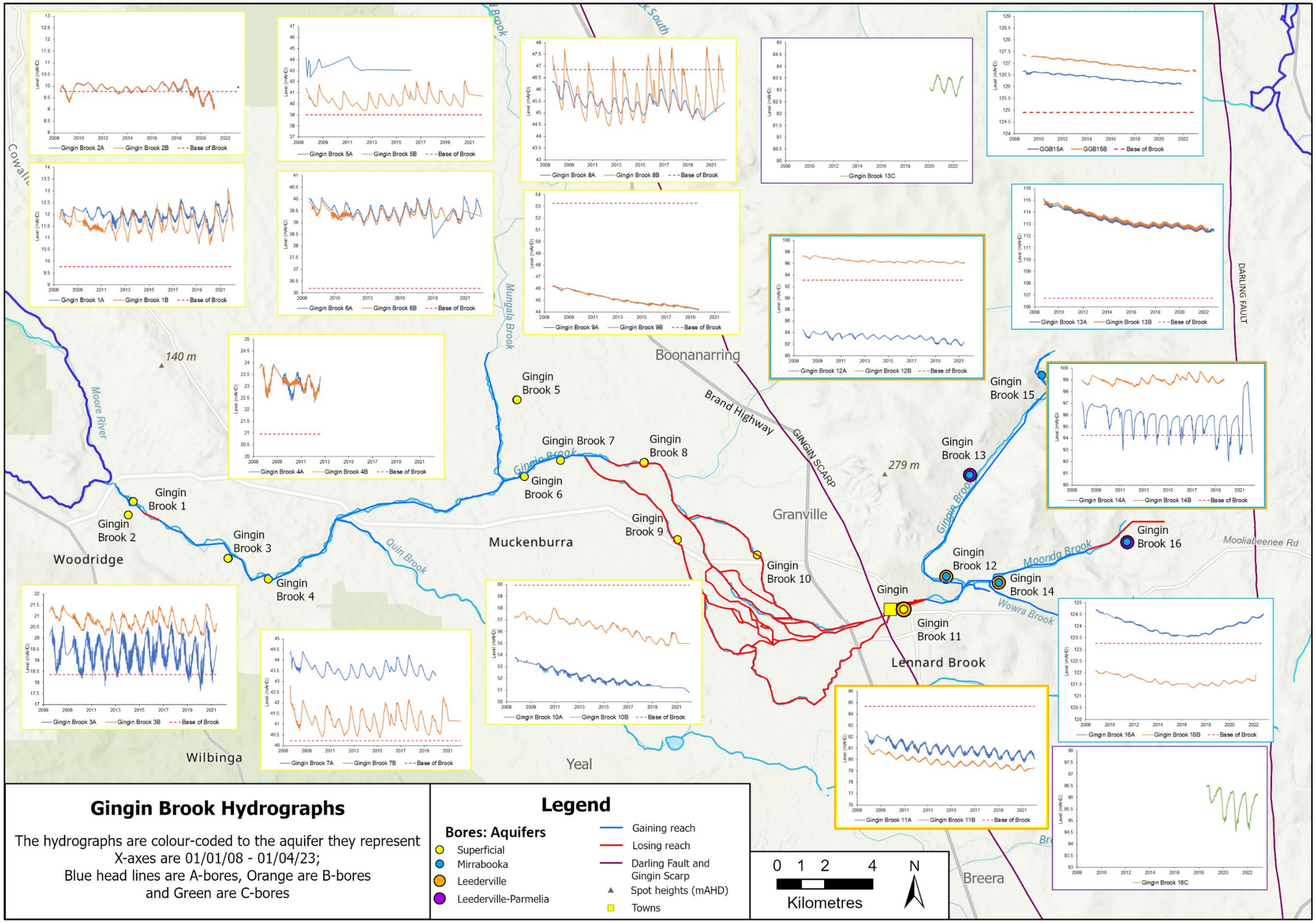
If you would like to receive updates about the progress of the new Gingin water allocation plan, including planned public consultation, please email allocation.planning@dwer.wa.gov.au to register your interest.

Appendices

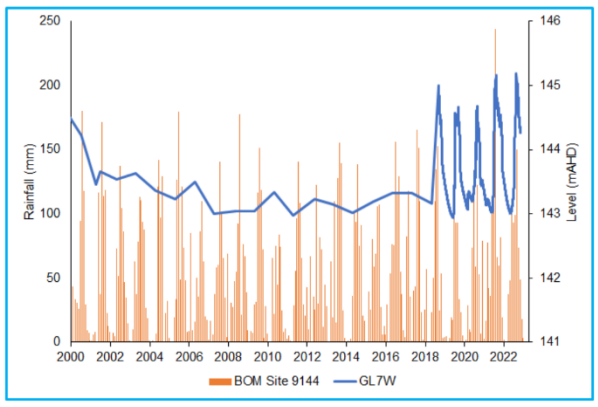
Appendix A — Superficial aquifer and rainfall trends

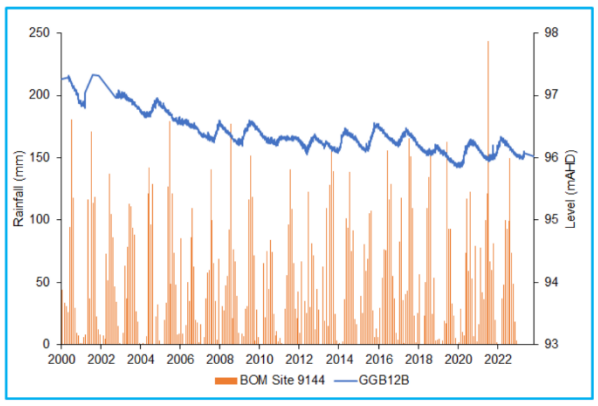


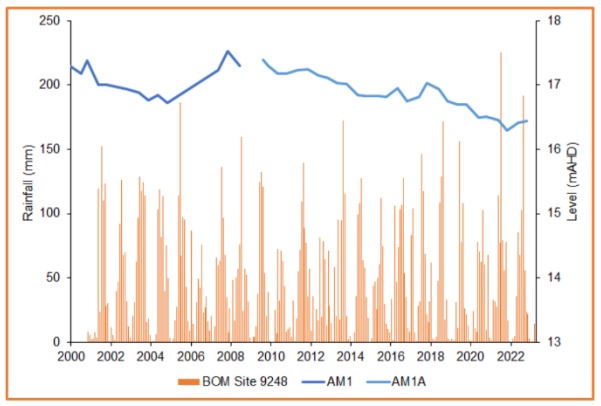
Appendix B — Groundwater level trends relative to the base of Gingin Brook

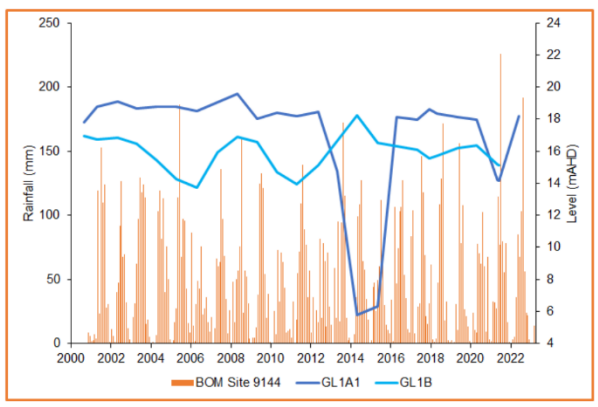


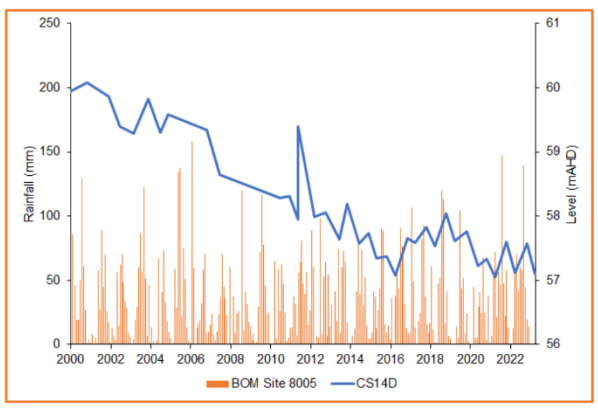
Appendix C — Yarragadee, Leederville, Leederville-Parmelia and Mirrabooka aquifer and rainfall trends

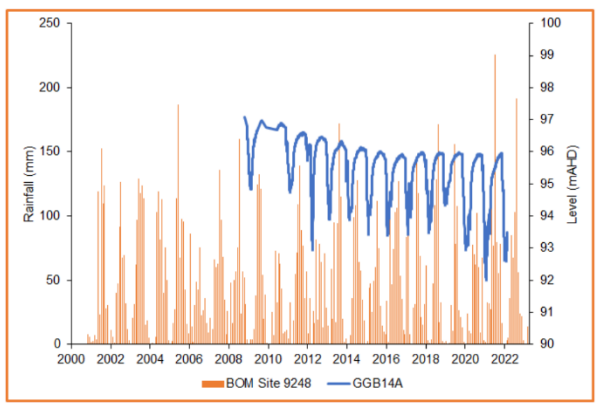


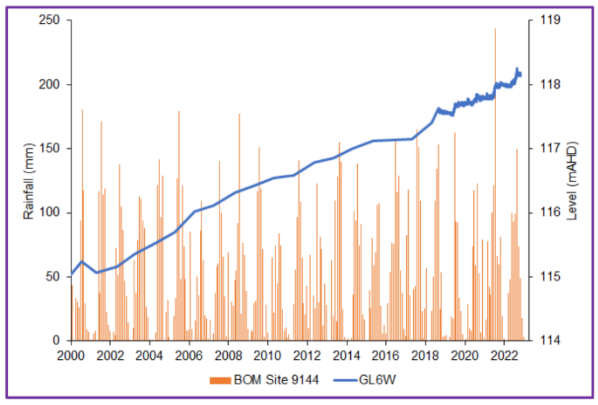


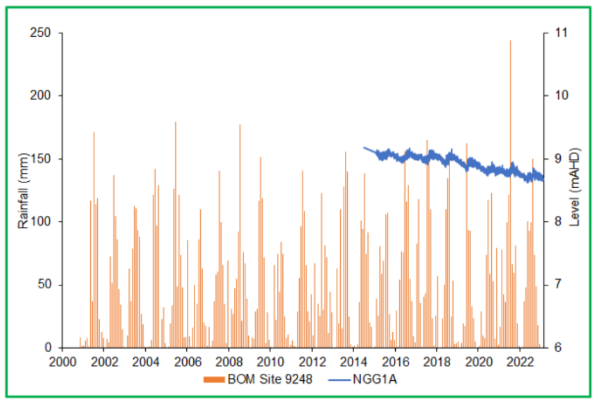


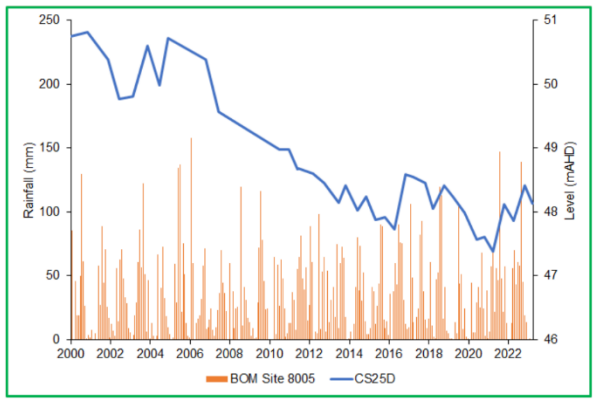


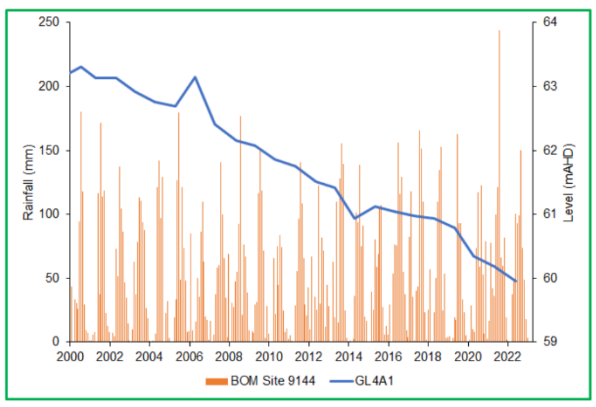


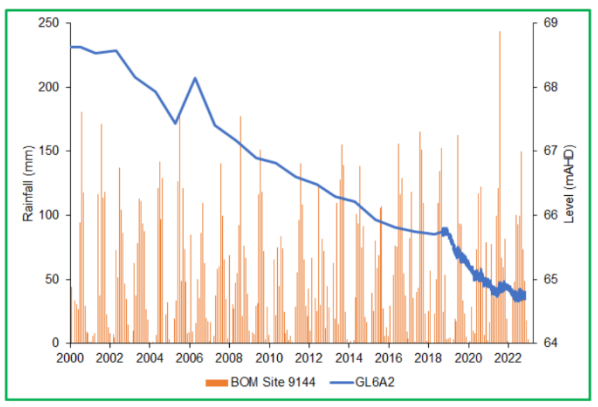


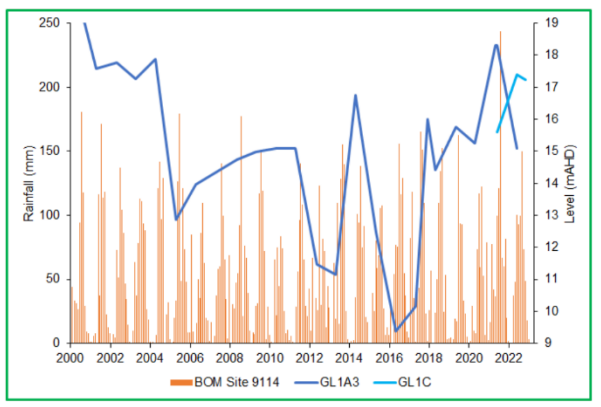












Mirrabooka, Leederville, Leederville-Parmelia, and Yarragadee aquifer performance indicator bore map

Legend

- Darling Fault and Gingin Scarp
- Bureau of Meteorology sites
- Towns
- Gingin groundwater area
- Spot heights (mAHD)

Bores: Aquifer

- Mirrabooka
- Leederville
- Leederville-Parmelia
- Yarragadee

Hydrographs show data from 2000 - 2023; Hydrographs are colour coded to the aquifer they represent

Appendix D — Protecting Gingin Brook Factsheet

Gingin Brook and its tributaries are one of the state's river systems most impacted by the drying climate. Gingin Brook is losing connection with underlying groundwater aquifers. This means that even in years with good rainfall, flows in Gingin Brook are likely to be low, particularly in summer.

As a result of the drying climate, the most important sections of the brook are those still in connection with underlying groundwater aquifers and receiving year-round streamflows. These areas continue to support a variety of water-dependent flora and fauna species and provide water for irrigated agriculture and domestic use.

Due to the complex interactions between surface water and groundwater throughout the Gingin Brook catchment, both groundwater and surface water users contribute to streamflow decline and have a role to play in protecting the system as climate dries. This is a particular issue during summer where streamflow is provided primarily by groundwater discharge and flows are at their lowest.

During the summer months, flows in Gingin and Lennard brooks are approaching the minimum level that supports the lifecycles of water-dependent flora and fauna. High levels of water use from multiple users, coinciding at similar times during hot weather, can exacerbate the impact of already low flows on stream health and water available for other users. It is of particular importance that water users and the community work together, particularly during the summer months, to minimise impacts to streamflow, the environment and other water users. This can be achieved by:

- Only taking what you need from the brook (or your bore) and speaking to the department, Perth NRM or the Department of Primary Industries and Regional Development regarding how you can be more efficient with your water use.
- Spreading your water use throughout the week and talking with your neighbours about staggering your pumping on different days or times to reduce the effect on flow in the brook. Simultaneous pumping over weekends has been a recurring issue in the past with water levels only recovering midway through the following week.
- Using online streamflow gauging data (Gingin Townsite, Lennard Brook or Gingin Brook near Moore River) to assess your watering requirements on specific days and considering how you may be able to preserve flows during this time. This includes bore owners taking water from shallow and deep aquifers up to 600 metres from the brook which can affect streamflow.
- Looking to see if there is enough flow remaining for downstream water users and the environment.
- Preventing stock access to the stream on your property which will improve water quality and the overall ecological health of the system.

It is important water users and the community work together with government to aid the protection of the regionally significant values of Gingin Brook.

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