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Department of Water

Gingin surface water allocation plan methods report

Supporting information

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Water resource allocation and planning series

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Gingin surface water allocation plan methods report

Background information and description of methods for the *Gingin surface water allocation plan*

Department of Water

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Introduction

This allocation limits method report is a supporting document to the *Gingin surface water allocation plan* and describes how we set the allocation limits for the surface water resources in the plan area.

The plan applies to the water resources of the Gingin surface water allocation area which covers approximately 1430 km^2 and is located 70 km north of Perth. In the plan area surface water is primarily used for agricultural and horticultural activities.

Water is abstracted by direct pumping from watercourses during the low flow (generally summer) period when the demand for water for irrigation is high.

1.1 What is an allocation limit?

An allocation limit is the total volume of water that the department sets aside for use annually from an allocation unit. This includes water available for licensing and for uses exempt from licensing (e.g. a riparian right under the *Rights in Water and Irrigation Act 1914* or commercial use in an unproclaimed area).

1.2 Allocation units

The plan applies to the Gingin surface water allocation area (plan area), which includes the Lennard, Moondah, Gingin, Wallering, Mungala and Quin brook surface water allocation subareas (Figure 1). It applies to the water that flows over or is held in the mainstream or tributaries of these subareas.

For allocation planning purposes the Gingin surface water allocation subarea has been further divided into seven resource units (Gingin Brook 1–7). As a result there are twelve resource units in the plan area (Figure 1) - referred to as resources (Table 1).

We have set an allocation limit for each resource (Chapter 5) which represents the total volume of surface water available in that resource.

Table 1 Gingin surface water allocation area by subarea and resource

Surface water allocation subarea	Surface water resource
Lennard Brook	Lennard Brook
Moondah Brook	Moondah Brook
Gingin Brook	Gingin Brook 1
	Gingin Brook 2
	Gingin Brook 3
	Gingin Brook 4
	Gingin Brook 5
	Gingin Brook 6
	Gingin Brook 7
Wallering Brook	Wallering Brook
Mungala Brook	Mungala Brook
Quin Brook	Quin Brook

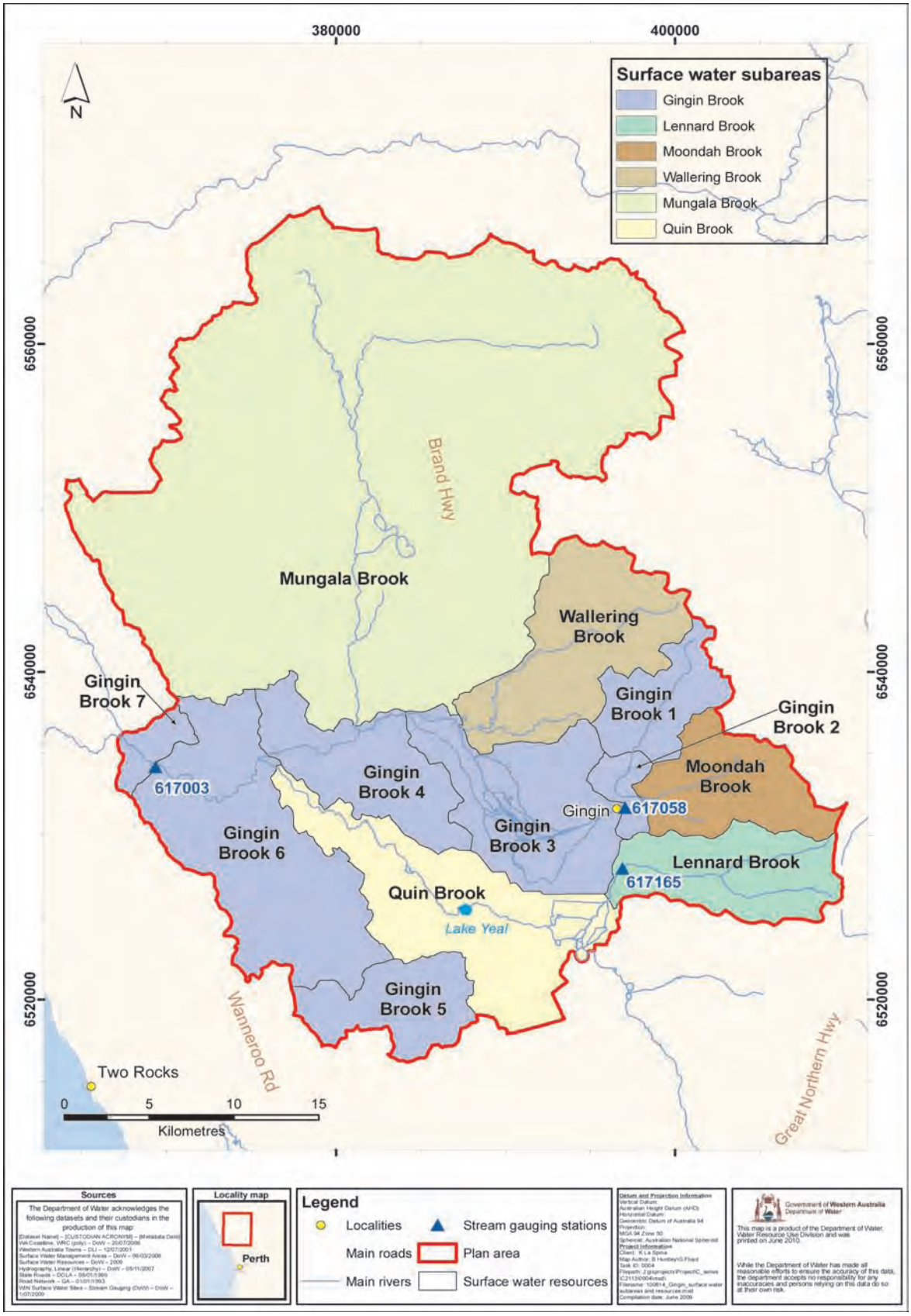


Figure 1 The plan area, surface water allocation subareas and surface water resources

1.3 Why we set allocation limits

The department developed the *Gingin surface water allocation plan* to formalise the cap on allocations from the Gingin surface water resources since the mid 1990s. The cap was put in place by the department so we could investigate and assess the impact of upstream abstraction on downstream water users as well as the environment. The decision to cap allocations was made in agreement with local committees and the community.

Since the mid 1990s, even with the cap on allocations, the department has continued to receive complaints and has dealt with stream disputes in the area. The main issue is that downstream surface water users are not able to take their full licence entitlement volume during the summer low flow period.

Annual rainfall has declined by 19% in the plan area, based on a comparison of the average annual rainfall from 1889 to 1974 (765mm) and 1997 to 2007 (621mm) (Appendix C).

Streamflow along Gingin Brook has also declined. Streamflow in upper Gingin Brook has declined by 14% and streamflow in lower Gingin Brook has declined by 26% (comparison of average annual streamflow over 1975 -1996 and 1997-2007 periods). Streamflow in Lennard Brook was increasing from 1963 to 2001. Data from 2009 and 2010 indicates that streamflow may no longer be increasing.

These trends indicate that further allocations from the Gingin surface water resources, above the current volumes of take, could further reduce reliability of supply to existing surface water users and increase the risk the environment.

We set allocation limits to formally cap allocations from the Gingin surface water area. The allocation limits provide a target to which we will recoup unused entitlements in the plan area to prevent future over-use.

1.4 Information we used for allocation decisions

To set allocation limits we need to understand how and when water is abstracted and used as well as how the resource and associated ecological and social values are affected by abstraction. To assess this we examine rainfall trends, hydrological trends, connectivity to groundwater, and the environmental values of the water resource.

Chapters 2 and 3 summarise the information the department considered for allocation decisions, including allocation limits. Appendix A provides a summary of the information we considered for each resource.

Chapter 2 contains information on water use including:

- Current use.
- Reliability of supply.
- Future demand.

Chapter 3 contains information on the water resource including:

- Rainfall.
- Streamflow.
- Surface and groundwater interactions.
- Environmental values.

2 Water use information

2.1 Current surface water use

Current licensed entitlements

The department stores information on licence entitlements in a water resource licensing system. There are 31 licence entitlements (as at April 2011) to abstract a total of 4 610 625 kL/year from the surface water resources in the plan area (Table 2).

Table 2 Estimated total abstraction (kL/yr) in the Gingin surface water plan area

Resource	Current entitlements [1]	Estimated unlicensed abstraction	Estimated total abstraction [2]
Lennard Brook	2 409 310	25 000	2 434 310
Moondah Brook	897 390	1 000	898 390
Gingin Brook 1	512 650	15 000	527 650
Gingin Brook 2	117 750	25 000	142 750
Gingin Brook 3	70 880	11 622	82 502
Gingin Brook 4	0	5 488	5 488
Gingin Brook 5	0	0	0
Gingin Brook 6	248 325	10 000	258 325
Gingin Brook 7	354 320	10 000	364 320
Wallering Brook	0	12 234	12 234
Mungala Brook	0	5 824	5 824
Quin Brook	0	3 963	3 963
Total	**4 610 625**	**125 131**	**4 735 756**

Notes: 1. Current entitlements as at April 2011.
2. Estimated total abstraction assumes 100% of the entitlement plus the estimate of unlicensed take is abstracted annually.

When surface water is taken

Surface water is pumped directly from the watercourse during the low flow (summer) period to irrigate for horticultural and agricultural purposes. Demand for surface water during the high flow (winter) period is low.

Reliability of supply

Over about the past twenty years the department has received phone calls and formal correspondence from surface water users near Gingin town site (Gingin Brook 3 resource) that report:

- increased occurrence of low and no flow events
- inability to take their full entitlement because of low flow and poor water quality during summer.

Rights to abstract water without a licence

Landowners who have legal access to a surface water resource may abstract water for stock and domestic use without a licence (referred to as a riparian right). The volume of water abstracted that is exempt from licensing is small in comparison to licensed abstraction for commercial use in the plan area.

The department estimated the volume of exempt abstraction (Table 2) to determine the allocation limits. We considered:

- local knowledge of surface water use
- the number of freehold properties with legal access to a watercourse
- the length of a watercourse within a resource boundary that is proclaimed under the *Rights in Water and Irrigation Act 1914*
- information from a water-use survey conducted in the plan area during 2007/2008 (unpublished).

Use in unproclaimed areas

Part of the Gingin surface water area is not proclaimed under the *Rights in Water and Irrigation Act 1914* (Appendix B). Ideally all surface water take would be managed through licensing. However, a licence is not required to take water in unproclaimed areas under the current legislation.

While we cannot currently license take in unproclaimed areas, this plan still applies as guidance. At the time of release of this plan abstraction from these areas was low and for non commercial purposes. This is not expected to change in the short term because flow in these resources is unreliable and generally not suitable for commercial activities.

The Government of Western Australia is currently reviewing and updating its legislation for the state's water resources. We anticipate that the new legislation will enable licensing in all areas of the state unless covered by an exemption.

2.2 Future demand and alternative water sources

Demand for surface water in the plan area has been stable and no future land use changes have been identified that would increase demand for surface water. This allocation plan promotes efficient use of the limited water available and allows access to water for commercial use through the trade, transfer or leasing of water from existing licensed entitlements.

Land is being subdivided for rural-residential purposes near Gingin town site. It is predicted that this change in land use will reduce demand for surface water due to smaller block sizes, increased access to scheme water and reduced access to the Gingin Brook.

Scheme water is not accessible outside the boundary of Gingin town site. Alternative sources of water out of town are limited to rainwater, groundwater or the winter abstraction of surface water.

The department prefers abstraction during the winter high flow period as the alternative water source for surface water users. The abstraction and storage of high winter flow for use in summer would reduce the dependence on summer flow and would minimise the effect of summer abstraction on social and ecological values.

However, most surface water users abstract exclusively in summer because the topography and soil type in the area is a limiting factor for the construction of on stream storage facilities and off-stream storages are uneconomical at this stage. As an action of future planning in the area the department will investigate the potential and options for licensing winter flow.

Depending on its availability and quality, groundwater is an alternative water source in the plan area. For up-to-date information on groundwater availability in the plan area please contact the Swan Avon Regional office.

3 Water resource information

3.1 Rainfall

In the south-west of Western Australia there has been a marked decline in rainfall since the mid 1970s. The department has adopted 1975 as the year at which we identify the beginning of a drying climate and we apply this to surface water allocation decisions for the south-west of Western Australia (Appendix C).

For example, over the period 1889 to 1974 average annual rainfall was 765 mm. The average dropped to 640 mm over the 1975 to 1996 period and over the most recent period (1997 to 2007) average annual rainfall decreased further to 621 mm.

Rainfall is projected to decline by an additional 15% by 2030 (CSIRO 2009). We will continue to monitor rainfall and streamflow in the plan area to help us evaluate whether we are meeting the objectives of the plan (see Chapter 5 and 6 of the plan).

3.2 Surface water hydrology

Streamflow trends

Appendix C provides detail on streamflow in the plan area recorded at the Gingin Brook (617065), Bookine Bookine (617003) and Molecap Hill (617165) gauging stations.

The annual, monthly and daily streamflow in Gingin Brook recorded at Gingin Brook (617058) and Bookine Bookine (617003) gauging stations show a declining trend since 1975. This reflects the decline in rainfall recorded over the same period.

Streamflow records at the Molecap Hill (617165) gauging station on Lennard Brook show an increasing trend in annual, monthly and daily streamflow since the early 1970s.

Molecap Hill gauging station closed in 2002 and reopened in late 2008. Over the past 10 years the response of flow to abstraction and reduced rainfall is unknown. However, the annual flow for 2009 and monthly flow from November 2008 to May 2010 is similar to or lower than the 1975 to 2001 averages, which suggests that streamflow may no longer be increasing in this resource.

Streamflow is predicted to decrease in the Gingin region by an additional 30% by 2030 under a median climate scenario (CSIRO 2009).

Seasonality of flow

Streamflow is highly seasonal with approximately 70 to 90% of average annual flow occurring between May and October across the plan area.

A comparison of long-term to recent streamflow records from Gingin Brook and Bookine Bookine gauging stations indicate that winter flows have declined more when compared to summer flows. A comparison of the long-term and recent

streamflow records (to 2001 only) from Molecap Hill gauging station show that streamflow increased in all months in Lennard Brook.

3.3 Surface and groundwater interaction

Hydrological and hydrogeological investigations completed in the Gingin area identify that there is a strong interaction between surface water and groundwater in the plan area. We have considered this connectivity when developing the allocation limits for the Gingin surface and ground water allocation plans.

In the past, groundwater discharge maintained a reliable volume of summer flow in all watercourses in the plan area.

However, over the last 40 years intensification of agricultural and horticultural activities in the plan area has increased demand for surface water and groundwater. This, coupled with declining rainfall has reduced the connection between surface and groundwater in some watercourses meaning these sections no longer flow all year in some years.

Findings from the recent hydrogeological investigation in the area (Tuffs, 2010) support these observations (Appendix D):

- In the Gingin Brook 3 resource the brook bed is above the maximum groundwater level recorded in all monitoring bores in the area. This means the brook is 'disconnected' from the shallow and deep groundwater system and is no longer maintained by groundwater discharge.
- Groundwater discharge from the Mirrabooka and Leederville aquifers maintains base flow in Gingin Brook 1 and 2 and Moondah Brook resources north of Gingin town site. Flow is quickly depleted in Gingin Brook 3 due to the network of channels characteristic of the resource and the disconnection from groundwater. Most complaints come from water users in Gingin Brook 3 resource, who increasingly report that there is no flow throughout summer and autumn.
- Groundwater begins to discharge again around the confluence with Mungala Brook in Gingin Brook 4 resource.
- Quin Brook is dry most of the year downstream of Lake Yeal. If winter flows are large enough surface water will recharge groundwater along this reach, however due to reduced rainfall these type of flows are infrequent. Flow is perennial near the confluence with Gingin Brook due to discharge from the superficial and Leederville aquifers.
- Lennard Brook has consistent continuous flow which is largely derived from groundwater discharge from the Mirrabooka and possibly the Leederville aquifers.

3.4 Ecological water needs

The ecological values and needs for surface water were assessed at a site along the Lennard Brook and two sites along the Gingin Brook by Storey and Davies in 2002.

The study showed that permanent flow is a feature of the flow regime that should be maintained. Permanent flow maintains upstream and downstream connectivity by maintaining lateral connectivity between the riparian zone, wetlands and main channel. Permanent flow is linked to the reproductive migration for native fish species like freshwater cobbler and is important to stimulate seed set and recruitment for riparian vegetation (and their associated nutrients, juveniles and propagules) (Storey and Davies 2002).

The aim of the study was to determine the water needs to meet identified environmental values for Gingin Brook and Lennard Brook. The study proposed environmental water requirements (EWR) as daily flows to be met each month.

The department compared the EWR to mean daily flow over the 1975 -2003 (long-term) and 1997-2008 (recent) period for upper and lower Gingin Brook. Based on available information (see section 3.2) the period of 1975-2001 (long-term) and 1997-2001 (recent) was used for Lennard Brook (Appendix E).

In upper and lower Gingin Brook the summer EWR were met over the long-term period. Over the recent period, which was drier, flow did not meet the EWR in some months of summer. A fish passage survey conducted in 2004 indicates that native fish are still present in Gingin Brook (Beatty and Morgan 2004). This suggests the flow regime of the recent, drier period was still sufficient to maintain summer refuge pools and support the fish population despite the EWR not being met.

The EWR for July was not met for upper Gingin Brook over the long-term period, nor was it met for June and July for the recent period. The July EWR was also not met for lower Gingin Brook over the recent period despite there being no winter abstraction in either resource over the entire period of record.

The department concluded that the static EWR developed for the Gingin Brook sites were not appropriate under a drying climate and we did not use them for allocation decisions in the final plan.

For Lennard Brook, mean daily flow for the long-term period met the EWR in all months except September. Mean daily flows for the recent period are higher than the long-term and met the EWR in all months. At the time of release of this plan monitoring data was only available to 2001 and from end 2008 to mid 2010 so the department could not be confident on how the resource has responded to abstraction and reduced rainfall over the past nine years.

The department concluded the EWR developed for Lennard Brook was not appropriate to base allocation decisions on until recent monitoring data can be assessed.

3.5 Social and cultural values

Maintaining a healthy river environment is important to the wider Gingin community to support social, cultural and economic values. A social water requirements study

identified the following as social and cultural values that are dependent on surface water and linked to Gingin Brook:

- Naturalness of waterway and riparian vegetation.
- Aesthetic appeal of permanent water associated with built structures (water wheel, bridges, road crossings, walkways, town weir).
- Water quality to protect aquatic fauna (fish, marron, gilgies).
- Indigenous mythological associations.
- Summer pools for swimming, fishing and environmental values.
- Water to allow for lawful riparian and licensed abstraction.

The study concluded that further work is required to confirm the interim surface water requirements presented in the report. It suggested that most of the identified social and cultural values linked to surface water in Gingin Brook would be maintained with permanent flow and if the ecological water requirements were met (Strategen and UWA 2005).

3.6 The impact of the hydrological trends

The reduction in permanent, summer flow has affected surface water users by restricting their ability to take their full entitlement year round and poses an increased risk to the ecological and social values of the resource.

A further reduction of summer flows could result in permanent ecological changes and limit use of the surface water resource as a viable water supply option.

Critical low flow thresholds

As part of implementing the *Gingin surface water allocation plan* we have set critical low flow thresholds for Lennard and Gingin brooks. Critical low flows represent the point at which we predict unacceptable risk to water users and the environment (Appendix E).

The thresholds have been developed using long-term streamflow information but do not take into account future climate predictions or ecological needs for water. Over the period of record, these thresholds have rarely been reached i.e. are likely to occur 1% to 2% of the time. In a drying climate we expect that the thresholds may be reached more often and pose unacceptable risks to existing users and the environment.

Through the plan evaluation process we will monitor how often the thresholds are reached and make allocation and licensing decisions based on any breaches of the thresholds. As part of implementing the allocation plan we have committed to identify key ecological values and develop critical low flow thresholds that will be appropriate to maintain them in a drying climate.

4 Allocation limit decisions

This chapter describes how the department set allocation limits for the Gingin surface water allocation area based on the information described in Chapter 2 & 3.

4.1 Process to set allocation limits

The department sets allocation limits in two main stages. We assess available scientific information and decide how much water to set aside for use. The stages run in parallel and may be iterative.

Stage one: Scientific assessment

In this stage we assess scientific information including streamflow and environmental water needs then estimate the yield of the resource (i.e. the volume of water that can be abstracted while maintaining the integrity of the resource and protecting key environmental values, where they have been identified).

Stage two: Management decision

In parallel with stage one, we decide whether less or more water should be made available for consumptive use (as compared to the yield), based on:

- Economic value of the resource (including existing use and future demand).
- Other factors like water quality or important cultural, ecological and social values which influence how water should be managed in the area.
- The departments capacity to manage and vary the take of water through licence conditions.
- Monitoring data obtained from Department of Water sites or from licensee monitoring reports.

The output of the process are allocation limits and associated allocation and licensing rules.

4.2 Stage one: Scientific assessment

We assessed available scientific information on the Gingin surface water resources. This included rainfall, streamflow and surface-groundwater interactions.

We did not derive a yield estimate based on the above information but did establish an understanding of the status of the resource. The assessment clearly showed the viability of most resources as a long-term surface water supply in Gingin has been affected by a drying climate and abstraction.

The department concluded that the current volume of annual abstraction is likely to be unsustainable from most resources.

4.3 Stage two: Allocation limit decisions

Based on the status of the resource and review of the water use information detailed in Chapter 2 we set the allocation limits for each resource. Appendix A and the resource reference sheets (at the end of the plan) provide details of the information we used for each resource to set the allocation limits.

We considered four allocation options and assessed whether they were appropriate for each surface water resource in the plan area:

1. Recover water (set at below current entitlements)
2. Set at current entitlements
3. Allocate water for stock and domestic use only
4. Set above current entitlements

1 Recover water

This option is applicable for resources where there is:

- high licensed abstraction for commercial purposes
- low to moderate exempt unlicensed abstraction
- streamflow characterised by:
    - declining minimum daily flows
    - reduced mean monthly streamflow
- a high risk to the values identified for the resource at the current level of abstraction

This option sets the allocation limit at 90% of current licensed entitlements, plus 100% of the estimated stock and domestic abstraction. Setting the allocation limit below current abstraction acknowledges the declining trends in rainfall and streamflow across the plan area and sets a target to which entitlements will be recouped.

At the time of release of the plan this option was appropriate for Moondah Brook and Gingin Brook resources 1, 2, 3, 6 & 7.

The plan outlines a recovery strategy the department will implement in these resources to bring entitlements to within the allocation limits (section 4.1 in the plan).

2 Set at current abstraction

This option is applicable for resources where there is:

- high licensed abstraction for commercial purposes
- moderate exempt unlicensed abstraction
- streamflow characterised by:
    - stable or increasing minimum daily flows

    - stable or increasing mean monthly streamflow
- low risk to the values identified for the resource at the current level of take.

This option sets the allocation limit at 100% of current licensed entitlements, plus 100% of estimates of exempt unlicensed abstraction.

At the time of release of the plan this option was appropriate for Lennard Brook. Molecap Hill gauging station shows an increasing trend in streamflow from 1975 to 2001. The station was closed in 2002 and reopened in late 2008. Monitoring data from 2009 indicates that streamflow may no longer be increasing (Appendix C). More monitoring information is required to confirm recent trends and assess whether additional water could be allocated from this resource.

3 Allocate water for stock and domestic use only

This option is applicable to resources where there is:

- no licensed abstraction for commercial purposes
- low to moderate exempt unlicensed abstraction
- streamflow characterised by:
    - very low flows and poor water quality during summer
    - declining minimum daily flows
    - declining mean monthly streamflow
- low to moderate risk to the values identified for the resource at the current level of take

This option sets the allocation limit at 100% of estimated exempt unlicensed abstraction and applies to resources that are not proclaimed or only partially proclaimed. At the time of release of the plan this option was appropriate for Gingin Brook 4, Gingin Brook 5, Wallering Brook, Mungala Brook and Quin Brook.

There is no water available for commercial use from these resources. By applying this allocation limit decision we are protecting the riparian rights of existing surface water users in these resources.

An allocation limit of zero was set for Gingin Brook 5 because it falls within an unproclaimed area, does not contain a defined stream channel, and is considered as part of the catchment area for Gingin Brook 6.

4 Set above current allocations

This allocation option allows more water for abstraction in addition to current licensed entitlements and estimates of exempt, unlicensed abstraction. To consider this option we need a good understanding of the yield of the resource and evidence that additional take will not cause unacceptable or unmanageable impacts to the resource.

Based on our assessment of the available scientific information the status of the resource indicates that the current volume of annual abstraction is likely to be unsustainable. The department concluded that take should be capped at or below current rates of abstraction for all resources.

This option is not appropriate for any of the resources in the plan area.

5 Allocation limits

The allocation limits for each resource are given in Table 3. They form the basis of the *Gingin surface water allocation plan* and are the main tool we use to manage abstraction in the plan area.

To keep account of how water is allocated the allocation limit is split into three components:

- licensable (general licensing, public water supply[1])
- unlicensable (exempt use, including riparian rights)
- reserves (public water supply[1]).

We issue licence entitlements up to the volume of the licensable component only. For the Gingin surface water resources, water set aside for the general licensing component is the allocation limit minus the water set aside for unlicensed use.

Table 3 Allocation limits (kL/yr) for Gingin surface water resources, grouped according to allocation limit option

Resource	Allocation limit (kL/yr)	Allocation limit components kL/yr	
		Unlicensable (exempt use)	**Licensable** (general licensing)
1 Recover water			
Moondah Brook	808 651	1 000	807 651
Gingin Brook 1	476 385	15 000	461 385
Gingin Brook 2	130 975	25 000	105 975
Gingin Brook 3	75 414	11 622	63 792
Gingin Brook 6	233 492	10 000	223 492
Gingin Brook 7	328 888	10 000	318 888
2 Set at current entitlements			
Lennard Brook	2 434 310	25 000	2 409 310

[1] there are no public water supply licenses or reserves in the Gingin surface water allocation area

Resource	Allocation limit (kL/yr)	Allocation limit components kL/yr	
		Unlicensable (exempt use)	**Licensable** (general licensing)
3 Allocate water for stock and domestic use only			
Wallering Brook	12 234	12 234	0
Mungala Brook	5 824	5 824	0
Quin Brook	3 963	3 963	0
Gingin Brook 4	5 488	5 488	0
Gingin Brook 5	0	0	0
Total	**4 515 624**	**125 131**	**4 390 493**

5.1 Implications for management

The *Gingin surface water allocation plan* was released for public comment in September 2009. The plan outlines our objectives, approach to allocating and licensing surface water, policies to guide this process and actions to implement and evaluate the plan.

Since the plan's release for public comment, the Gingin surface water area has been managed according to the allocation limits and decisions described in the plan and this methods report. Some licence entitlements have been recouped and dealt with according to the recovery strategy outlined in Chapter 4 of the plan.

Current licensed entitlements for Gingin Brook 2 are now 117 750 kL/yr. A volume of 399 000 kL/yr was recouped during a licence transfer. This volume was a reserved entitlement that has never been abstracted

Current licensed entitlements in Gingin Brook 3 are now 70 880 kL/yr. A total of 197 700 kL/yr is no longer licensed from this resource due to one licence recoup, three expired licences and two entitlements being incorporated into the unlicensed component of the allocation limit because they were identified as being in an unproclaimed area.

The total volume of 596 700 kL/yr will not be made available for new licences in the Gingin Brook 2 and 3 resources. This is in line with our objectives, policy on recouping in over-allocated resources and actions for implementing the plan. The new allocation limit for Gingin Brook 2 and 3 for the final *Gingin surface water allocation plan* has been set at 90% of *current* licensed entitlements (Table 2 and Table 3) and better reflects the actual volume of water abstracted from this resource annually.

Appendices

Appendix A - Summary of information considered for each resource

Eight points were considered when developing the allocation limits for each resource:

1. Licensed entitlements (September 2010)
2. Estimates of exempt abstraction
3. Review of metered abstraction
4. Groundwater availability (alternative water source)
5. Review of ground and surface water interaction
6. Nearest gauging station
7. Hydrological trends
8. Values for water use
    - Social/cultural, economic, ecological
    - low, moderate or high

The above points are summarised for each resource in Table A1 – A12.

Table A1 Summary of information considered for the Lennard Brook

Information	Details
1	Fifteen licences totalling 2 409 310 kL/year, for horticulture
2	Approximately 25 000 kL/year
3	Unknown, not all users are metered
4	Limited groundwater is currently available
5	Most summer flow is maintained by groundwater discharge from the Mirrabooka aquifer and possibly the Leederville aquifer.
6	Molecap Hill (617165).
7	General increasing trend in annual streamflow 1975–2001. The gauging station was closed in 2001. The trend since 2001 is unknown.
8 Social Cultural	Low: no significant sites that depend on flow have been identified High: permanent significant sites
Economic	High: based on licensed entitlements and exempt use
Ecological	High: flows into wetlands in Bambanup NR and Lake Yeal, sections registered as CCW

Table A2 Summary of information considered for the Moondah Brook

Information	Details
1	Three licences totalling 897 390 kL/year, for horticulture and agriculture
2	Approximately 1 000 kL/year
3	One licensee is reporting actual take above the licensed entitlement
4	Limited groundwater is currently available
5	Most summer flow is maintained by groundwater discharge from the Mirrabooka aquifer.

Information	Details
6	No gauging station on this resource. Flow data gained from Gingin Brook gauging station (617058)
7	Decreasing trend in streamflow observed at Gingin Brook gauging station since 1975
8 Social	High: identified social values are maintained with permanent flow water users downstream of this resource have expressed concern about reduced flows during the low flow period
Cultural	High: stored data on significant sites
Economic	High: based on licensed entitlements
Ecological	Mod: section registered as multiple use wetland and CCW

Table A3 Summary of information considered for the Gingin Brook 1

Information	Detail
1	One licence for 512 650 kL/year, for agriculture
2	Approximately 15 000 kL/year
3	Not reported
4	Limited groundwater is currently available
5	Most summer flow is maintained by groundwater discharge from the Mirrabooka and possibly the Leederville aquifer.
6	No gauging station on this resource. Flow data gained from Gingin Brook gauging station (617058).
7	Decreasing trend in streamflow observed at Gingin Brook gauging station, since 1975.
8 Social	High: Gingin Brook from the headwaters to start of 'horseshoe' is registered with the National Estate - Water users downstream of this resource have expressed concern about reduced flows during the low flow period.
Cultural	Low: no registered or significant sites
Economic	High: based on licensed entitlements and exempt use
Ecological	Mod: registered multiple use wetland, small area of CCW

Table A4 Summary of information considered for the Gingin Brook 2

Information	Detail
1	Three licences totalling 117 750 kL/year for horticulture and agriculture
2	Approximately 25 000 kL/year
3	Not all users are metered. One user reports take below the licensed entitlement due to a staged development.
4	Limited groundwater is currently available
5	Most summer flow is maintained by groundwater discharge from the Mirrabooka and Leederville aquifers.
6	Gingin Brook (617058)
7	Decreasing trend in streamflow observed at the Gingin Brook gauging station since 1975.
8 Social	High: Gingin Brook from the headwaters to start of 'horseshoe' is registered with the National Estate - Water users downstream of this resource have expressed concern about reduced flows during the low flow period.
Cultural	Mod: stored data on significant sites

Information	Detail
Economic	High: based on licensed entitlements and exempt use
Ecological	Low: registered multiple use wetland

Table A5 Summary of information considered for the Gingin Brook 3

Information	Detail
1	seven licences totalling 70 880 kL/year for agriculture
2	Approximately 11 622 kL/year
3	Not all users are metered. One user reports take below the licensed entitlement.
4	No groundwater is available in this resource
5	Summer flow, if present, is due to groundwater discharge in the upper reaches of Gingin and Moondah Brook. Downstream of Gingin town site the groundwater level is below the base of the Brook so does not discharge along this reach.
6	No gauging station within this resource. Closest station is upstream at the Gingin Brook gauging station (617058).
7	N/A
8 Social Cultural	High: Granville Park and Three Bridges maintained by permanent flow Mod/High: permanent significant sites west of Brand Hwy
Economic	Mod: based on licensed entitlements and exempt use
Ecological	Mod: registered as multiple use wetland, small areas of CCW

Table A6 Summary of information considered for the Gingin Brook 4

Information	Detail
1	No licences (partially proclaimed)
2	Approximately 5 488 kL/year
3	Not applicable
4	No groundwater is available in this resource.
5	Most summer flow is maintained by groundwater discharge from superficial and Leederville aquifers.
6	No gauging station within this resource. Closest station is the Bookine Bookine gauging station (617003).
7	Decreasing trend in streamflow observed at the closest station, the Bookine Bookine gauging station, since 1975.
8 Social Cultural	Low: no significant sites that depend on flow have been identified High: permanent significant sites
Economic	Low: exempt use only
Ecological	Mod: registered as multiple use wetland, small areas of CCW.

Table A7 Summary of information considered for the Gingin Brook 5

Information	Detail
1	No licences (unproclaimed)
2	No use due to lack of accessible channel
3	Not applicable
4	No groundwater is available in this resource.
5	This resource is a catchment area for Gingin Brook with no defined stream channel or groundwater interactions.
6	N/A

Information	Detail
7	N/A
8 Social Cultural	High: 100% nature reserve and state forest (not dependant on permanent flow) Low: no registered or significant sites
Economic	Low: no surface water abstracted
Ecological	High: Yeal Nature Reserve, Gnangara-Moore river state forest, small areas of CCW

Table A8 Summary of information considered for the Gingin Brook 6

Information	Detail
1	One licence for 248 325 kL/year for turf farm irrigation
2	Approximately 10 000 kL/year
3	Entitlement is not being used
4	No groundwater is available in this resource.
5	Most summer flow is maintained by groundwater discharge from superficial aquifer
6	Bookine Bookine gauging station (617003)
7	Decreasing trend in streamflow observed at the Bookine Bookine gauging station since 1975.
8 Social Cultural	Mod: 30% nature reserve and state forest High: permanent significant sites
Economic	Mod: based on licensed entitlements and exempt use
Ecological	High: Yeal Nature Reserve, Gnangara-Moore river state forest, registered as multiple use wetland with numerous areas of CCW

Table A9 Summary of information considered for the Gingin Brook 7

Information	Detail
1	One licence for 354 320 kL/year for pasture
2	Approximately 10 000 kL/year
3	Reported as fully utilised
4	No groundwater is available in this resource.
5	Most summer flow is maintained by groundwater discharge from superficial aquifer.
6	No gauging station within this resource. Closest station is upstream at the Bookine Bookine gauging station (617003).
7	Decreasing trend in streamflow observed at the closest station, the Bookine Bookine gauging station, since 1975.
8 Social Cultural	High: Old Junction Bridge and North West Stock Route dependent on permanent flow High: permanent significant sites
Economic	Mod: based on licensed entitlements and exempt use
Ecological	Mod: registered as multiple use wetland, confluence with Moore River

Table A10 Summary of information considered for the Wallering Brook

Information	Detail
1	No licences (mostly unproclaimed)
2	Approximately 12 234 kL/year

Information	Detail
3	Not applicable
4	Some groundwater is currently available.
5	No groundwater discharge in lower reaches. Possible discharge from Mirrabooka aquifer in headwaters
6	N/A
7	N/A
8 Social	High: Boonanarring nature reserve
Cultural	High: permanent significant sites
Economic	Low: exempt use only
Ecological	High: Yeerealup and Boonalarup lakes, registered as multiple use wetland west of Brand Hwy

Table A11 Summary of information considered for the Mungala Brook

Information	Detail
1	No licences (partially unproclaimed)
2	Approximately 5 824 kL/year
3	Not applicable
4	Some groundwater is currently available
5	Groundwater discharges from the superficial and Leederville aquifers at the confluence with Gingin Brook.
6	N/A
7	N/A
8 Social	High: Moore River NP and NR, Sand Spring Well NR. Bartletts Well, Yurine Swamp, Bootine and Boonanarring NR
Cultural	High: registered permanent significant sites
Economic	Low: exempt use only
Ecological	High: Beermullah Lake, White Lake. Extensive areas registered as multlple use, resource enhancement and CCW wetlands

Table A12 Summary of information considered for the Quin Brook

Information	Detail
1	No licences (mostly unproclaimed)
2	Approximately 3 963 kL/year
3	Not applicable
4	No groundwater is available in this resource.
5	There are both gaining and losing reaches along this watercourse. Quinn Brook flows all year at the confluence with Gingin Brook as base flow is maintained by groundwater discharge from the superficial and Leederville aquifers.
6	N/A
7	N/A
8 Social	High: Gnangara-Moore river state forest, Yeal NR, Bambanup NR
Cultural	Low: small portion of registered permanent significant site associated with Lennard Brook
Economic	Low: exempt use only
Ecological	High: numerous areas of registered CCW, Yeal Lake

Appendix B - Proclaimed areas

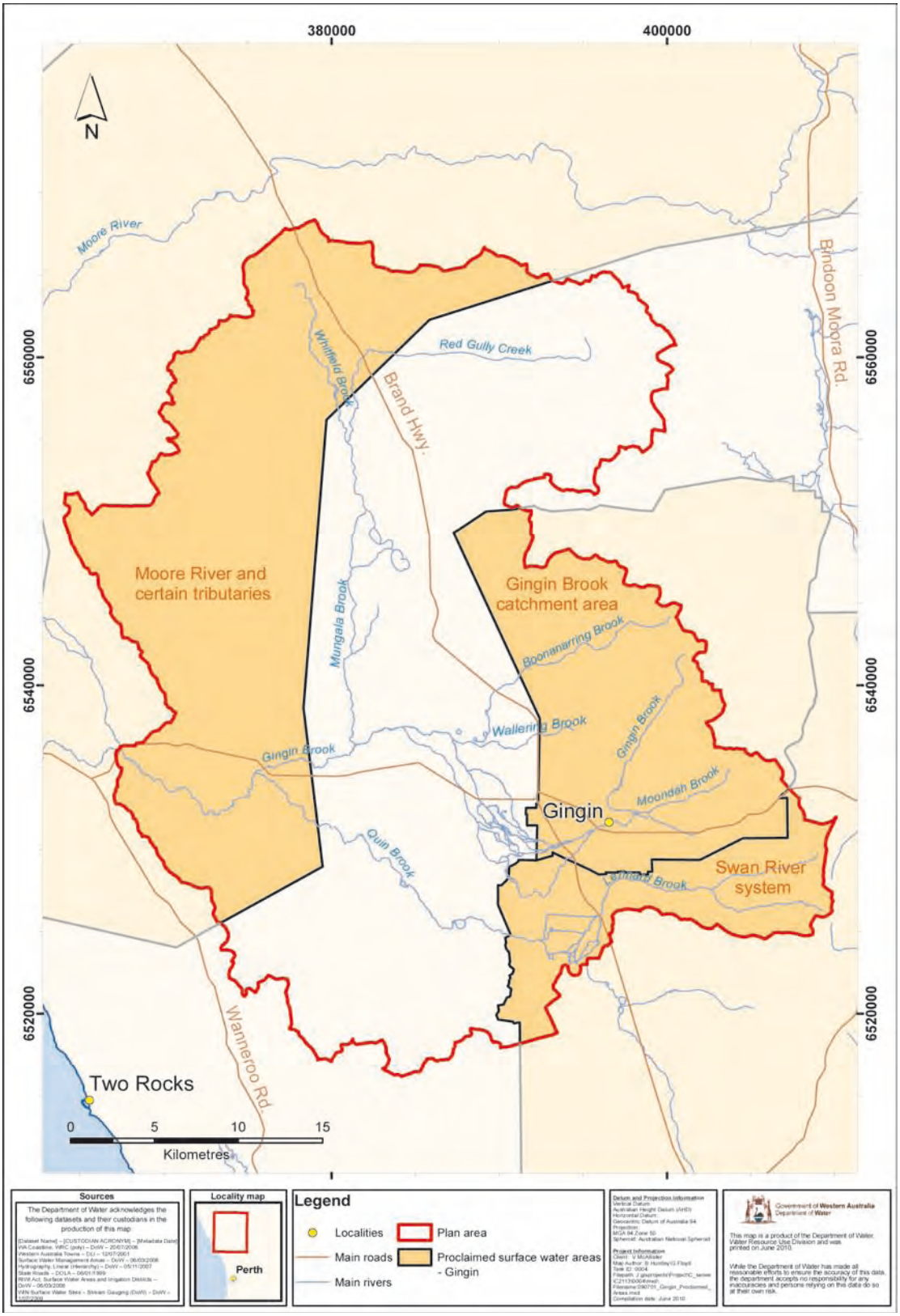


Figure B1 Proclaimed areas within the Gingin surface water allocation plan area

Appendix C - Summary of the hydrology of Gingin and Lennard Brooks

Background

Gingin Brook is an important perennial freshwater stream with strong groundwater interaction that is primarily fed by springs and seeps along the stream banks.

Much of the land close to (1 to 2 km) the Gingin Brook has been cleared for agriculture. The Gingin Brook system is an important source of water for agricultural and rural residential purposes. During the summer months, water demand for these land uses is high. Water is currently pumped both from the brook and from the adjacent unconfined and confined aquifers.

The hydrology of Gingin Brook is described in this appendix, with specific reference to streamflow at the Gingin Brook (617065), Bookine Bookine (617003) and Molecap Hill (617165) streamflow gauging stations (Figure C1). Rainfall data for the catchment was recorded at Gingin meteorological station (009018) (Figure C1).

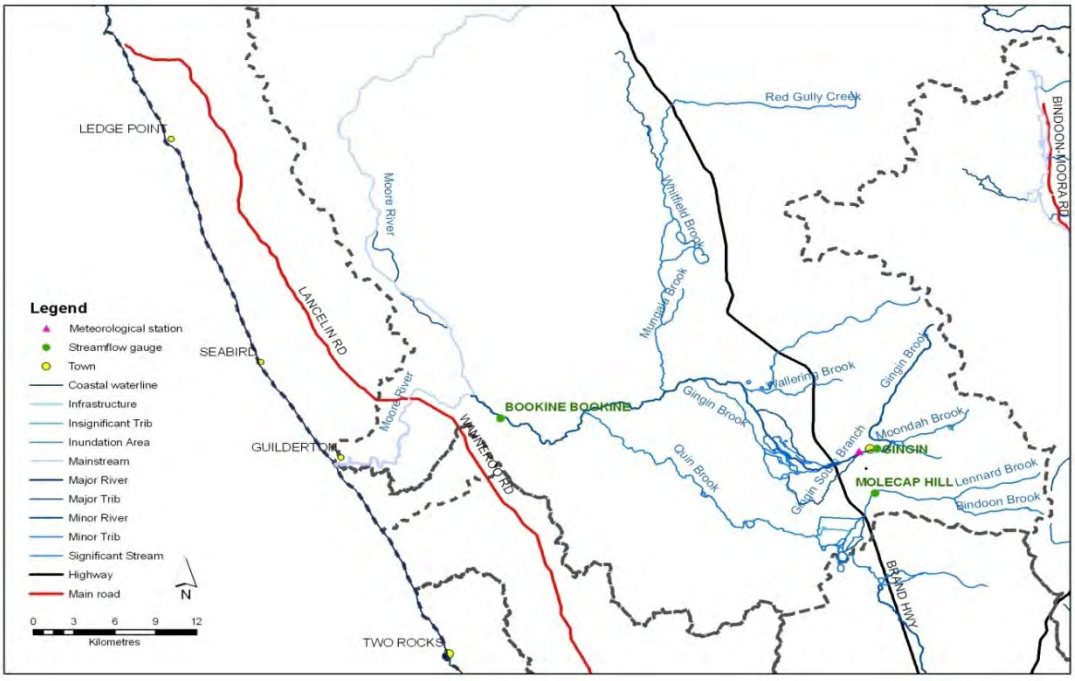


Figure C1 Location of Gingin Brook meteorological station (009018) and flow gauging stations

Rainfall

The mean annual rainfall for Gingin Brook (at the Gingin Brook meteorological station, 009018) from 1889 to 2007 was 729 mm, with 80 per cent of this rainfall occurring between May and September.

Figure C2 shows the mean annual rainfall at Gingin Brook from 1889 to 2007. There has been a decline in annual rainfall since the mid 1970s. The average rainfall from 1889 to 1974 was 765 mm; however for the last 10 year period (1997 to 2007) average rainfall has decreased to 621 mm.

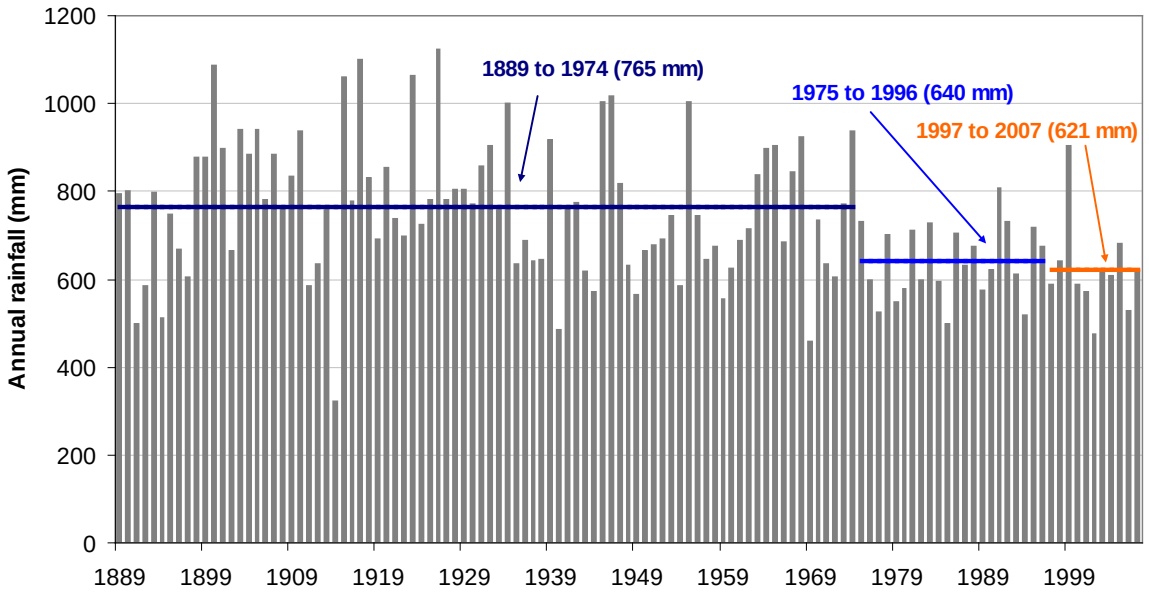


Figure C2 Annual rainfall at Gingin Brook meteorological station (009018)

Rainfall is highly seasonal, with the peak rainfall occurring in July. For the period of record (1890 to 2007) approximately 86% of rainfall has occurred between May and October.

Comparison between average monthly rainfall for the long term (1890 to 1974) and recent shorter term (1975 to 2007) periods (Figure C3) show a reduction in rainfall for almost all months of the year, particularly the winter months (June and July).

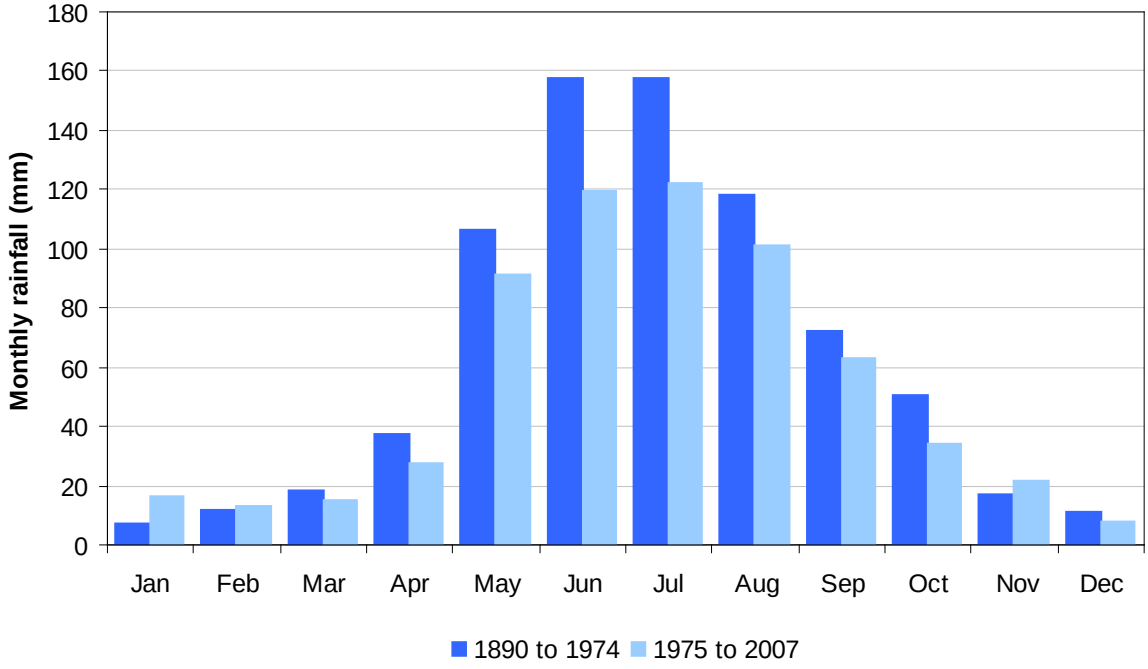


Figure C3 Monthly rainfall at Gingin Brook meteorological station (009018)

Streamflow

Streamflow records have been analysed from three long-term gauging stations within the catchment – Gingin Brook (617058), Bookine Bookine (617003) and Molecap Hill (617165).

Gingin Brook (617058)

The Gingin Brook streamflow gauging station is located near the Gingin townsite with a catchment area of 106 km^2. Approximately 68% of the catchment is cleared. The station has been operating since June 1957.

Figure C4 shows the annual streamflow at Gingin Brook (617058). Average annual streamflow was 14 GL for the period 1958 to 1974, compared to 11 GL for the period 1997 to 2007.

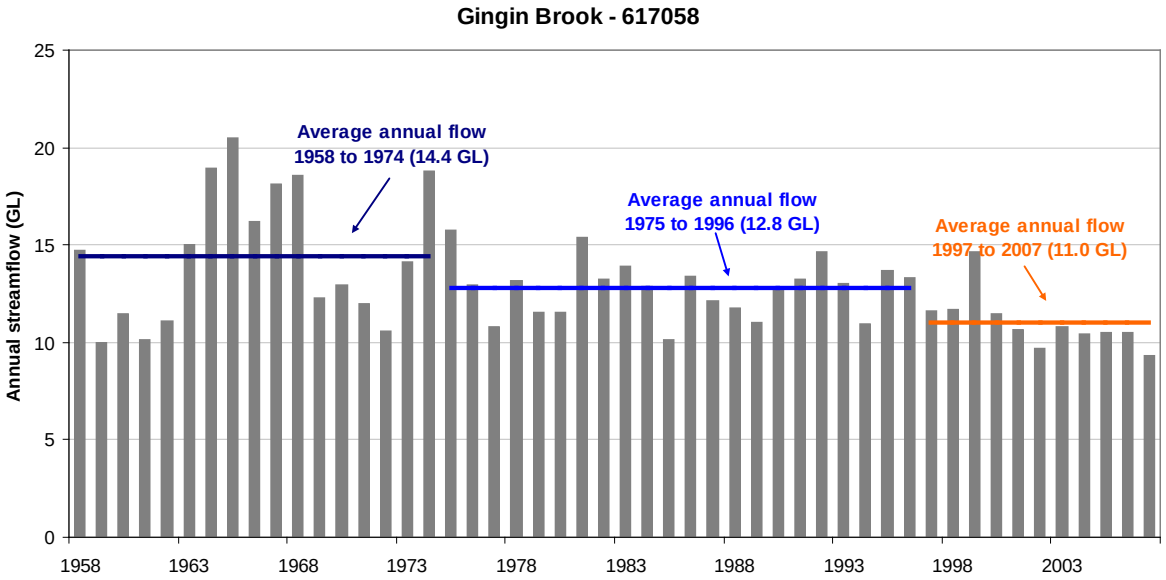
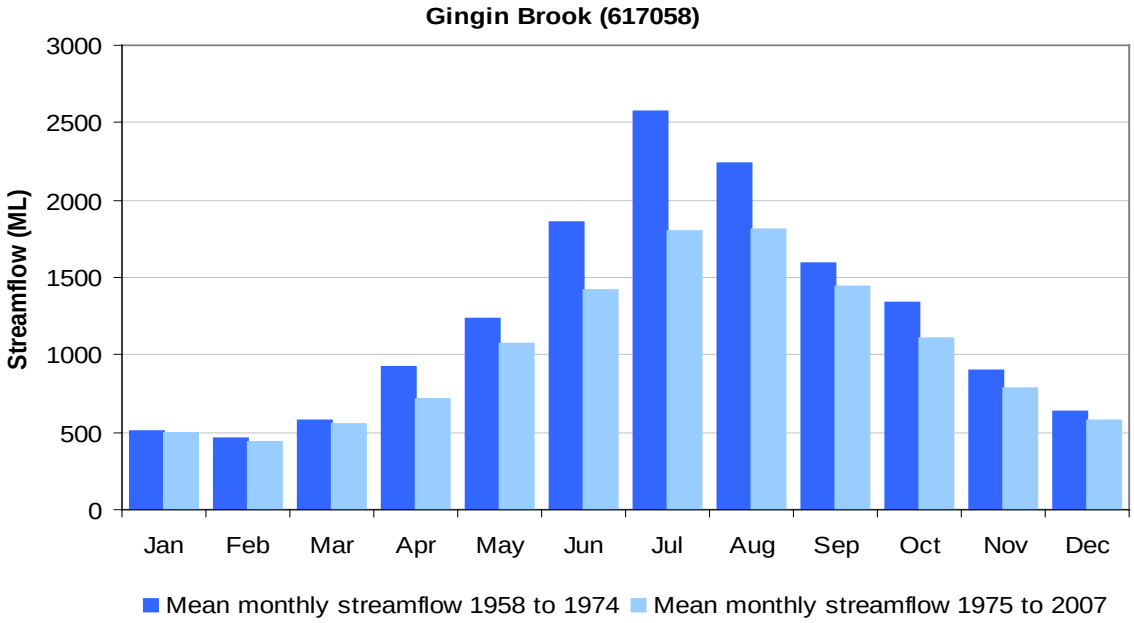


Figure C4 Annual streamflow at Gingin Brook (617058)

Streamflow is highly seasonal with approximately 70% of mean annual flow occurring from May to October (Figure C5). The decreasing trend seen in annual streamflow was also evident in the comparison of mean monthly streamflow for the periods 1958 to 1974 and 1975 to 2007 (Figure C5). Streamflow was lower in the 1975 to 2007 period for all months, with the most noticeable reduction from June to August.



FigureC5 Monthly streamflow at Gingin Brook (617058)

Figure C6 is a plot of the minimum daily flow for each year on record at Gingin Brook (617058). The negative gradient of the trend line shows that there is a declining trend in the minimum flows for the brook at this gauging station.

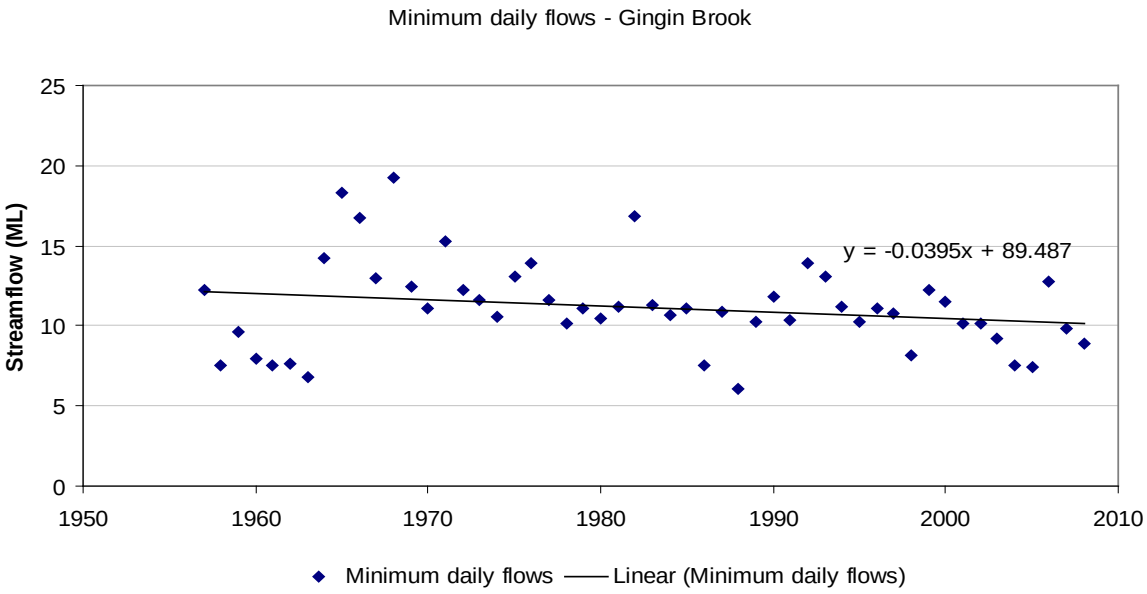


Figure C6 Minimum daily flow for each year at Gingin Brook (617058)

Daily flow duration curves show the probability of equalling or exceeding a given daily flow. Daily flows have been grouped into (approximately) 10-year periods, and the resulting flow duration curves are included in Figure C7. The curves highlight the reduction in daily streamflow over the period of record. For instance, the median daily flow (flow with a probability of being exceeded 50 per cent of the time) from 1958 to 1966 was approximately 36 ML, while the median daily flow from 1997 to 2007 was

approximately 27 ML. The daily flow duration curves also show that flow is perennial for all periods; daily flow has exceeded 6 ML on 100 per cent of days.

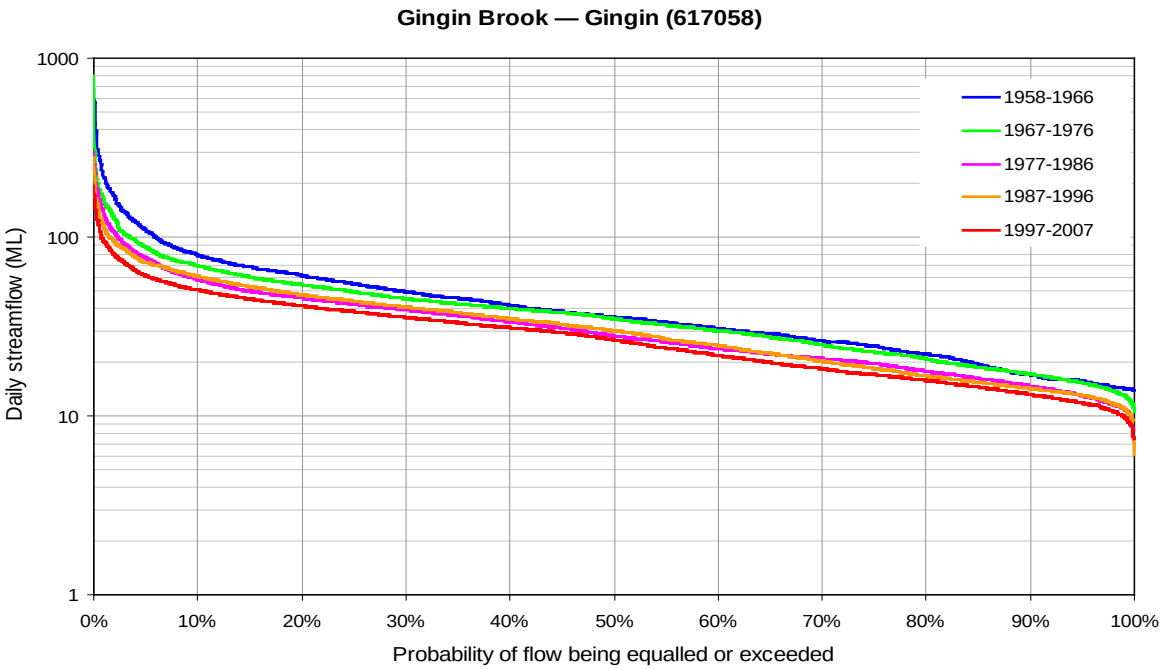


Figure C7 Daily flow duration curves at Gingin Brook (617058)

(Note that the vertical axis is logarithmic).

Bookine Bookine (617003)

The Bookine Bookine streamflow gauging station is located approximately 3 km upstream of the confluence between the Gingin Brook and Moore River (Figure C8). The station has a catchment area of 1370 km^2 and has been operating since May 1972.

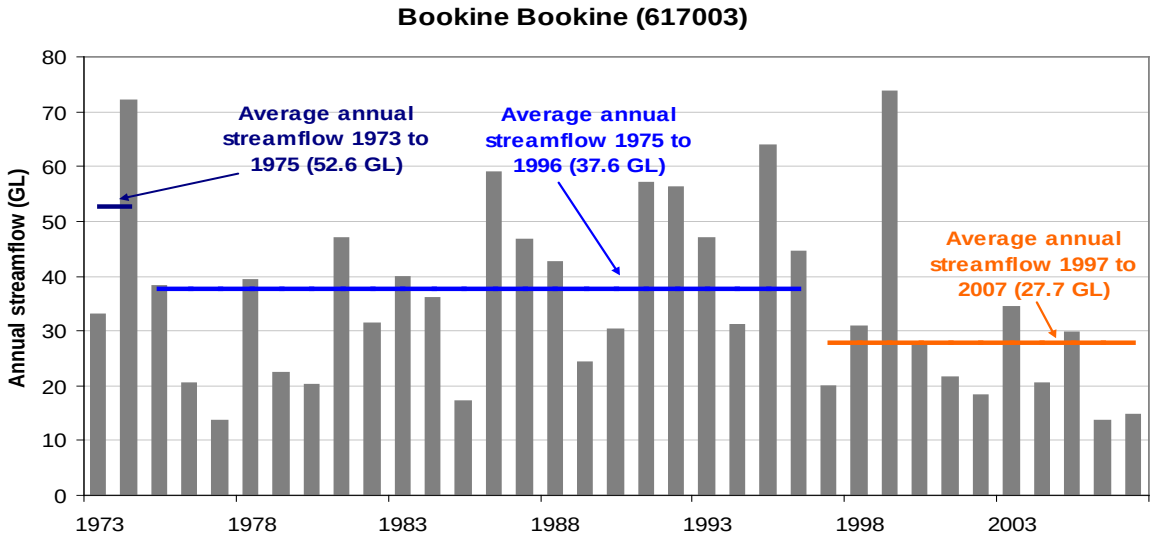


Figure C8 Annual streamflow at Bookine Bookine (617003)

There has been a decline in annual streamflow at Bookine Bookine (617003). The average annual streamflow from 1975 to 1996 was 38 GL, while the average annual

streamflow for the last ten was 28 GL (Figure C8). Flow at Bookine Bookine is highly seasonal with 92% occurring between May and October.

The mean monthly streamflow plot for these two periods highlights the reduction in streamflow for most months, with the most dramatic streamflow reductions occurring in July and August (Figure C9).

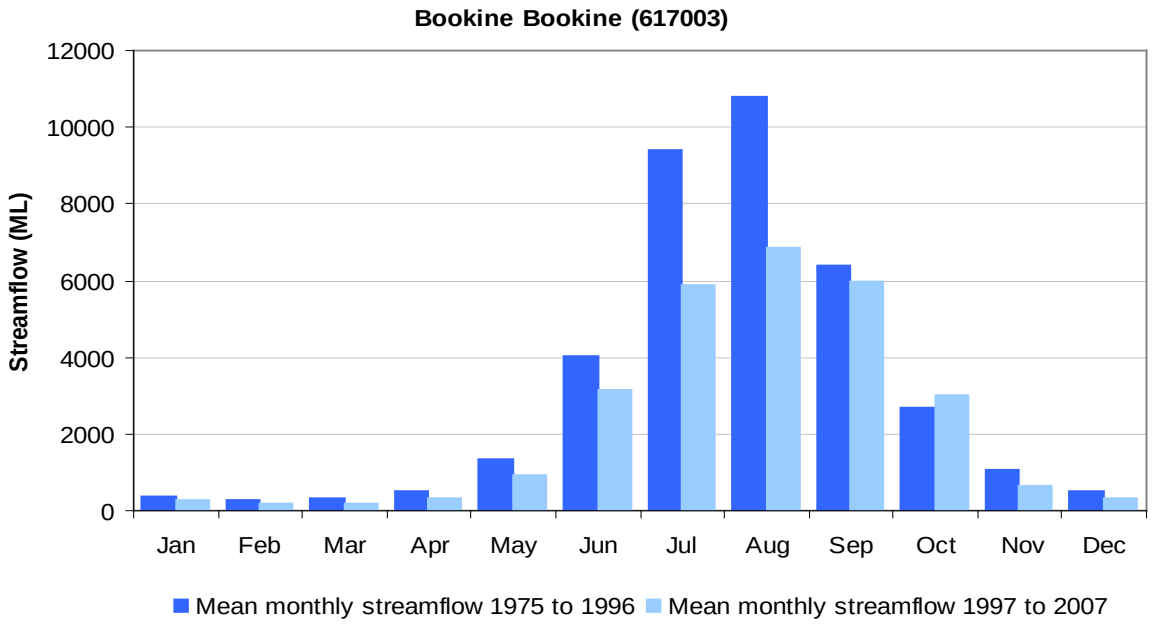


Figure C9 Monthly streamflow Bookine Bookine (617003)

The minimum daily flow for each year has decreased at Bookine Bookine (617003) over the period of record (Figure C10). This reduction in daily flows is also evident in daily flow duration curves categorised into 10 year periods (Figure C11). For instance, the median daily flow (equalled or exceeded on 50 per cent of days) was 34 ML for the period 1973 to 1982, compared to17 ML for the period from 2003 to 2007.

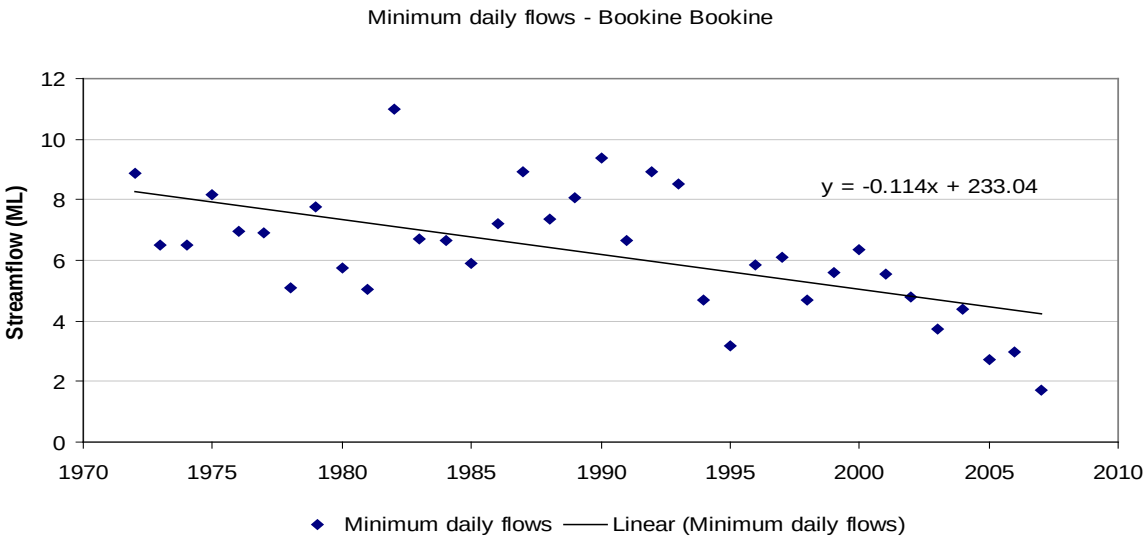


Figure C10 Minimum daily flow for each year at Bookine Bookine (617003)

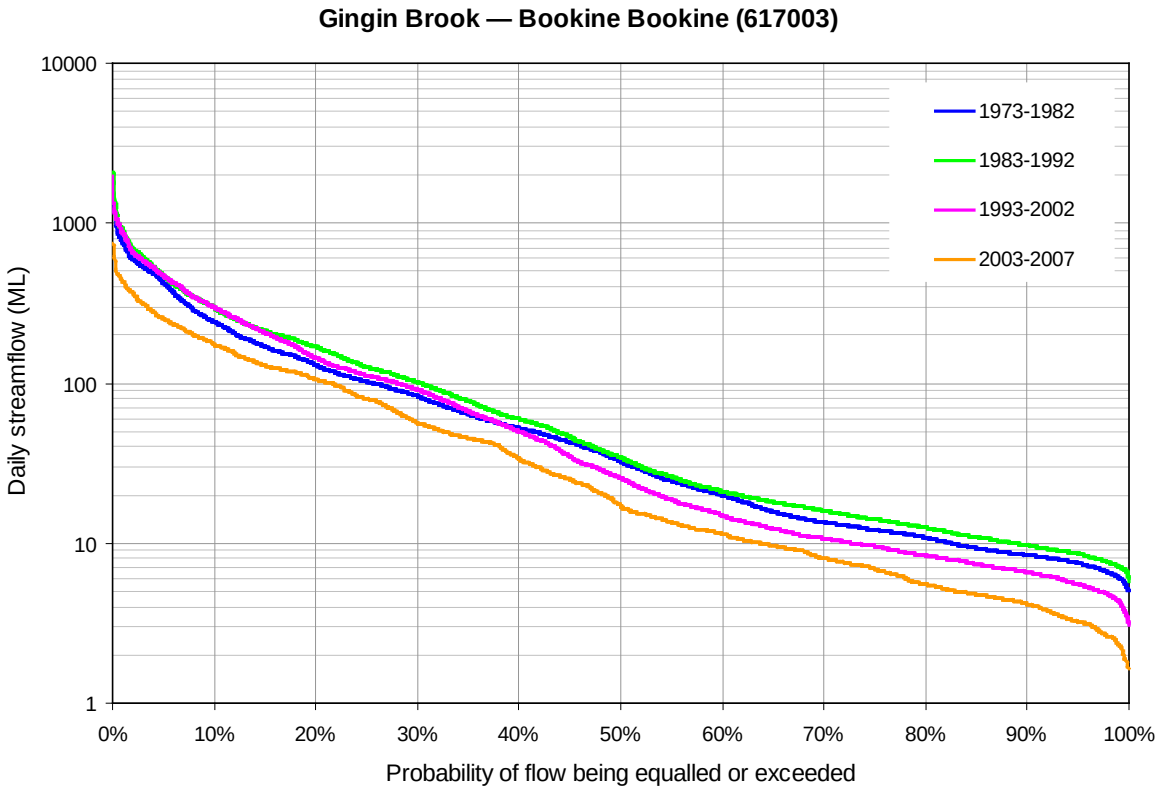


Figure C11 Daily flow duration curves for Gingin Brook at Bookine Bookine (617003)

Molecap Hill (617165)

The Molecap Hill streamflow gauging station is located on Lennard Brook and has a catchment area of 59 km^2. The station operated from 1963 and closed in 2001. It was reopened in late 2008.

There has been a general increasing trend in annual streamflow at the station since the early 1970s (Figure C12). The average annual streamflow for the period 1963 to 1974 was 5.2 GL, while the average annual streamflow for 1975 to 2001 was 6.5 GL.

Since the release of the plan for public comment we now have streamflow data from late 2008 to May 2010. Total annual streamflow for 2009 was 6.2 GL which is just below the annual average of 6.5 GL over the 1975 – 2001 period.

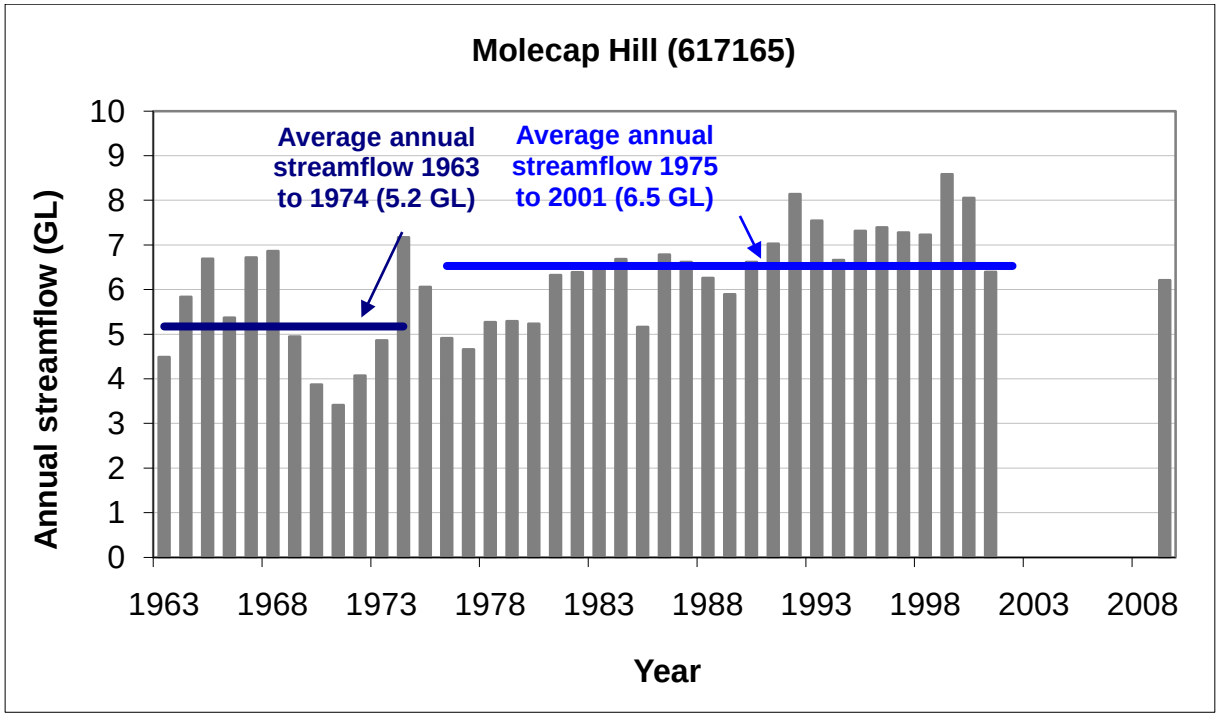


Figure C12 Annual streamflow at Molecap Hill gauging station (617165)

Figure C13 shows that average monthly streamflow was higher for the 1975–2001 period compared to the 1963–1974 for all months. Monthly flow from November 2008 to May 2010 is generally similar or lower than the 1975 to 2001 averages, which suggests that streamflow may no longer be increasing in this resource.

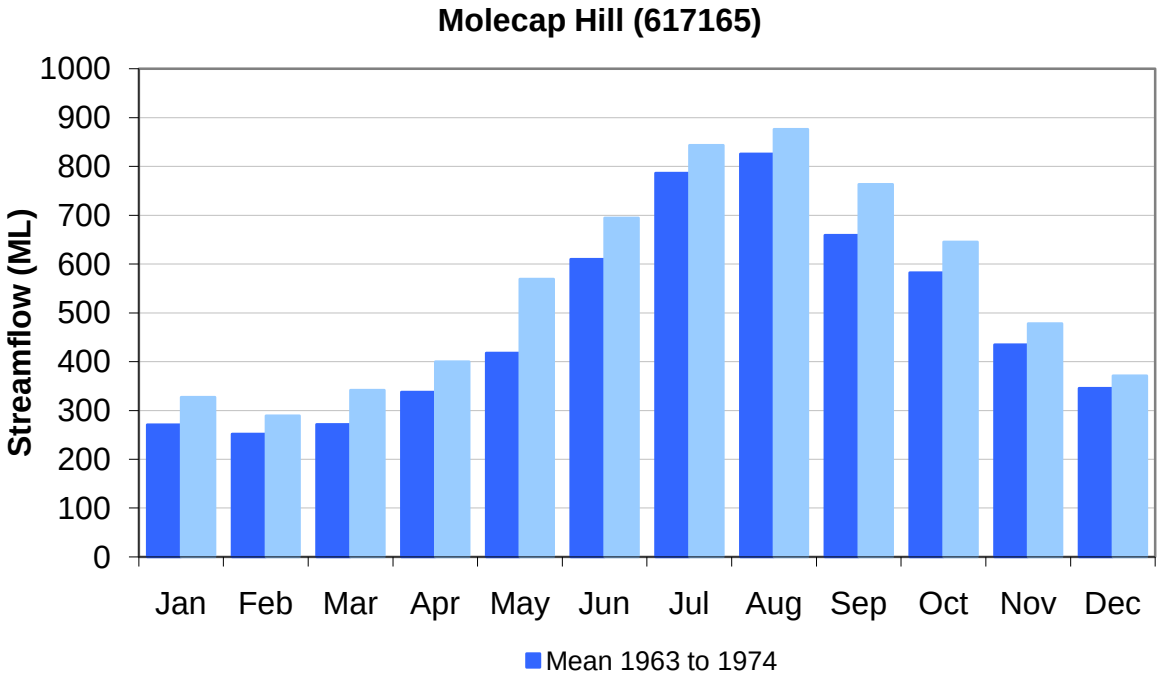


Figure C13 Monthly streamflow at Molecap Hill gauging station (617165)

The increase in flows for the 1963 to 2001 period of record is evident in the positive trend line of Figure C14 which shows the minimum daily flows.

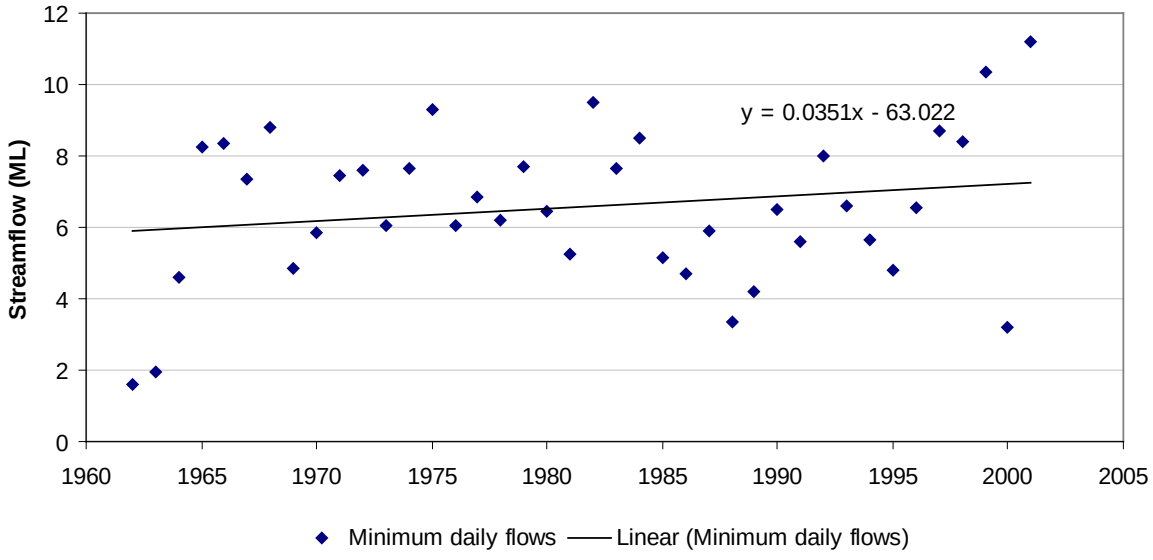


Figure C14 Minimum daily flow for each year at Molecap Hill gauging station (617165)

Daily flow duration curves for Molecap Hill have been categorised into 10-year periods. These also show an increase in daily flows, particularly for the most recent period (1993 to 2001), where the median daily flow was 19 ML compared to 14 ML for 1963 to 1972 (Figure C15).

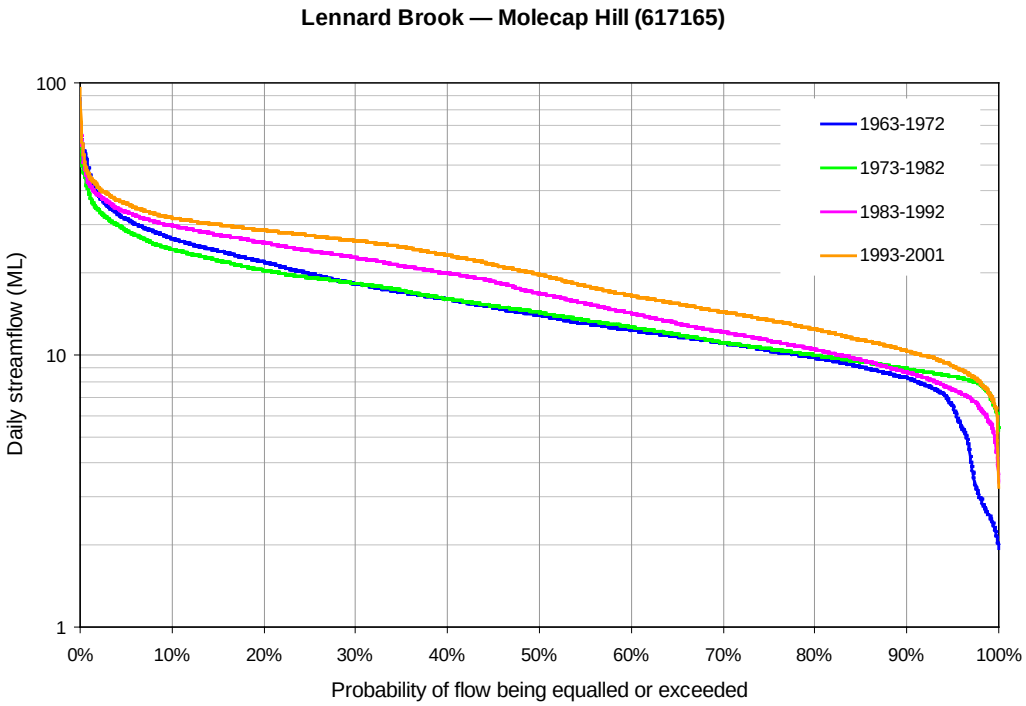


Figure C15 Daily flow duration curves at Molecap Hill gauging station (617165). (Note that the vertical axis is logarithmic).

Variation in streamflow throughout the catchment

In 2007 the department undertook the Gingin Brook snapshot project. Flow and water quality measurements were recorded at a number of sites within the Gingin Brook catchment. These 'snapshots' were repeated on a number of occasions during the year to capture seasonal variability. The snapshot results give a good indication of streamflow variability throughout the catchment, particularly in the area west of the Brand Highway. There is a large difference in flow at different locations along the brook due to its interaction with groundwater.

Figure C16 and Figure C17 show the snapshot results for February and May 2007. It is apparent from the snapshots that the upper reaches of Gingin and Moondah Brooks (to 3 km downstream of the Gingin town site) are 'gaining' streams, as is the Gingin Brook between the confluence with Mungala Brook and the confluence with Moore River. This means that groundwater is likely to be discharging along these reaches of these streams. The Gingin Brook ceased to flow in the mid reaches, west of Brand Highway, in March 2007. Overall there is 40% to 50% more streamflow in May than March.

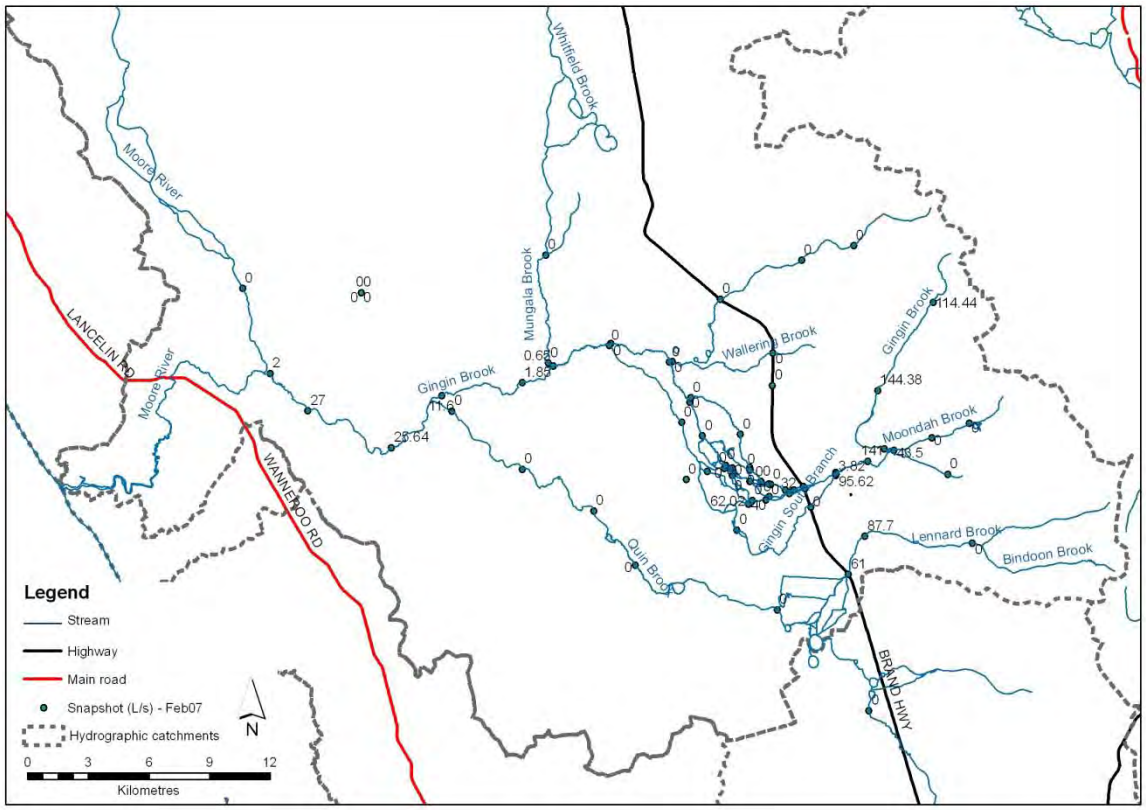


Figure C16 Gingin snapshot February 2007

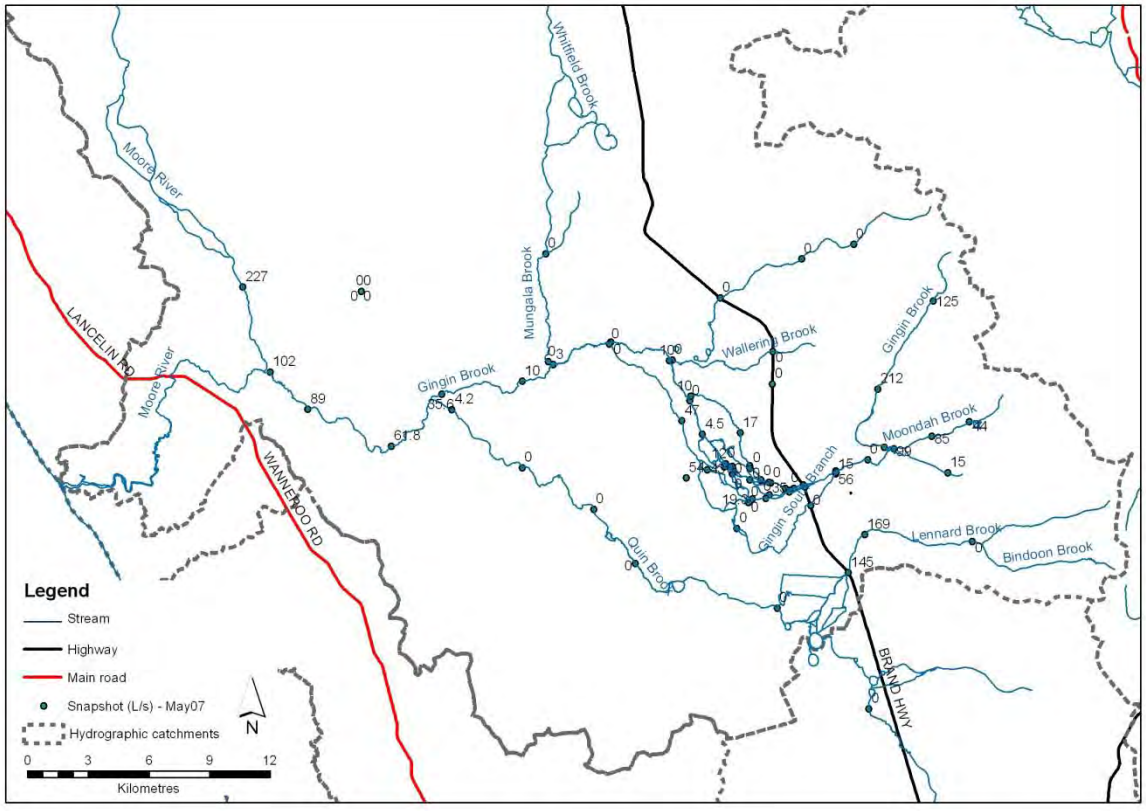


Figure C17 Gingin snapshot May 2007

Appendix D – Groundwater connectivity map for Gingin Brook

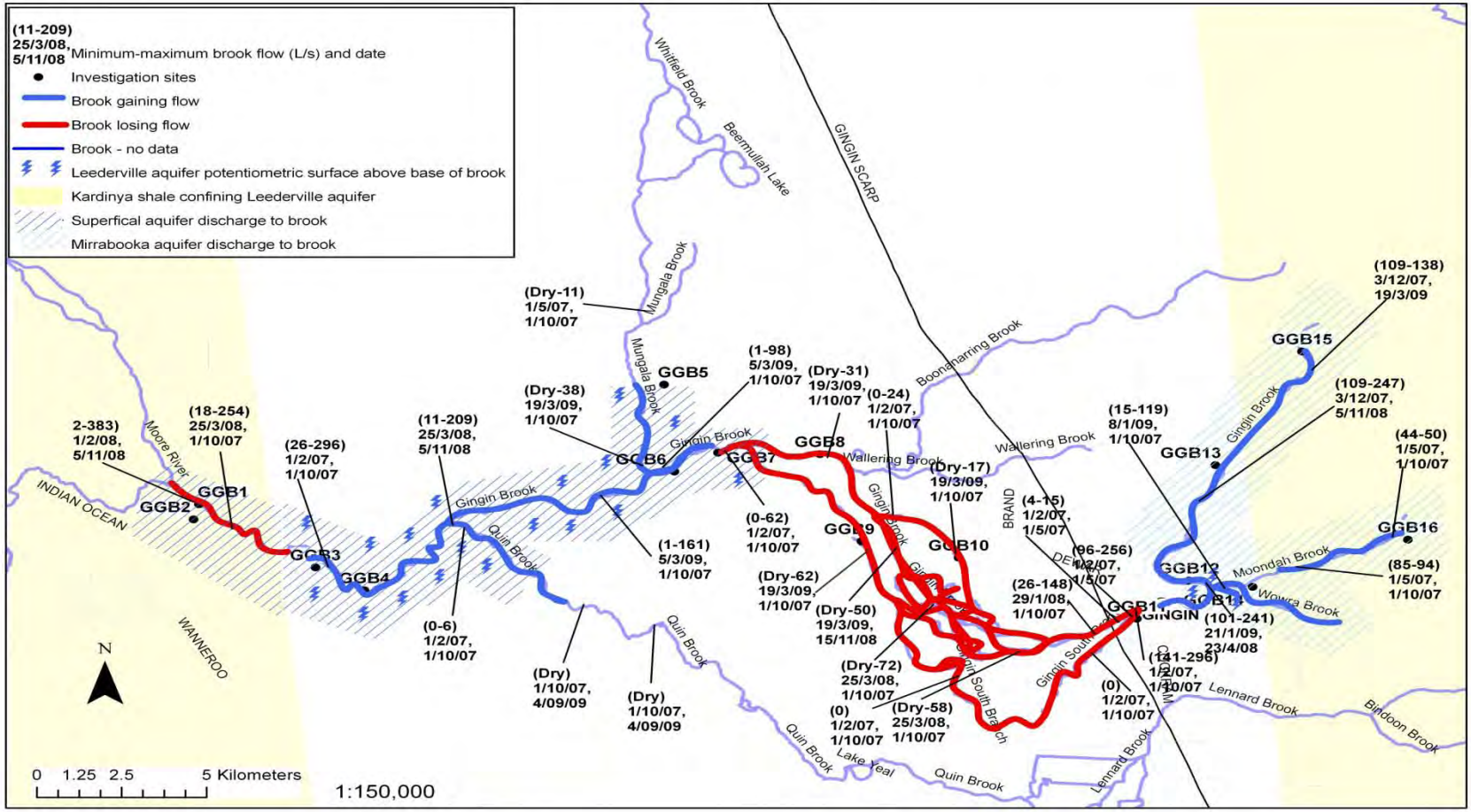


Figure D1: Connectivity map and spot flow analysis of Gingin Brook

Appendix E - Comparison of long-term streamflow record to the ecological water requirements

To better understand the effect of recent flows on ecological values, this summary compares the ecological water requirements developed by Storey and Davies (2002) to the long-term and recent flow regimes recorded at gauging stations located on upper and lower Gingin Brook and Lennard Brook.

In Tables E1 to E3 mean daily flows which did not meet the ecological water requirement are indicated in bold.

Table E1 Monthly ecological water requirement for Lennard Brook compared to mean daily flow at Molecap Hill gauging station (617165)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecological water requirement ML/day	9.3	9.3	9.3	11.5	13.2	18.6	25.9	27.7	27.7	20.1	13.6	9.3
Mean daily flow 1975–2001 ML/day	10.6	10.3	11.0	13.3	18.4	23.1	27.2	28.3	**25.4**	20.8	15.9	12.0
Meandaily flow 1997–2001 ML/day	14.1	12.8	14.0	16.9	21.6	25.8	29.5	30.2	29.4	24.8	18.9	15.0

Table E2 Monthly ecological water requirement for middle Gingin Brook compared to monthly mean daily flow at Gingin Brook gauging station (617058)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecological water requirement ML/day	15.7	15.7	15.7	21.3	30.2	45.2	83.5	50.4	50.1	22.7	15.7	15.7
Mean daily flow 1975–2003 ML/day	16.1	15.8	18.4	24.2	35.2	48.2	**60.3**	59.8	**48.7**	36.0	26.7	19.1
Mean daily flow 1997–2008 ML/day	**15.4**	**14.2**	16.5	22.6	31.5	**41.4**	**48.3**	51.8	**46.2**	34.3	22.6	16.3

Table E3 Monthly ecological water requirement for Lower Gingin Brook compared to mean monthly flow at Bookine Bookine gauging station (617003)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ecological water requirement ML/day	9.6	9.6	9.6	13.2	27.9	85.0	190.6	157.2	152.1	64.5	24	9.6
Mean daily flow 1975–2003 ML/day	11.0	9.8	10.2	15.5	41.2	128.1	284.2	325.7	219.9	95.2	32.3	14.6
Mean daily flow 1997–2008 ML/day	**8.3**	**6.3**	**6.6**	**11.2**	29.6	105.6	**189.2**	221.0	198.9	97.9	**21.9**	9.8

Appendix F - Critical low flow thresholds for Gingin and Lennard brooks

Decision

The Department of Water recognises that summer flows are important for water supply for domestic and commercial use and to maintain social, cultural and ecological values in the Lennard and Gingin brooks.

Daily flows in Gingin Brook are declining (refer to Appendix C and E above). The lowest daily flows have generally occurred from January to March. The decrease in summer flow has been attributed to increased abstraction for stock, domestic and commercial use, and declining rainfall and groundwater discharge in the area.

Given the declining trend in rainfall, the department is limited to maintaining summer flow by managing the volume and timing of water abstraction during the low flow period. As part of the *Gingin surface water allocation plan* abstraction has been capped by setting allocation limits.

We will continue to monitor surface water flow and assess if summer flows continue to decline, even with caps on abstraction. This information will inform the revision of allocation limits where appropriate.

We will compare the gauged summer flows against thresholds, referred to as ‘critical low flow thresholds’ (CLFT). The CLFT represent the point at which we predict unacceptable risk to surface water users and the environment.

The greater the frequency and duration of flows equalling or falling below these thresholds, the greater we perceive the risk to be to the economic, social, cultural and environmental values of the Gingin and Lennard brooks.

Method

The critical low flow thresholds are based on the long term flow record. For Gingin Brook this is gauged daily streamflow between 1975 and 2007, and for Lennard Brook it is gauged daily streamflow between 1963 and 2001.

The approach assumes that flows over the long term period of record have been sufficient to protect environmental values in the brooks, such as native fish. Environmental investigations (Beatty and Morgan 2004) have identified that these values persist under the past flow regimes where the critical low flow thresholds have been reached, but vary rarely (1% of the time). By maintaining similar flows in the future we assume a low level of risk will be maintained for these values.

The approach does not take into account future climate predictions or proposed ecological water requirements.

Using flow–duration curves (Figures F1 and F2) we have identified the low flows from the long term record that occur very infrequently and set these as the critical low flow thresholds.

In Gingin Brook between 1975 and 2007 the flow was above 10 ML/day 99% of the time (Figure F1). Flows below 10 ML/day occurred 24 times for a maximum duration of 5 days and a mean duration of 2.5 days. The appropriate critical low flow threshold for Gingin Brook was therefore chosen as a flow of below or equal to 10 ML/day for two consecutive days per year.

The daily flow duration curve for Lennard Brook (Figure F2) indicates that a flow of 5 ML/day was exceeded on 98% of days (1963–2001). Flows below 5 ML/day occurred on 22 occasions with a maximum duration of 4 days and a mean duration of 2.4 days. The critical low flow threshold for Lennard Brook was therefore chosen as flow below or equal to 5 ML/day for two consecutive days per year.

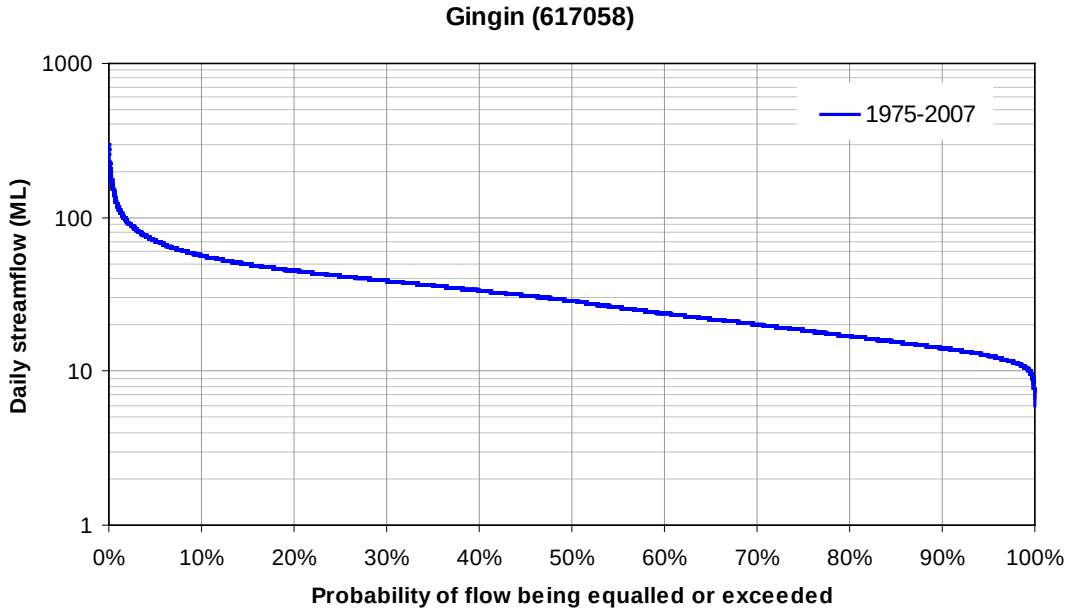


Figure F1 Flow–duration curve for Gingin Brook (1975–2007)

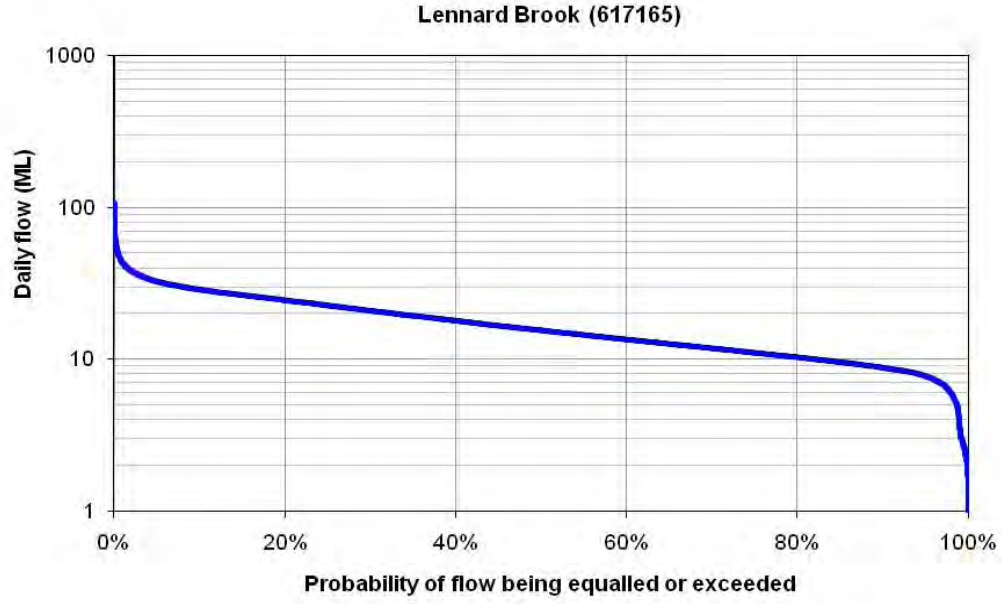


Figure F2 Flow–duration curve for Lennard Brook (1963–2001)

Future work: Refining the low flow thresholds

The critical low flow thresholds developed for Gingin and Lennard brooks are thresholds that we can use to monitor the summer flow regime now. We are concerned that in a drying climate the thresholds may be reached more often and, because they have been developed using hydrological information only, they do not necessarily reflect the ecological requirements of the surface water resources in the Gingin area.

Ecological sampling has previously been undertaken (Beatty & Morgan 2004; Storer *et al* 2010). This has shown that the Gingin and Lennard brooks have a relatively unique native fish species assemblage, including two threatened species, when compared with other rivers in the south west of Western Australia (Storer 2010 pers. comm.).

An ecological water requirement study (Storey & Davies 2002) was also completed which identifies ecological values and recommends a monthly volume that should be set aside to meet environmental needs (Appendix E).

The proposed ecological water requirements are a holistic approach designed to maintain the existing biodiversity and ecological processes at a low level of risk. That is; to maintain channel form, provide for connectivity both within channel, and laterally with the floodplain (for the movement of nutrients, organic matter and biota) and for the inundation of riparian vegetation and wetland connectivity in the Gingin and Lennard brooks (Storey & Davies 2002).

We will refine the existing critical low flow thresholds to incorporate maintenance of key ecological values (rather than purely hydrological indicators). The revised thresholds may not be the same as the proposed ecological water requirements as specified by Storey & Davies (2002) because they will represent the minimum flows required to maintain key ecological values – rather than a holistic target for a ‘normal’ summer flow regime.

We will use the existing ecological information, and do additional ground truthing to refine the current CLFT as part of the monitoring program for the allocation plan (section 5 in the plan). As part of this process we will:

- Identify key ecological values and objectives.
- Identify the flow regime required to maintain the ecological values.
- Identify the appropriate management response if the ecological thresholds are regularly breached.

When developed, the department will implement the revised thresholds and management response. We will use them to revise the allocation limits for the Gingin surface water area, and to manage summer pumping where appropriate.

Glossary

Abstraction The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality.

Allocation limit Annual volume of water set aside for use from a water resource.

Baseflow The component of streamflow supplied by groundwater discharge.

Ecological water requirement The water regime needed to maintain the ecological values (including assets, functions and processes) of water-dependent ecosystems at a low level of risk.

Flow regime A description of the variation of the flow rate over time.

Groundwater Water which occupies the pores and crevices of rock or soil beneath the land surface.

Licence A quantity of water specified on a formal permit which entitles the licence holder to 'take' water from a watercourse, wetland or underground source, in accordance with the *Rights in Water and Irrigation Act 1914*.

Recharge Water that infiltrates into the soil to replenish a groundwater aquifer.

Resource unit The Department of Water's administrative units for allocating water. Often referred to as resources.

Surface water Water flowing over or held in streams, rivers and wetlands on the surface of the land.

Surface water management area Areas defined by the Department of Water, used for water allocation planning and management, which are generally hydrologic basins or parts of basins.

Stock and domestic water use Water that is used for ordinary domestic purposes associated with a dwelling, such as water for cattle or stock other than those being raised under intensive conditions; water for up to 0.2 ha (if groundwater) or 2 ha (if surface water) of garden from which no produce is sold. This take is generally considered a basic right.

Take Take, in relation to water, means to remove water from, or reduce the flow of water in, a watercourse, wetland or underground water source, including by:

- pumping or siphoning water
- stopping, impeding or diverting the flow of water
- releasing water from a wetland
- permitting water to flow under natural pressure from a well
- permitting stock to drink from a watercourse or wetland

and includes storing water during, or ancillary to, any of those processes or activities.

(Definition from the *Rights in Water and Irrigation Act 1914*)

Water entitlement The quantity of water that a person is entitled to take on an annual basis in accordance with the *Rights in Water and Irrigation Act 1914* through a licence.

Volumes of water

One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

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