Australian Capital Territory

Water Resources Environmental Flow Guidelines 2026

Disallowable instrument DI2026–11

made under the

Water Resources Act 2007, s 12 (Environmental flow guidelines)

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1 Name of instrument

This instrument is the *Water Resources Environmental Flow Guidelines 2026*.

2 Commencement

This instrument commences on the day after its notification day.

3 Approval of environmental flow guidelines

I approve the environmental flow guidelines in schedule 1.

4 Revocation

This instrument revokes the *Water Resources Environmental Flow Guidelines 2019 (No 2)* (DI2019-190).

Suzanne Orr
Minister for Climate Change, Environment, Energy and Water

06/02/2026

Schedule 1

ACT Water Resources Environmental Flow Guidelines - 2026

ACT Government

Acknowledgement of Country

The City and Environment Directorate acknowledges the Ngunnawal people as traditional custodians of the ACT and recognise any other people or families with connection to the lands of the ACT and region.

We respect the Aboriginal and Torres Strait Islander people, particularly our Aboriginal and Torres Strait Islander staff, and their continuing culture and contribution they make to the Canberra region and the life of our city.

Produced by the City and Environment Directorate. Enquiries about this publication should be directed to the City and Environment Directorate.

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Executive summary

The ACT is located within the upper Murrumbidgee River catchment and is the largest urban area in the Murray-Darling Basin. Aquatic ecosystems in the ACT are highly valued by Traditional Custodians and the broader community as living systems that embody the interconnectedness of all life. They provide the ACT's consumptive water supply as well as considerable cultural, recreational and amenity value, recognising that water flows are the lifeblood that sustains all life relationships within these systems. Decline in the condition of ACT waterways is of major concern and the subject of ongoing management. This includes protecting and delivering environmental water to support key ecological values and maintain the holistic wellbeing of these life-supporting systems while honouring Traditional knowledge that has sustained these waters as healthy Country.

The Water Resources Environmental Flow Guidelines (the Guidelines) are an instrument under the *Water Resources Act 2007* (ACT) that set the flow requirements needed to maintain aquatic ecosystems. The Guidelines are used with other regulatory instruments to manage water resources in the ACT, with recognition that healthy water systems support all life including human communities. The Guidelines align with the deep knowledge of Traditional Custodians who have maintained these water systems as healthy living Country through seasonal management, cultural fire practices, and a spiritual relationship with water as a living ancestor.

The Guidelines:

- Provide annual guidance on environmental water requirements (quantity and timing of water) to support achievement of the environmental objectives and targets to be set by the ACT Long-Term Watering Plan.
- Help maintain and preserve the cultural values of waterways by ensuring the natural rhythms and health of these ecosystems, which are integral to the traditions and spiritual practices of Traditional Custodians and reflect a deep understanding of water as a sacred life force that connects all beings.
- Recognise that the economic and social importance of water can vary over time, particularly during periods of drought. The Guidelines accommodate this by adjusting environmental flow requirements during times of drought, while balancing the ongoing need to protect aquatic ecosystems. These critical periods demand enhanced protection to maintain ecological resilience and support intergenerational continuity.

Environmental flow requirements for key river reaches, for the purposes of the *Water Resources Act 2007* (ACT), are presented in

Table ***1***. These are based on the best available science and acknowledge Traditional knowledge systems, which offer valuable perspectives on the long-term patterns of life in these watersheds. Information gathered from ongoing monitoring and evaluation will be used to inform future Guideline reviews, supporting an adaptive management approach that learns from life system responses and honours the complexity and wisdom inherent in natural systems.

The Guidelines acknowledge the intrinsic value of all waterbodies as a component of an interconnected and dynamic water system. They recognise that all waterbodies play an equally vital role in maintaining ecological health, supporting biodiversity, and sustaining environmental flows.

While the ACT can manage certain risks to meeting environmental water requirements, others fall outside the Territory's jurisdiction such as the operation of the Snowy Hydro Scheme and the release of flows from Tantangara Dam. In these cases, the ACT will continue engaging with NSW and the Commonwealth Government to seek outcomes that best support the Territory's environmental objectives.

The Guidelines have had an ongoing review cycle of 5 years since implementation. The next review, after a further five years of operation, has two priority purposes:

- To identify opportunities to improve the water requirements set in the Guidelines to *ensure long-term ecological objectives and short-term ecological outcomes are being* achieved, and
- To improve alignment of the Guidelines with the long-term objectives and watering requirements set in the Long-Term Watering Plan.

This review and potential update may be conducted earlier if evidence indicates it is warranted.

Table 1. Summary of flow requirements set in the Guidelines for key reaches in the ACT. Note that the summary does not include flow requirements for drought conditions.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

<table>
<tr><th>Reach</th><th>Flow requirements</th></tr>
<tr><td>Cotter River: upstream of Corin Reservoir</td><td>Maintain natural flows</td></tr>
<tr><td>Cotter River: Corin Dam to Bendora Reservoir</td><td>Base flow – Maintain minimum monthly base flows (ML/month) as shown below[1]:
<table>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>465</td><td>280</td><td>341</td><td>450</td><td>589</td><td>840</td><td>1395</td><td>1922</td><td>2760</td><td>1984</td><td>1290</td><td>806</td></tr>
</table>
Small fresh - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months.
Large fresh - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid- October.</td></tr>
<tr><td>Cotter River: Bendora Dam to Cotter Reservoir</td><td>Base flow – Maintain minimum monthly base flows (ML/month) as shown below[2]:
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<tr><td>713</td><td>448</td><td>589</td><td>720</td><td>961</td><td>1350</td><td>2201</td><td>3007</td><td>4320</td><td>3100</td><td>2010</td><td>1271</td></tr>
</table>
Small fresh - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months.
Large fresh - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid- October.</td></tr>
</table>

[1] Daily flows (ML/day) can be varied by the Environment Protection Authority following consultation with a licence holder provided monthly volumes are maintained.

[2] Daily flows (ML/day) can be varied by the Environment Protection Authority following consultation with a licence holder provided monthly volumes are maintained.

Queanbeyan River: Downstream of Googong Dam

Base flow - October – June of 10 ML/day and July to September of 15 ML/day or natural inflow whichever is the lesser.

Small fresh - Maintain a flow of ≥100 ML/day for 1 day every 2 months.

Murrumbidgee River (ACT reaches)

Base flow: Maintain minimum daily base flows (ML/day) at Lobbs Hole (gauge 410761) as shown below:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
33	22	16	35	55	65	79	99	169	128	130	53

Maintain daily base flows (ML/day) at Mt MacDonald (gauge 410738) greater than or equal to as shown below:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
76	69	54	65	73	122	193	227	312	230	276	105

Small fresh: Protect a minimum of 250 ML/d for a period of 1 day, once every 30 days.

Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flows that are larger than the 80th percentile flow.

Lake Burley Griffin

Allow water level fluctuations of up to 0.6 m below full supply level. Where possible limit drawdown to 0.2 m July – November.

Jerrabomberra wetlands

Base flow: Maintain monthly base flows (ML/month) greater than or equal to as shown below:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
0	4.8	2.7	5.2	8	20.7	27.8	26.8	28.5	21.4	10.4	5.4

Molonglo River Upstream and Downstream of Lake Burley Griffin

Base flow: Maintain monthly base flows (ML/month) above Lake Burley Griffin (gauge 410729) greater than or equal to as below:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
201	311	284	249	311	446	517	546	467	442	402	335

Maintain monthly base flows (ML/month) at a minimum 80th percentile flow (the flow that is exceeded 80% of the time) below Lake Burley Griffin. It is noted that there is currently no appropriate gauge at the time of establishing this Guideline to calculate base flows below Lake Burley Griffin.

Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flows above the 80th percentile flow.

Other modified reaches

Base flow: Maintain 80th percentile monthly flow in all months.
Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.

Urban streams (lined and unlined)

Base flow: Maintain 80th percentile monthly flow in all months.

Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.

Urban lakes, ponds and wetlands

Allow water level fluctuations of up to 0.6 m below full supply level, where possible limit drawdown to 0.2m July – November.

All natural reaches

Maintain natural flows.

Groundwater

Groundwater abstraction is limited to 10% of the long-term recharge.

1. Introduction

1.1. Background

Regulation of rivers to support consumptive purposes and increasing urban development has greatly altered waterways in the Murray-Darling Basin including the ACT. These changes have disrupted the fundamental life patterns and relationships that have sustained aquatic life communities for millennia and interrupted the Traditional management systems. In some Australian streams, allocation of water for off-stream consumptive uses can exceed total flow impacting the interconnected communities of life that depend on flowing waters. Consumptive uses are often given priority as water rights, entitlements, and licences have legal and commercial status.

The poor state of freshwater ecosystems in the Murray-Darling Basin has sparked a shift towards the allocation of water for environmental purposes (Murray-Darling Basin Authority (MDBA), 2012). Environmental water is recognised as a key requirement in both federal and territory water policy (*Water Act 2007* (Cth)*; Water Resources Act 2007* (ACT)) and reflects growing understanding that healthy water systems are fundamental to the wellbeing of all life.

At a Basin scale, environmental water is a key management lever for achieving system wide ecological outcomes, which include:

- protecting and restoring water-dependent ecosystems of the Murray-Darling Basin as interconnected life systems that support diverse communities of life
- protecting and restoring the ecosystem functions of water-dependent ecosystems that support the balance and connections among all living things within them
- ensuring that water-dependent ecosystems are resilient to climate change and other risks and threats and can continue to support life across generations while maintaining the cultural landscapes that Traditional Custodians have a responsibility to protect.

The ACT has a variety of aquatic ecosystem types, including water supply catchments, regulated rivers, urban streams, lakes and ponds, and natural unmodified reaches. Each represents a unique expression of water as life, supporting different, but interconnected communities of plants, animals, and other life forms, and each holds specific cultural significance within Traditional knowledge systems that understand the relationship between different types of water Country. Changes in land use, changes to river channels, streamflow diversion, discharges to streams, introduction of flora and fauna, and recreational fishing are some of the key factors that have influenced the aquatic ecosystem values in many of these waterways and altered the traditional life patterns that Traditional Custodians have understood and worked with for thousands of years.

The Guidelines outline ecological objectives, short-term ecological outcomes with associated indicators and targets, and priority ecosystem functions to be protected by the environmental flow regime. This approach recognises that each species and life form contribute to the overall health and resilience of the life community. These objectives, outcomes and functions are based on Commonwealth threatened species legislation, ACT legislation and policies, and research insights.

1.2. Purpose and scope of the Environmental Flow Guidelines

The primary purpose of the Guidelines is to maintain aquatic systems as thriving life communities that support the wellbeing of all life forms, including human communities. They are intended to inform annual environmental flow planning that support both the immediate needs of ecosystems and communities, and the long-term care and stewardship of water resources.

The Guidelines cover the full range of aquatic ecosystems found in the ACT (Table 2). Different environmental flow requirements have been set for each of type of ecosystem. These requirements recognise that each ecosystem type represents a unique expression of water-life relationships with specific needs for maintaining healthy communities. These requirements are addressed in detail in section 3.

The Guidelines cover all key waterways in the ACT.

1.3. National responsibilities

Murray Darling Basin Plan

As a signatory to an intergovernmental agreement established under the Murray–Darling Basin Plan (the Basin Plan), the ACT is required to manage water resources in a way that is consistent with the requirements of the Basin Plan. This recognises that water systems extend beyond political boundaries and that healthy systems require coordinated management across the entire living landscape, while honouring Traditional territories and cultural connections that similarly extend across contemporary political boundaries. The Australian Capital Territory Water Resource Plan for Surface Water and Groundwater 2019 (ACT Water Resource Plan) sets out the amount of water that is available for the environment and the rules and arrangements for using that water, ensuring consistency with the Basin-Wide Environmental Watering Strategy (BEWS).

The ACT Water Resource Plan, with particular focus on the Guidelines, supports compliance with section 10.28 of the Basin Plan: *No net reduction in the protection of planned environmental water.* This ensures that life-supporting water continues to be available for the aquatic communities that depend on it and maintains the flow patterns that Traditional knowledge recognises as essential for healthy Country.

Environmental watering throughout the Murray-Darling Basin is achieved through a combination of planned environmental water and held environmental water, where:

- held environmental water is water available under a water access right or held on a water licence for the purposes of achieving environmental outcomes (Water Act 2007 (Cth), section 4), and
- planned environmental water is water that is committed or preserved for achieving environmental outcomes through a plan or legislation and cannot be used for any other purpose unless required for emergency purposes or specified times and circumstances (Water Act 2007 (Cth), section 6) and recognises that certain water flows are essential for maintaining life patterns and cultural relationships that must be protected.

The Guidelines specify the planned environmental water and the associated requirements and arrangements for ACT dams including Googong Dam. All water supply dams have environmental flow release requirements specified in the Guidelines. Urban dams have translucent flows, as they are normally full and hence outflows equal inflows less water take, losses for evaporation and seepage into groundwater. These requirements recognise that even water supply infrastructure is operated in ways that support life systems both upstream and downstream.

Long-Term Watering Plan

Under the Basin Plan, Basin States are required to prepare a long-term watering plan (LTWP) for its water resource plan area (in the case of the ACT, the ACT itself). The LTWP details environmental objectives and targets at a regional scale, as well as watering requirements for a range of priority environmental assets (PEAs) and priority ecosystem functions (PEFs). Regional objectives described in the LTWP nest under the expected environmental outcomes set out in the BEWS. PEAs and PEFs represent the most critical life systems and life processes that require specific water flows to maintain their essential roles in supporting life communities, including their cultural significance. PEAs and PEFs are assets and functions that by definition require watering. This is in keeping with the environmental objectives of the Basin Plan.

The methods for formally identifying PEAs, PEFs and their environmental watering requirements are detailed in the Basin Plan. Fundamental to identifying the PEAs and PEFs in the ACT is that they are environmental assets or functions that can be managed with environmental water. This recognises that human management can either support or disrupt life systems, and that conscious management to support life requires specific water flows that honour both ecological processes and Traditional knowledge about how water systems maintain their health.

Many of the ACT's important freshwater assets are in conservation areas and cannot be managed with environmental water, beyond limiting extractions. For example, the Ginini Flats Wetlands Ramsar site is in the headwaters of Ginini Creek in Namadgi National Park; as water cannot be delivered to this asset, the way of managing water at this site is by preventing extraction and allowing natural life patterns to continue.

The ACT LTWP is currently being developed and will be informed by these Guidelines. The LTWP and the Guidelines are interconnected components of water resource management, both aiming to protect and restore the health of aquatic ecosystems as thriving life communities that support the wellbeing of all life while honouring Traditional knowledge and cultural relationships with Country.

1.4. Statutory basis for environmental flows in the ACT

Water Resources Act 2007 (ACT)

The Guidelines are an instrument under the Water Resources Act 2007 (ACT) (the Act). The Act's objectives are:

- to ensure that management and use of the water resources of the Territory sustain the physical, economic and social wellbeing of the people of the ACT while protecting the ecosystems that depend on those resources;

- to protect aquatic ecosystems and aquifers from damage and, where practicable, to reverse damage that has happened; and
- to ensure that the water resources are able to meet the reasonably foreseeable needs of future generations.

To support the delivery of these objectives, the Act:
- requires the determination[3] of water management areas and, having regard to the Guidelines and a range of other factors, the amount of water available for taking from each area[4]
- provides that the Environment Protection Authority license the taking of both surface and groundwater from areas as provided for by the Water Resources (Water Available from Areas) Determination 2024 and the Guidelines.

The Guidelines support the delivery of the Act's objectives as they set out the flows required to maintain aquatic ecosystems in ACT waterways.

Supporting legislation, policies and strategies

The Guidelines are linked with other ACT legislation, policies and strategies including the *Water Resources Act 2007* (ACT), the *Environment Protection Act 1997*, the *Nature Conservation Act 2014*, the Water Resources (Water Use and Catchment General Code) Determination 2023, the ACT Water Strategy 2014–44, the ACT Nature Conservation Strategy 2013–23, the ACT Aquatic and Riparian Conservation Strategy and the identified Threatened Species Action Plans (Figure 1). It also has regard to paramount water rights to specific NSW water sources.

This integrated policy framework recognises that supporting life systems requires coordinated action across multiple areas of government and the community, and that Traditional knowledge provides essential guidance for understanding the relationships between different management activities and their effects on Country.

Closing the Gap – Inland Water Target

In alignment with the National Agreement on Closing the Gap, the ACT supports the recognition and realisation of Aboriginal and Torres Strait Islander peoples' rights and interests in inland water resources.

In 2020, jurisdictions agreed to a new Target being developed to help measure progress towards securing Aboriginal and Torres Strait Islander interests in water bodies inland from the coastal zone under state and territory water rights regimes (Target 15C). While Target 15C is yet to be finalised within the National Agreement as of June 2025, the ACT affirms its commitment to the principles underpinning development of an Inland Waters Target/s.

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[3] Both the Water Resources (Water Available from Areas) Determination 2024 and Water Resources (Water Management Areas) Determination 2019 are instruments under the *Water Resources Act 2007* (ACT).

[4] The Water Resources (Water Available from Areas) Determination 2024 specifies the environmental allocation in each ACT water management area. The volume of water available for abstraction is limited to the volume remaining after environmental flow volumes have been provided.

Queanbeyan and Molonglo waters

Under the *Seat of Government Acceptance Act 1909* (Cth) the Commonwealth gained rights to the waters of the Queanbeyan and Molonglo Rivers and their tributaries (in NSW) for all the purposes of the Territory. These rights were established by an agreement with NSW for the surrender of territory for the national capital.

The Commonwealth developed Googong Dam on the Queanbeyan River to supply urban water to the ACT. The *Canberra Water Supply (Googong Dam) Act 1974* (Cth) enables the ACT Government to manage water releases, including those required to meet environmental needs.

While the only NSW waters yet developed for the ACT's urban water supply are those entering the Googong Reservoir, the remaining waters over which the Commonwealth has rights (that is, the Molonglo River upstream of the ACT and Jerrabomberra Creek upstream of the ACT) are important for supporting aquatic ecosystems within the ACT and maintaining the life supporting connectivity between upstream and downstream life systems. Adequate environmental flows for these waterways are essential for maintaining downstream ecological health in both the ACT and NSW.

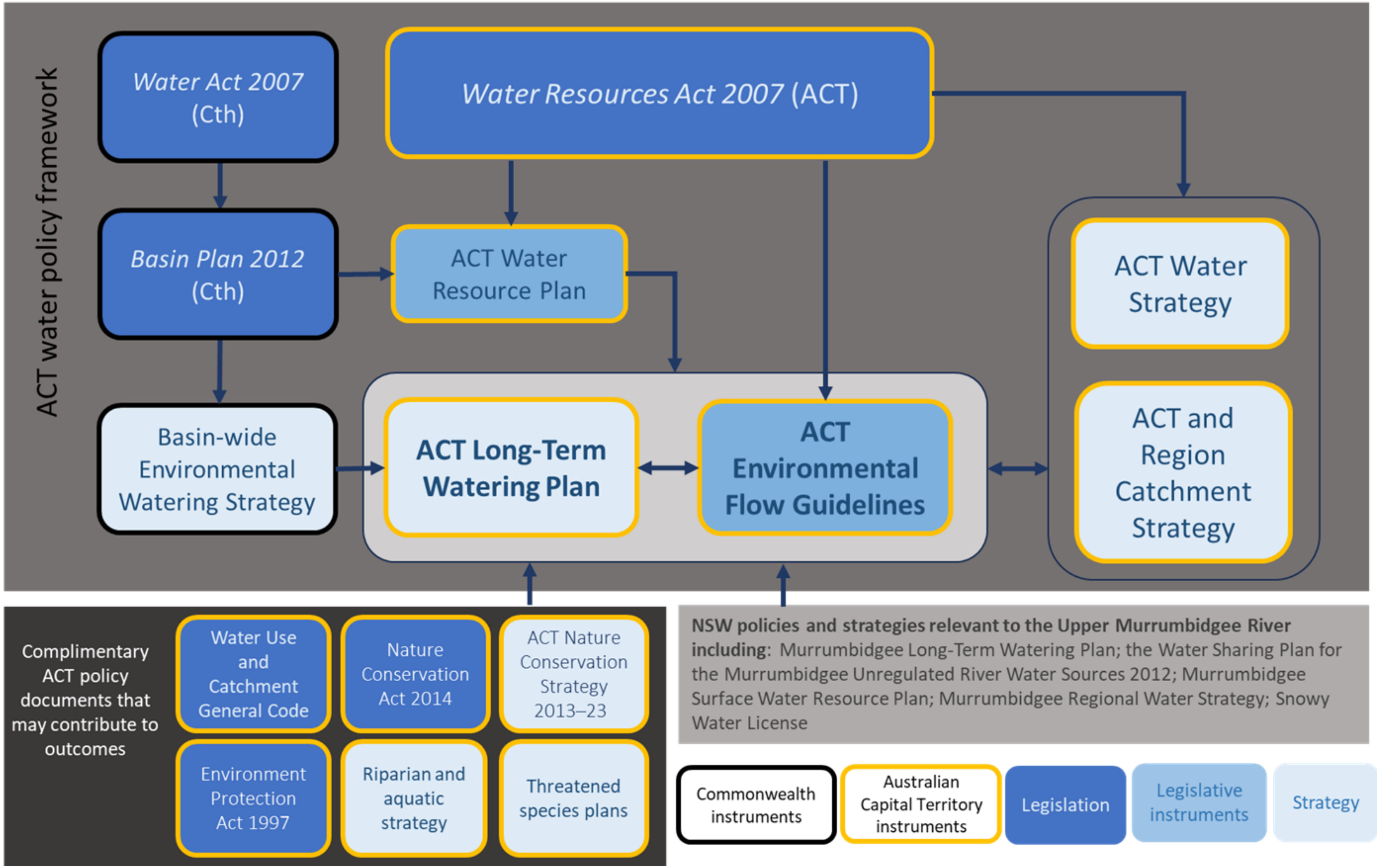

Figure 1. Policy context of the ACT Environmental Flow Guidelines

Table 2. Aquatic ecosystems and associated management goals

Category of Aquatic Ecosystem[1]	Description	Management Goal	Example waterways[2] in this Category
Natural ecosystems (Conservation catchments)	Ecosystems that have persisted in a relatively pristine condition.	Primary goal: maintain aquatic ecosystems in their pristine state. Secondary goals: support a range of functions including flow management and protection goals related to recreational activities.	Waterways in Namadgi National Park, except the Cotter River catchment. Waterbodies in Tidbinbilla Nature Reserve.
Water supply ecosystems (Water Supply catchments)	Ecosystems in catchments designated to provide the ACT water supply.	Primary goal: provide water supply. Secondary goals: support a range of functions including protection of ecological values, protection of ecological values associated with the reservoirs, conservation, and recreation.	Waterways in the Cotter River and Lower Cotter catchments. The Googong Foreshore.[3,4]
Modified ecosystems (Conservation catchments, Drainage and Open Space catchments)	Majority of ecosystems modified by catchment activities (land use change, discharges) or by changes to the flow regime.	Primary goals: support a range of functions including protection of ecological values, recreation, and conservation. Secondary goal: provide water supply.	All waterways not included in the other three categories. Includes the Paddys, Murrumbidgee and Molonglo rivers, and Lake Burley Griffin. Naas and Gudgenby rivers downstream of Namadgi National Park.
Urban ecosystems (Drainage and Open Space catchments and Urban Areas)	Ecosystems in urban lakes, ponds, wetlands, and streams that have been developed as a result of urbanisation.	Support a range of functions including recreation, conservation, irrigation, and stormwater runoff.	Waterways within the urban area, excluding the Molonglo River.

[1] The terminology used to describe aquatic ecosystems, for environmental flow purposes, are shown with the closest water use catchment category listed in the Water Resources (Water Use and Catchment General Code) Determination 2023.
[2] Waterways include all streams, rivers, lakes, ponds, reservoirs, and aquifers.
[3] The Queanbeyan River within the Googong Foreshore and the Googong Foreshore are not identified as water supply catchments in the Water Resources (Water Use and Catchment General Code) Determination 2023 but are considered water supply ecosystems for the purposes of the Guidelines.
[4] While the Naas and Gudgenby sub-catchments have been identified as potential water supply catchments, they will not be used for the ACT's water supply in the foreseeable future. Thus, they are regarded as Natural Ecosystems in Namadgi National Park, and Modified Ecosystems downstream of Namadgi National Park.

1.5. Roles and responsibilities for implementing the Environmental Flow Guidelines

The Guidelines are implemented through a variety of processes including water abstraction licences and rules, compliance with licences and rule requirements, reservoir operations, and the implementation of adaptive management. All these processes require recognition that water management decisions affect life systems, and that Traditional knowledge provides guidance to support healthy aquatic ecosystems. Roles and responsibilities for different agencies are outlined in Table 3.

Table 3. Roles and responsibilities in relation to implementing the Environmental Flow Guidelines.

Roles and responsibility in relation to Environmental Flow Guidelines	
Minister for Water	The Minister for Water approves the Environmental Flow Guidelines as a Disallowable Instrument.
City and Environment Directorate	The City and Environment Directorate is responsible for: • reviewing the Guidelines • managing impounded water • ongoing monitoring and oversight of adaptive management in relation to the Guidelines • integrating Traditional knowledge of ecosystem health and maintaining partnerships with Traditional Custodians for ongoing guidance on Country management • managing, monitoring and maintaining the physical condition of the urban stormwater network which comprises of sumps, stormwater pipes, stormwater channels, water quality pond embankments, cut off drains, retarding basins gross pollutant traps, dams and weirs • managing the Inner North Reticulation Network (aquifer recharge).
Environment Protection Authority (EPA)	The EPA is responsible for the regulation of water take, water quality and environmental flows.
National Capital Authority (NCA)	The NCA manages Lake Burley Griffin and Scrivener Dam on the Molonglo River. Currently there are no requirements to release environmental flows through Scrivener Dam and the dam is operated as a structure to maintain the water level in Lake Burley Griffin within operating tolerance. In times of low flow or drought, water may not be released through the dam for several months to maintain the Lake level.
Icon Water	Icon Water is responsible for operation of Corin, Bendora, Cotter and Googong Dams. They also operate the Murrumbidgee to Googong Pipeline. Icon Water is required to comply with their licence requirements which includes the need to deliver environmental flows and the establishment of an Environmental Management Plan. Icon Water's primary levers for environmental management are the operation of built infrastructure including dam walls, water transfer pipelines and abstraction of water.

2. Aquatic ecological objectives, outcomes and functions

The environmental flow regime aims to support life movement, system connectivity and holistic community resilience. Long-term ecological objectives, short-term ecological outcomes and priority ecosystem functions have been set to assess the effectiveness of the Guideline's flow requirements. These benchmarks align with Traditional understanding of ecosystem maintenance needs and honours Traditional understanding of river health.

2.1 Long-term ecological objectives

The setting of ecological objectives allows specific ecological values to be targeted by components of the environmental flow regime. In addition, quantified ecological objectives can be used to assess the effectiveness of environmental flows, and the information can be used to develop an adaptive management approach for environmental flows.

The ecological objectives within the Guidelines include:

Native fish objectives

- F1 - Improved and resilient populations of Two-spined Blackfish
- F2 - Improved and resilient populations of Macquarie Perch
- F3 - Re-establish viable and resilient populations of Silver Perch
- F4 - Re-establish viable and resilient populations of Trout Cod
- F5 - Improved and resilient populations of Murray Cod
- F6 – Improved and resilient populations of Golden Perch.

Other fauna objectives

- O1 – Improved and resilient frog populations
- O2 – Improved and resilient platypus populations
- O3 – Improved and resilient turtle populations
- O4 – Improved and resilient Murray Crayfish (and other crayfish species) populations
- O5 – Improved and resilient Rakali populations.

Connectivity objectives

- C1 - Longitudinal connectivity is improved and maintained during all conditions.

Vegetation objectives

- V1 - Improved condition, connectivity, and resilience of native riparian vegetation species.

The long-term objectives outlined in the Guidelines represent desired outcomes for water management in the ACT. They will inform the development of the ACT LTWP and may be refined over time through evidence-based monitoring, evaluation, and adaptive management, ensuring they remain relevant and achievable as knowledge and conditions evolve.

Population resilience

Resilience is the amount of change a system can undergo (its capacity to absorb disturbance) and remain within the same regime that essentially retains the same function, structure and feedbacks (Walker and Salt, 2006). The focus of ecological resilience is maintaining function (Gunderson et al., 2002). In the context of the long-term ecological objectives set for the ACT, resilient populations are those that can absorb periods of disturbance and are able to maintain key functions or life history processes.

Viable populations

Viable populations are self-supporting population with genetic variety among healthy individuals and breeding pairs that are well enough distributed to ensure a high probability of survival despite the foreseeable effects of demographic, environmental and genetic events, and of natural catastrophes (Soulé, 1987).

A consultative process has underpinned the development of the long-term ecological objectives, including input from ACT Government agencies, Icon Water, the ACT and Region Catchment Management Coordination Group, the Murray-Darling Basin Authority, the National Capital Authority, the New South Wales Government’s Department of Planning and Environment, Traditional Custodians, academics in the field of hydrology and freshwater ecology, and community groups. Whilst native fish, connectivity and vegetation objectives were designed to align with the BEWS, those under the ‘other fauna category’ have been included to capture key additional values identified through targeted stakeholder engagement.

Some of the long-term ecological objectives do not have prescribed targets or indicators associated with the short-term ecological outcomes. In most cases this is due to one of three circumstances:

- environmental flows cannot be actively managed for particular outcomes in the applicable waterbodies;
- there is limited capacity to manage water levels for ecological outcomes due to priority of water supply; or
- baseline survey data does not exist for the objective, hence accurate indicators have not been developed.

2.2 Short-term ecological outcomes

While understanding long-term ecological objectives is critical for long-term planning, clear articulation of expected short-term outcomes to support delivery of long-term ecological objectives is important, given the role of the Guidelines in setting annual guidance.

The overarching short-term ecological outcomes (5 years), as shown in Figure 2, are:

- *Life history requirements of key species are supported*. This includes providing appropriate conditions for spawning or breeding, eggs to develop and hatch, recruitment into the population, growth and condition, and movement and dispersal.

- *Quality habitats are provided*. This includes providing diverse hydraulic conditions, variable depth profiles, quality and variable structural habitat, and ensuring water quality is maintained.
- *Diverse and abundant food sources are available*. This includes ensuring healthy macroinvertebrate communities, which in turn support species higher up in the food chain.
- *Populations are maintained during drought conditions*. Achieving the other short-term ecological objectives written above will play a critical role in supporting achievement of this outcome.

Reach specific short-term expected outcomes for waterways within scope of the Guidelines are detailed in section 3.

2.3 Priority ecosystem functions

Ecological functions are the natural processes and interactions that sustain ecosystems. Environmental water can be used to support these functions, resulting in achieving the identified short-term ecological outcomes and subsequently long-term ecological objectives.

The priority ecosystem functions captured by the Guidelines are:

PEF 1 - Support critical life history requirements of key species

Environmental water has the capacity to support life-history requirements in different ways depending on individual species requirements. This includes providing conditions that support spawning or breeding, eggs to successfully hatch, recruitment, growth, and movement and dispersal. These life history requirements are inherently linked with habitat requirements.

Recent research has put fish species into functional groups based on their life history requirements in relation to flow (Ellis et al., 2022). This approach allows us to synthesise flow requirements for species that are similar, subsequently designing environmental watering requirements that meet the needs of multiple species. Under this approach, Two-spined Blackfish, Macquarie Perch, Trout Cod and Murray Cod are all in the functional group called river specialists (Ellis et al., 2022). Golden Perch and Silver Perch are considered flow pulse specialists.

PEF 2 - Provide longitudinal connectivity

Longitudinal connectivity is the connection of river flows into downstream reaches or through to the sea, also described as the connectedness of a river along its length. Connectivity provides significant environmental functions by transporting and distributing nutrients, sediments, and carbon, as well as enabling aquatic species to move to various river reaches as part of their life-cycle requirements, in search of opportunities for feeding and breeding. It also provides an important function by supporting genetic diversity and providing a natural flushing of the river system.

Longitudinal connectivity provides the conditions for the aquatic organisms to move freely through water bodies such as the stream network. A major contributing factor to the loss of longitudinal connectivity in systems is the construction of impoundments and barriers to regulate water which often results in obstruction of migratory passages, populations experiencing isolation and lack the opportunity to recruit. Lack of longitudinal connectivity caused by river regulation can also reduce hydrodynamic diversity and diminish health and resilience of lowland ecosystems. However, improvements achieved through environmental watering by providing longitudinal connectivity, has also delivered long-term benefits.

PEF 3 - Provide quality in-stream and riparian habitats

Habitat usually refers to the in-stream and riparian physical and chemical conditions suitable for habitation by biota, so it is species specific, and may even vary according to the life cycle of biota (Townsend & Hildrew, 1994; Norris & Thoms, 1999). Habitat quality can be expressed as the presence or absence of suitable habitat (noting the presence of elements that prevent the habitat being accessed), the volume or area of ideal habitat available, or a rating of the relative quality of the habitat that is present. The presence of diverse native vegetation is typically considered an indicator for aquatic and riparian habitat quality.

Whilst species have individual habitat requirements, a holistic approach to assessing in-stream habitat quality has included:

- quality of substrate and other structural habitat (e.g. woody debris and macrophytes)
- channel morphology and water depths
- water quality
- hydraulic conditions

Quality riparian habitats include a diversity of native vegetation species.

PEF 4 - Enhance in-stream productivity

In stream productivity allows for the progress of energy throughout the food web. A good environment that has a ‘productive’ stream allows for food and energy to pass through plants and algae systems via biomass. This process also holds larger implications for the ecosystem health overall, as the primary production levels allow for carbon diversion throughout the ecosystem and has direct impact on the dissolved oxygen concentration of the water systems.

The four primary environmental attributes that contribute to in-stream productivity are (Overton et al., 2009):

- connectivity between the river and catchment
- light availability
- nutrient availability
- river discharge

Water management has the capacity to directly influence connectivity between the river and catchment, and river discharge. Indirectly, water management can also influence nutrient availability. Each flow component can make some contribution to productivity, highlighting the benefits of flow variability for productive streams. High flows that inundate areas rich in terrestrial organic matter have the greatest capacity to enhance in-stream productivity (Junk et al., 1989). However, rapid increases in productivity that can occur due to overbank flows can result in harmful declines in dissolved oxygen (Baldwin & Wallace, 2009; McNeil et al., 2013). This risk can be mitigated through managing overbank flow to occur during colder temperatures and to reduce the load of material on the floodplain by increasing the frequency of overbank flows (Baldwin & Wallace, 2009).

PEF 5 - Provide drought refuge for water-dependent species

Biotic refuges have been defined as places in which individuals or populations can avoid the negative effects of disturbance, or where impacts are lower than surrounding areas, and where viable sources of population can survive disturbance to repopulate non-refuge areas following disturbance (Lancaster & Belyea, 1997; McNeil et al., 2013). As the climate continues to dry, maintenance of drought refuges will be essential to ensuring populations are resilient.

For native fish species it has been suggested drought refuges have the following attributes (McNeil et al., 2013):

- Physical habitat
    - Water quality (including dissolved oxygen levels)
    - Intact riparian zones
    - Presence of deep holes
    - Substrate quality and variability
    - In stream structure
    - Range of depths
- Hydrological processes
    - Permanence of water
    - Groundwater inputs
    - Natural flow regime
    - Permanent flow
    - Presence of flow regulation infrastructure
- Spatial connectivity
    - Lateral connectivity
    - Longitudinal connectivity
- Biological integrity
    - Intact ecological processes
    - Diverse and abundant intact riparian vegetation
    - Diverse and abundant intact macrophytes
    - Diverse and abundant invertebrate assemblages

During drought conditions there will be limited capacity to actively manage many of these attributes. The maintenance of base flows during drought will be critical. However, using environmental water to prepare drought refuges by supporting the PEFs documented above will be critical. Furthermore, refuge locations should be the focus of complementary management activities to reduce threats. Key threatening processes and mitigation actions are outlined in section 3.

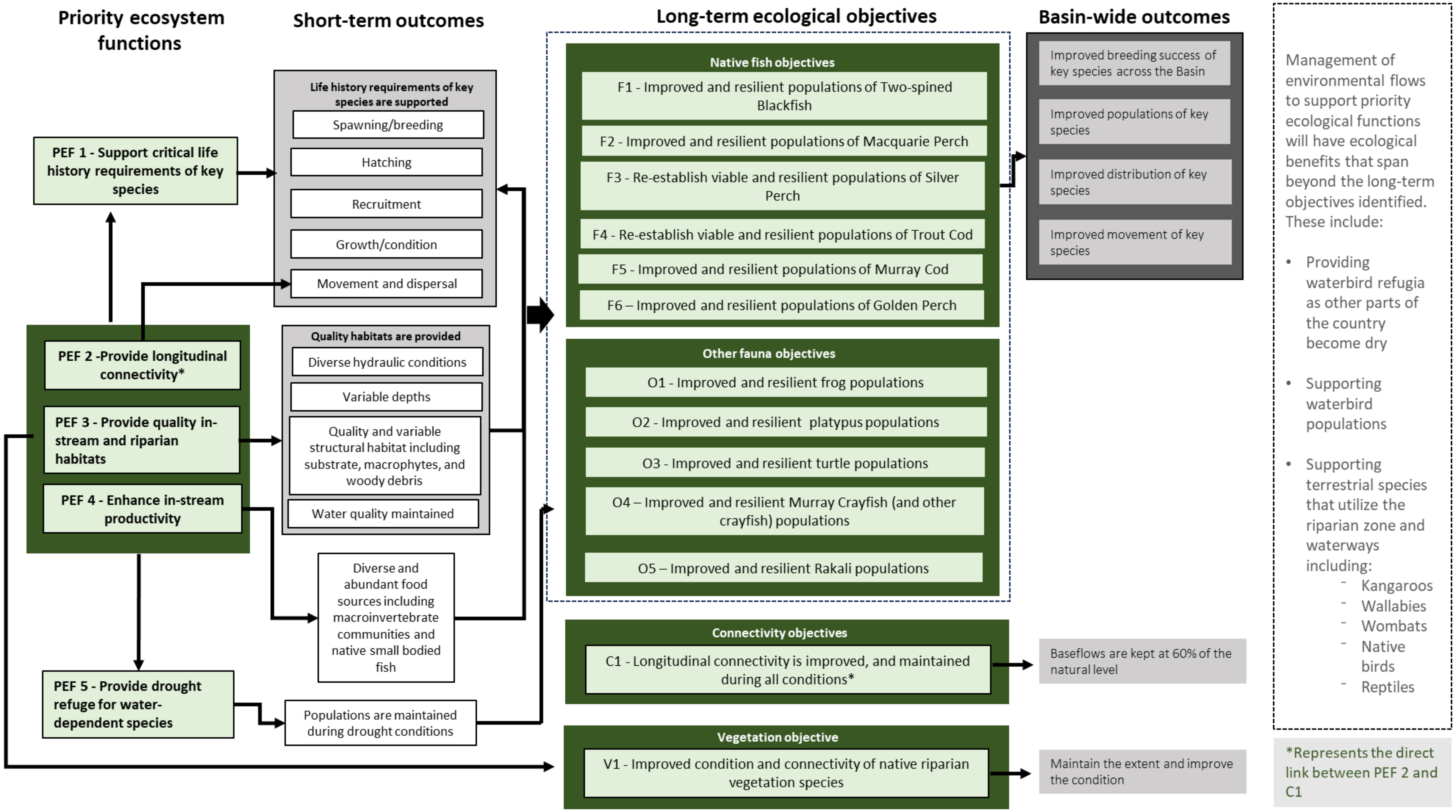

Figure 2. Logic for achieving long-term ecological objectives for the ACT. Note that the Guidelines is focussed on achieving short-term outcomes

3. Environmental flow requirements and expected outcomes

This section outlines the environmental flow requirements and associated short-term ecological outcomes and long-term ecological objectives for:

- Water supply ecosystems (Table 4)
- Modified ecosystems (Table 5)
- Urban ecosystems (Table 6)
- Natural ecosystems (Table 7)
- Groundwater (Table 8)

Environmental flow requirements and expected outcomes have evolved over time since the Guidelines were first implemented in 1999. In addition to supporting the achievement of ecological outcomes, a priority of this Guideline is to ensure that there is no net reduction in planned environmental water (PEW) as required in section 10.28 of the Basin Plan. The methods and rules used to calculate environmental flow requirements, and details of how these assure the protection of PEW, are outlined in Appendix B. Not all long-term objectives have indicators and targets that directly relate to them. Future versions of the Guidelines may include other indicators and targets as progress is made towards achieving the long-term objectives.

As outlined in Section 5, implementation of a robust monitoring and evaluation program to review these flow requirements over the next 5 years is necessary to assess the effectiveness of the Guideline's flow requirements in meeting the short-term ecological outcomes and long-term ecological objectives.

3.1 Water supply ecosystems

Table 4. Environmental flow requirements for the ACT's water supply ecosystems and aligned short-term expected outcomes, indicators, targets, and long-term objectives.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

** Not all long-term objectives have indicators and targets that directly relate to them; however, it is intended that the Guidelines continues to adapt overtime to support achievement of long-term objectives.*

Reach	Relevant flow gauge(s)	Flow requirements[5]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (>5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
Cotter River: upstream of Corin Reservoir	410730	Maintain natural flows.			Natural flows support quality habitats and diverse and abundant food sources.	Macroinvertebrate assemblages.	Australian River Assessment System (AUSRIVAS) scores maintained at Band A level.	F1 - Improved and resilient populations of Two-spined Blackfish O4- Improved and resilient Murray Crayfish (and other crayfish species) populations* O1 - Improved and resilient frog populations*
					Natural flows support life-history requirements of Two-spined Blackfish.	Juvenile recruitment of Two-spined Blackfish.	Two-spined Blackfish young of the year and year 1+ age classes (<120 mm total length) comprise >30% of the monitoring catch.	

[5] The Utility (Water Conservation) Regulation 2006 made under the Utilities Act 2000, provides approval of a set of water conservation measures. The Scheme of temporary restrictions on the use of water from Icon Water water supply system sets the target annual reduction relative to Water Conservation Measures.

Reach	Relevant flow gauge(s)	Flow requirements[5]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (>5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
						Two-spined Blackfish presence.	Total catch is >2 Two-spined Blackfish for 60% of samples (30 m sections) in each reach.	O2 - Improved and resilient Platypus populations* O5 - Improved and resilient Rakali populations*
Corin Reservoir	410742	Drawdown regime must, as far as practically possible, ensure careful management of drawdown in November to protect spawning sites.			Drawdown levels in Corin reservoir support the life-history requirements of Two-spined Blackfish (protect spawning sites).	Juvenile recruitment of Two-spined Blackfish.	Two-spined Blackfish young of the year and year 1+ age classes (<120 mm total length) comprise >30% of the monitoring catch.	F1 - Improved and resilient populations of Two-spined Blackfish.
Cotter River: Corin Dam to Bendora Reservoir	410752	**Base flow** – Maintain minimum monthly base flows (ML/month) as shown below[6]: **Jan** 465; **Feb** 280 **March** 341; **April** 450 **May** 589; **June** 840 **July** 1395; **Aug** 1922 **Sept** 2760; **Oct** 1984 **Nov** 1290; **Dec** 806 **Small fresh** - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months. **Large fresh** - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid-October. **Special purpose flows** – Released as required following subject matter expert consultation to balance community water security and environmental conservation objectives. **Flow variability** - Where daily base flow requirements are being met or exceeded, outflows should be adjusted once per week to either 50% above or below the average volume. From October- December where daily base flow requirements are being met or exceeded, outflows shall be adjusted once per week to either 25% above or below	**Base flow** - Maintain a flow of ≥40 ML/day or monthly base flows (as per permanent measures), whichever is lesser volume. **Small fresh** - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months. **Large fresh** - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid-October or as agreed in writing with the Environment Protection Authority.	**Base flow** - Maintain an average flow of ≥20 ML/day or inflow, whichever is lower. **Small fresh** - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months or as agreed in writing with the Environment Protection Authority. **Large fresh** - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid-October or as agreed in writing with the Environment Protection Authority.	The flow regime supports quality in-stream habitats and diverse food sources. The flow regime supports life-history requirements of Two-spined Blackfish.	Macroinvertebrate assemblages.	Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.	F1 - Improved and resilient populations of Two-spined Blackfish O2 - Improved and resilient Platypus populations* O5 - Improved and resilient Rakali populations*
						Filamentous algae cover.	Non-dominance (<20% cover) of filamentous algae in riffles.	
						Water quality.	Temperature, turbidity and dissolved oxygen mimic natural inflows recorded above Corin Dam (410730).	
						Macrophyte cover.	Instream macrophyte cover is <20%.	
						Sediment levels.	Sediment deposition is limited to <20% of total depth of pools measured at base flow.	
						Juvenile recruitment of Two-spined Blackfish	Two-spined Blackfish young of the year and year 1+ age classes (<120 mm total length) comprise >30% of the annual monitoring catch.	
						Two-spined Blackfish presence.	Total catch is >2 Two-spined Blackfish for 60% of samples (30 m sections) in each reach.	

[6]. Daily flows (ML/day) can be varied by the Environment Protection Authority following consultation with a licence holder provided monthly volumes are maintained.

<table>
<tr><th rowspan="2">Reach</th><th rowspan="2">Relevant flow gauge(s)</th><th colspan="3">Flow requirements[5]</th><th colspan="3">Short-term ecological outcomes (5 year)</th><th rowspan="2">Long-term ecological objectives (>5 year)</th></tr>
<tr><th>Permanent measures</th><th>Drought stage 1 restrictions</th><th>Drought stage 2 restrictions or more severe restrictions</th><th>Expected outcome</th><th>Indicator</th><th>Target</th></tr>
<tr><td></td><td></td><td>the average volume to minimise dislodgement of native fish eggs.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Bendora Reservoir</td><td rowspan="2">410717</td><td colspan="3" rowspan="2">Drawdown regime must, as far as practically possible, ensure careful management of drawdown October - December to protect spawning sites</td><td rowspan="2">Drawdown levels in Bendora reservoir support the life-history requirements of Two-spined Blackfish and Trout Cod (protect spawning sites).</td><td>Two-spined Blackfish presence.</td><td>Minimum 2 post-juvenile Two-spined Blackfish per fyke net night per year.</td><td rowspan="2">F1 - Improved and resilient populations of Two-spined Blackfish
F4 - Resilient populations of Trout Cod</td></tr>
<tr><td>Juvenile recruitment of Trout Cod.</td><td>-</td></tr>
<tr><td rowspan="8">Cotter River: Bendora Dam to Cotter Reservoir</td><td rowspan="8">410747 (base flows, small freshes, large freshes, variability)</td><td rowspan="8">Base flow - Maintain minimum monthly base flows (ML/month) as shown below[7]:<table>
<tr><td>Jan</td><td>713</td><td>Feb</td><td>448</td></tr>
<tr><td>March</td><td>589</td><td>April</td><td>720</td></tr>
<tr><td>May</td><td>961</td><td>June</td><td>1350</td></tr>
<tr><td>July</td><td>2201</td><td>Aug</td><td>3007</td></tr>
<tr><td>Sept</td><td>4320</td><td>Oct</td><td>3100</td></tr>
<tr><td>Nov</td><td>2010</td><td>Dec</td><td>1271</td></tr>
</table>Small fresh - Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months.
Large fresh - Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid- October.
Special purpose flows – released as required following subject matter expert consultation to balance community water security and environmental conservation objectives.
Flow variability - Where daily base flow requirements are being met or exceeded, outflows should be adjusted once per week to either 50% above or below the average volume.
From October- December where daily base flow requirements are being met or exceeded, outflows shall be adjusted once per week to either 25% above or below the average volume to minimise dislodgement of native fish eggs.</td><td rowspan="8">Base flow – Maintain a flow of ≥40 ML/day or monthly base flows (as per permanent measures), whichever is lesser volume.
Small fresh – Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months.
Large fresh – Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid-October.</td><td rowspan="8">Base flow – Maintain an average flow of ≥20 ML/day or inflow, whichever is lower.
Small fresh – Maintain a flow of ≥150 ML/day for 3 consecutive days every 2 months.
Large fresh – Maintain a flow of ≥550 ML/day for 2 consecutive days between mid-July and mid-October.</td><td rowspan="8">The flow regime supports quality in-stream habitats and diverse food sources.

The flow regime supports life-history requirements of Two-spined Blackfish.

The flow regime supports life-history requirements of Macquarie Perch.</td><td>Macroinvertebrate assemblages.</td><td>Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.</td><td rowspan="8">F1 - Improved and resilient populations of Two-spined Blackfish
F2 - Improved and resilient populations of Macquarie Perch
O2 - Improved and resilient Platypus populations*
O5 - Improved and resilient Rakali populations*</td></tr>
<tr><td>Filamentous algae cover.</td><td>Non-dominance (<20% cover) of filamentous algae in riffles.</td></tr>
<tr><td>Water quality.</td><td>Temperature, turbidity and dissolved oxygen mimic natural inflows recorded above Corin Dam (gauge 410730).</td></tr>
<tr><td>Macrophyte cover.</td><td>Instream macrophyte cover <20%.</td></tr>
<tr><td>Sediment levels.</td><td>Sediment deposition is limited to <20% of total depth of pools measured at base flow.</td></tr>
<tr><td>Juvenile recruitment of Two-spined Blackfish.</td><td>Young of the year and year 1+ age classes (<120 mm total length) comprise >30% of the monitoring catch.</td></tr>
<tr><td>Two-spined Blackfish presence.</td><td>Total catch is >2 Two-spined Blackfish for 60% of samples (30 m sections) in each reach.</td></tr>
<tr><td>Juvenile recruitment of Macquarie Perch.</td><td>Macquarie Perch recruitment detected at 80% of monitoring sites.</td></tr>
</table>

[7] Daily flows (ML/day) can be varied by the Environment Protection Authority following consultation with a licence holder provided monthly volumes are maintained.

<table>
<tr><th rowspan="2">Reach</th><th rowspan="2">Relevant flow gauge(s)</th><th colspan="3">Flow requirements[5]</th><th colspan="3">Short-term ecological outcomes (5 year)</th><th rowspan="2">Long-term ecological objectives (>5 year)</th></tr>
<tr><th>Permanent measures</th><th>Drought stage 1 restrictions</th><th>Drought stage 2 restrictions or more severe restrictions</th><th>Expected outcome</th><th>Indicator</th><th>Target</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Minimum capture of 1 Macquarie Perch (<150 mm) per net night per site.</td><td></td></tr>
<tr><td>Cotter Reservoir</td><td>410704</td><td colspan="3">Drawdown regime must, as far as practically possible, ensure careful management of drawdown September-December (inclusive) to support spawning movement and protect spawning sites.</td><td>Drawdown levels support life history requirements of Macquarie Perch.</td><td>Macquarie Perch presence.</td><td>Minimum total catch 3 Macquarie Perch per fyke net night, per year, comprised of >50% individuals <150 mm.</td><td>F2 - Improved and resilient populations of Macquarie Perch</td></tr>
<tr><td rowspan="4">Cotter River: Downstream of Cotter Dam</td><td rowspan="4">410700</td><td rowspan="4">Base flow –Maintain a minimum flow of 15 ML/day.
Small fresh - Maintain a flow of ≥100 ML/day for 1 day every 2 months.
Flow variability – If release volumes are above base flow, releases should occur in a manner that reflects seasonal variability.</td><td rowspan="4">Base flow – Maintain a minimum flow of 15 ML/day.
Flow variability – If release volumes are above base flow, releases should occur in a manner that reflects seasonal variability.</td><td rowspan="4">Base flow – Maintain a minimum flow of 15 ML/day.
Flow variability – If release volumes are above base flow, releases should occur in a manner that reflects seasonal variability.</td><td rowspan="4">Provide a flow regime that supports quality in-stream and riparian habitats and diverse food sources.</td><td>Macroinvertebrate assemblages.</td><td>Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.</td><td rowspan="4">V1 - Improved condition, connectivity, and resilience of native riparian vegetation species
O2 - Improved and resilient Platypus populations*
O5 - Improved and resilient Rakali populations*</td></tr>
<tr><td>Filamentous algae cover.</td><td>Non-dominance (<20% cover) of filamentous algae in riffles.</td></tr>
<tr><td>Water quality</td><td>Temperature, turbidity and dissolved oxygen mimic natural inflows recorded above Corin Dam gauge (410730).</td></tr>
<tr><td>Riparian condition.</td><td>Rapid appraisal riparian assessment (RARC) Catchment Health Indicator Program (CHIP) score is maintained between 3 (fair) and 1 (excellent).</td></tr>
<tr><td rowspan="3">Queanbeyan River: Downstream of Googong Dam</td><td rowspan="3">410760</td><td rowspan="3">Base flow - October – June of 10ML/Day and July to September of 15 ML/day or natural inflow whichever is the lesser.
Small fresh - Maintain a flow of ≥100 ML/day for 1 day every 2 months.</td><td rowspan="3">Base flow – 10 ML/Day or natural inflow whichever is the lesser.
Small fresh - Maintain a flow of ≥100 ML/day for 1 day every 2 months.</td><td rowspan="3">Base flow – 10 ML/Day or natural inflow whichever is the lesser.
Small fresh - Maintain a flow of ≥100 ML/day for 1 day every 2 months.</td><td rowspan="3">Provide a flow regime that supports quality in-stream and riparian habitats and diverse food sources.</td><td>Macroinvertebrate assemblages.</td><td>Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.</td><td rowspan="3">O2 - Improved and resilient Platypus populations*
O5 - Improved and resilient Rakali populations*</td></tr>
<tr><td>Filamentous algae cover.</td><td>Non-dominance (<20% cover) of filamentous algae in riffles.</td></tr>
<tr><td>Water quality.</td><td>Temperature, turbidity and dissolved oxygen mimic natural inflows recorded above Googong Dam (gauge 410781).</td></tr>
</table>

3.2 Modified ecosystems

Table 5. Environmental flow requirements for the ACT's modified aquatic ecosystems and aligned short-term expected outcomes, indicators, targets, and long-term objectives.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

** Not all long-term objectives have indicators and targets that directly relate to them; however, it is intended that the Guidelines continues to adapt overtime to support achievement of long-term objectives.*

<table>
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<tr><th>Permanent measures</th><th>Drought stage 1 restrictions</th><th>Drought stage 2 restrictions or more severe restrictions</th><th>Expected outcome</th><th>Indicator</th><th>Target</th></tr>
<tr><td rowspan="7">Murrumbidgee River (ACT reaches)</td><td rowspan="7">41001702 (base flows)
410738 (base flows)
410761 and 410738 (small fresh)</td><td rowspan="7">Base flow: Maintain minimum daily base flows (ML/day) at Angle Crossing pumping station (Gauge 41001702) as shown below:<table><tr><td>Jan</td><td>33</td><td>Feb</td><td>22</td></tr><tr><td>March</td><td>16</td><td>April</td><td>35</td></tr><tr><td>May</td><td>55</td><td>June</td><td>65</td></tr><tr><td>July</td><td>79</td><td>Aug</td><td>99</td></tr><tr><td>Sept</td><td>169</td><td>Oct</td><td>128</td></tr><tr><td>Nov</td><td>130</td><td>Dec</td><td>53</td></tr></table>Maintain daily base flows (ML/day) at Cotter pumping station – Mt MacDonald (Gauge 410738) as shown below:<table><tr><td>Jan</td><td>76</td><td>Feb</td><td>69</td></tr><tr><td>March</td><td>54</td><td>April</td><td>65</td></tr><tr><td>May</td><td>73</td><td>June</td><td>122</td></tr><tr><td>July</td><td>193</td><td>Aug</td><td>227</td></tr><tr><td>Sept</td><td>312</td><td>Oct</td><td>230</td></tr><tr><td>Nov</td><td>276</td><td>Dec</td><td>105</td></tr></table>Small fresh: Protect a minimum of 250 ML/day for a period of 1 day, once every 30 days at gauges 410761 and 410738.
Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flows that are larger than the 80th percentile flow.</td><td rowspan="7">Base flow: Protect inflows at Angle Crossing pumping station (Gauge 41001702).
Base flow: Protect inflows at Cotter pumping station – Mt MacDonald (Gauge 410738) or as agreed in writing with the Environment Protection Authority.</td><td rowspan="7">Base flow: Protect inflows at Angle Crossing pumping station (Gauge 41001702).
Base flow: Protect inflows at Cotter pumping station – Mt MacDonald (Gauge 410738) or as agreed in writing with the Environment Protection Authority.</td><td rowspan="7">Provide a flow regime that supports quality riparian and in-stream habitats and diverse food sources.
To provide a flow regime that meets the life-history requirements of a variety of key species including:
• Murray Cod
• Trout Cod
• Macquarie Perch
• Golden Perch
• Silver Perch
• Murray Crayfish
• Platypus
• Rakali.</td><td>Macroinvertebrate assemblages.</td><td>Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.</td><td rowspan="7">F5 - Improved and resilient populations of Murray Cod
O2 - Improved and resilient Platypus populations
O5 - Improved and resilient Rakali populations
F2 - Improved and resilient populations of Macquarie Perch*
F3 - Re-establish viable and resilient populations of Silver Perch*
F4 - Re-establish viable and resilient populations of Trout Cod*
F6 - Improved and resilient populations of Golden Perch*
O4 - Improved and resilient Murray Crayfish (and other crayfish species) populations*
O1 - Improved and resilient frog populations*
O3 - Improved and resilient turtle populations*
C1 - Longitudinal connectivity is improved and maintained during all conditions</td></tr>
<tr><td>Filamentous algae cover.</td><td>Non-dominance (<20% cover) of filamentous algae in riffles.</td></tr>
<tr><td>Sediment levels.</td><td>Sediment deposition is limited to <20% of total depth of pools measured at base flow.</td></tr>
<tr><td>Recruitment of juvenile Murray Cod.</td><td>Recruitment of Murray Cod detected at 80% sites in reach.</td></tr>
<tr><td>Platypus and Rakali distribution.</td><td>Increased number of sites where Rakali and Platypus are present (from 2024 baseline).</td></tr>
<tr><td>Murray Crayfish distribution.</td><td>Detection of Murray Crayfish at 80% of sampling sites.</td></tr>
<tr><td>Connectivity.</td><td>Base flows are maintained 100% of the time.</td></tr>
</table>

[8] The Utility (Water Conservation) Regulation 2006 made under the Utilities Act 2000, provides approval of a set of water conservation measures. The Scheme of temporary restrictions on the use of water from Icon Water water supply system sets the target annual reduction relative to Water Conservation Measures.

<table>
<tr><th rowspan="2">Reach</th><th rowspan="2">Relevant flow gauge(s)</th><th colspan="3">Flow requirements[8]</th><th colspan="3">Short-term ecological outcomes (5 year)</th><th rowspan="2">Long-term ecological objectives (>5 year)</th></tr>
<tr><th>Permanent measures</th><th>Drought stage 1 restrictions</th><th>Drought stage 2 restrictions or more severe restrictions</th><th>Expected outcome</th><th>Indicator</th><th>Target</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>V1 - Improved condition, connectivity, and resilience of native riparian vegetation species*</td></tr>
<tr><td>Lake Burley Griffin (LBG)</td><td>410732/570016 (NCA)</td><td colspan="3">Allow water level fluctuations of up to 0.6m below full supply level. Where possible limit drawdown to 0.2m July-November from normal operating lake levels.</td><td>Drawdown regime of Lake Burley Griffin does not inhibit habitat quality of Murray Cod or Golden Perch.</td><td>Murray Cod and Golden Perch presence.</td><td>Presence of Murray Cod and Golden Perch detected at 80% sites during fish surveys.</td><td>F5 - Improved and resilient populations of Murray Cod
F6 - Improved and resilient populations of Golden Perch</td></tr>
<tr><td>Jerrabomberra wetlands</td><td>410790</td><td colspan="3">Base flow: Maintain monthly base flows (ML/month) greater than or equal to as shown below:<table><tr><td>Jan</td><td>2.7</td><td>Feb</td><td>4.8</td></tr><tr><td>March</td><td>2.7</td><td>April</td><td>5.2</td></tr><tr><td>May</td><td>8</td><td>June</td><td>20.7</td></tr><tr><td>July</td><td>27.8</td><td>Aug</td><td>26.8</td></tr><tr><td>Sept</td><td>28.5</td><td>Oct</td><td>21.4</td></tr><tr><td>Nov</td><td>10.4</td><td>Dec</td><td>5.4</td></tr></table></td><td>Support quality riparian and in-stream habitats and diverse food sources.</td><td>Macroinvertebrates
Platypus distribution.</td><td>Waterwatch water bug scores at Jerrabomberra Wetlands are fair or above.
Platypus are detected annually at Jerrabomberra Wetlands.</td><td>O2 - Improved and resilient Platypus populations
O1 - Improved and resilient frog populations*
O3 - Improved and resilient turtle populations*</td></tr>
<tr><td rowspan="6">Molonglo River upstream and downstream of Lake Burley Griffin</td><td rowspan="6">410729 (upstream of Lake Burley Griffin)</td><td colspan="3" rowspan="6">Base flow: Maintain monthly base flows (ML/month) above Lake Burley Griffin (Gauge 410729) greater than or equal to as below:<table><tr><td>Jan</td><td>201</td><td>Feb</td><td>311</td></tr><tr><td>March</td><td>284</td><td>April</td><td>249</td></tr><tr><td>May</td><td>311</td><td>June</td><td>446</td></tr><tr><td>July</td><td>517</td><td>Aug</td><td>546</td></tr><tr><td>Sept</td><td>467</td><td>Oct</td><td>442</td></tr><tr><td>Nov</td><td>402</td><td>Dec</td><td>335</td></tr></table>Maintain monthly base flows (ML/month) at minimum 80th percentile flow (the flow that is exceeded 80% of the time) below Lake Burley Griffin. It is noted that there is currently no appropriate gauge at the time of establishing this Guideline to calculate base flows below Lake Burley Griffin.
Protection of large flows: Abstraction will be restricted to a long-term average of 10% of the flows above the 80th percentile flow.</td><td rowspan="6">Support quality riparian and in-stream habitats and diverse food sources.
Ensure water is available to support life-history requirements of a variety of key species including Murray Cod, Rakali and Platypus.
Provide drought refuge.</td><td>Macroinvertebrate assemblages.</td><td>Macroinvertebrate assemblages are maintained at AUSRIVAS band A level</td><td rowspan="6">F5 - Improved and resilient populations of Murray Cod
O2 - Improved and resilient Platypus populations
O5 - Improved and resilient Rakali populations
O4 - Improved and resilient Murray Crayfish (and other crayfish species) populations*
C1 - Longitudinal connectivity is improved and maintained during all conditions</td></tr>
<tr><td>Filamentous algae cover.</td><td>Non-dominance (<20% cover) of filamentous algae in riffles</td></tr>
<tr><td>Sediment levels.</td><td>Sediment deposition is limited to <20% of total depth of pools measured at base flow</td></tr>
<tr><td>Recruitment of juvenile Murray Cod.</td><td>Recruitment of Murray Cod detected at 80% sites in reach.</td></tr>
<tr><td>Platypus and Rakali distribution.</td><td>Increased number of sites where Rakali and Platypus are present (from 2024 baseline).</td></tr>
<tr><td>Connectivity.</td><td>Base flows are maintained 100% of the time.</td></tr>
</table>

Reach	Relevant flow gauge(s)	Flow requirements[8]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (>5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
Other modified reaches	410713 (Paddys River)	**Base flow**: Maintain 80th percentile monthly flow in all months. **Protection of large flows:** Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.			Specific outcomes and objectives are not detailed for non-defined modified reaches, but it is intended that protection of flow in all modified reaches will contribute to the overarching short-term ecological outcomes and long-term ecological objectives listed in section 2.			

3.3 Urban ecosystems

Table 6. Environmental flow requirements for the ACT's urban aquatic ecosystems and aligned short-term expected outcomes, indicators, targets, and long-term objectives.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

** Not all long-term objectives have indicators and targets that directly relate to them; however, it is intended that the Guidelines continues to adapt overtime to support achievement of long-term objectives.*

Reach	Relevant flow gauge(s)	Flow requirements[9]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (>5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
Urban streams (lined and unlined)	410751 (Ginninderra Ck upstream Barton Highway) 410750 (Ginninderra Ck upstream Charnwood) 410772 (Sullivans Ck at Southwell Park) 410775 (Sullivans Creek at Barry Drive) 410745 (Yarralumla Ck at Curtain) 410779 (Tuggeranong Catchment)	**Base flow**: Maintain 80th percentile monthly flow in all months. **Protection of large flows:** Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.			Supports quality riparian and in-stream habitats and diverse food sources.	Water quality.	Turbidity is at <10 NTU at all sites sampled 80% of the time.	O1 - Improved and resilient frog populations* O3 - Improved and resilient turtle populations*
						Macroinvertebrate assemblages (unlined streams only).	Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.	
						Filamentous algae cover (unlined streams only).	Non-dominance (<20% cover) of filamentous algae in riffles.	

[9] The Utility (Water Conservation) Regulation 2006 made under the Utilities Act 2000, provides approval of a set of water conservation measures. The Scheme of temporary restrictions on the use of water from Icon Water water supply system sets the target annual reduction relative to Water Conservation Measures.

Reach	Relevant flow gauge(s)	Flow requirements[9]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (>5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
Urban lakes, ponds and wetlands		Allow water level fluctuations of up to 0.6m below full supply level, where possible limit drawdown to 0.2m July-November.			Support maintenance of base flows. The flow regime supports stocked native fish populations.	Fish kills.	No fish kills reported.	O1 - Improved and resilient frog populations* O3 - Improved and resilient turtle populations*

3.4 Natural ecosystems

Table 7. Environmental flow requirements for the ACT's natural aquatic ecosystems and aligned short-term expected outcomes, indicators, targets, and long-term ecological objectives.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

** Not all long-term objectives have indicators and targets that directly relate to them; however, it is intended that the Guidelines continues to adapt overtime to support achievement of long-term objectives.*

Reach	Relevant flow gauge(s)	Flow requirements[10]			Short-term ecological outcomes (5 year)			Long-term ecological objectives (5 year)
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
All natural reaches	410731 (Mt Tennant) 410736 (Orroral River)	Maintain natural flows.[11] No abstraction is permitted from natural lakes or ponds. Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.			Supports quality riparian and in-stream habitats and diverse food sources. The flow regime supports resilient populations of small fish such as Mountain Galaxias in streams where they occur.	Macroinvertebrate assemblages.	Macroinvertebrate assemblages are maintained at AUSRIVAS band A level.	O2 - Improved and resilient Platypus populations* O5 - Improved and resilient Rakali populations* O1 - Improved and resilient frog populations* O3 - Improved and resilient turtle populations*
						Filamentous algae cover.	Non-dominance (<20% cover) of filamentous algae in riffles.	

[10] The Utility (Water Conservation) Regulation 2006 made under the Utilities Act 2000, provides approval of a set of water conservation measures. The Scheme of temporary restrictions on the use of water from Icon Water water supply system sets the target annual reduction relative to Water Conservation Measures.
[11] Based on a minimum of 30 years of gauge data or all available gauge data.

3.5 Groundwater

Table 8. Environmental flow requirements for the ACT groundwater and aligned short-term expected outcomes, indicators, targets, and long-term objectives.

Note: Refer to Appendix A for an overview of environmental flow concepts, including details on the 80th percentile flow, flow variability and temporary requirements or special purpose flows. Appendix B provides further detail on the rules and methods used for determining environmental flow volumes (refer to Table B.1).

** Not all long-term objectives have indicators and targets that directly relate to them; however, it is intended that the Guidelines continues to adapt overtime to support achievement of long-term objectives.*

Reach	Relevant flow gauge(s)	Flow requirements[12]			Short-term outcomes			Long-term objectives
		Permanent measures	Drought stage 1 restrictions	Drought stage 2 restrictions or more severe restrictions	Expected outcome	Indicator	Target	
All reaches		Groundwater abstraction is limited to 10% of the long-term recharge.			Maintain base flows to support quality habitat and drought refuge.	Connectivity.	Base flows are maintained 100% of the time.	C1 - Longitudinal connectivity is improved and maintained during all conditions

[12] The Utility (Water Conservation) Regulation 2006 made under the Utilities Act 2000, provides approval of a set of water conservation measures. The Scheme of temporary restrictions on the use of water from Icon Water water supply system sets the target annual reduction relative to Water Conservation Measures.

4. Risks to achieving outcomes

4.1 Risks to meeting environmental water requirements

There are several risks to meeting the environmental water requirements set in the Guidelines (Table) including:

- risk relating to upstream water management
- climate related risks
- risks relating to balancing the ACT's consumptive water needs
- knowledge related risks.

To manage these risks there is a need for cooperative arrangements. Ongoing reviews and adaptive management are essential to ensuring the appropriate water requirements are in place (see section 5).

Table 9. Risks to meeting environmental watering requirements, mitigation opportunities and possible partners to establish cooperative arrangements with.

Risk	Mitigation opportunities
Management of Snowy Hydro scheme continues to impede environmental water delivery into the upper Murrumbidgee River.	Without increased flows into upper Murrumbidgee River, flow requirements set for the Murrumbidgee in the Guidelines will not be achieved and subsequently the short-term ecological outcomes and long-term ecological objectives of the Guidelines cannot be achieved. Under current flow volume releases from Tantangara Dam, timing of releases to coincide with downstream tributary events will be necessary to contribute to small or large freshes for PEFs as much as possible. However, current management arrangements have resulted in a lack of flexibility when releasing water from Tantangara Dam. This lack of flexibility includes an annual planning regime, limitations on capacity to release water volumes and an inability to vary volumes of releases with a 24-hr period. Potential partners: Federal Government, NSW Government, Snowy Hydro, and the ACT and Region Catchment Management Coordination Group.
Flows from Tantangara Dam are not being protected in the upper Murrumbidgee above ACT.	Protection of flows from unauthorised consumptive take in the upper Murrumbidgee River is essential to ensuring flow requirements can be met. A revised NSW Water Sharing Plan may protect environmental releases from Tantangara Dam in the upper Murrumbidgee between Tantangara Dam and the ACT, which may mitigate this risk. Ongoing communication between

Risk	Mitigation opportunities
	ACT and NSW regarding compliance actions will support mitigation of this risk. Potential partner: NSW Government.
Climate change reduces inflows and capacity to deliver environmental water.	Reduced capacity to deliver flows because of reduced inflows cannot be mitigated in the context of the Guidelines. Maximising the use of water when it is available to support the short-term outcomes set for the Guidelines is essential to build resilience for drier periods.
Knowledge gaps result in the inability to produce a sufficient evidence base for decision making regarding environmental flow management.	The Guidelines must be underpinned by a monitoring and research framework that aims to fill key knowledge gaps to support environmental flow decision making. Potential partner: NSW Government.
Flow requirements conflict with the ACT's water supply needs limiting capacity to deliver suitable environmental flow regimes.	The ACT Government will continue to work closely with Icon Water to establish licence requirements that support their role in delivering the ACT's water supply whilst also meeting environmental requirements. Potential partner: Icon Water.

4.2 Risks to achieving objectives

Achieving short-term ecological outcomes requires navigating a range of challenges, many of which are intensified by climate change. Shifts in climate patterns can affect the delivery of environmental water and the achievement of flow objectives, while events such as bushfires and droughts pose significant pressures on ecosystems and conservation efforts.

At the same time, pressures from invasive species—through competition, predation, and disease—highlight the importance of coordinated and sustained management to support ecological resilience. Land management practices and in-stream barriers can impact riparian habitats and aquatic species, underscoring the need for integrated catchment-scale solutions.

By strengthening adaptive management through targeted research and monitoring, we can enhance our capacity to respond to these evolving challenges. Preserving genetic diversity among vulnerable species is a key part of this effort, supporting waterway health and long-term ecological sustainability.

Addressing these complex risks calls for a holistic and strategic approach—one that brings together science, policy, Traditional knowledge, and community engagement to protect ecosystems and achieve environmental flow outcomes and objectives.

5. Review of the Guidelines and adaptive management

The Guidelines have had an ongoing review cycle of 5 years since implementation in 1999. The Guidelines will be reviewed again after a further 5 years of operation or earlier if evidence indicates it is warranted.

The next review has two priority purposes:

- To identify opportunities to improve the water requirements set in the Guidelines to ensure long-term ecological objectives and short-term ecological outcomes are being achieved.
- To improve alignment of the Guidelines with the long-term objectives and watering requirements set in the Long-Term Watering Plan.

While the Guidelines are grounded in the best available scientific knowledge, ongoing monitoring and data collection are essential to fully assess their effectiveness. Continued efforts to strengthen our understanding of flow-ecology relationships (see existing knowledge in Appendix A) will support adaptive management and help achieve long-term ecological objectives.

There is also significant potential to enhance the environmental flow requirements by incorporating emerging technologies and Traditional knowledge. These complementary approaches can enrich our understanding and improve outcomes for ecosystems and communities alike.

A Monitoring, Evaluation, Reporting and Improvement (MERI) Framework will be instrumental in guiding the next review and update of the Guidelines. This framework will test the logic in Figure 2 and help establish Key Evaluation Questions to assess progress and identify opportunities for refinement.

The development of the MERI Framework will also consider indicators, monitoring needs, and data analysis approaches to ensure a robust and adaptive evaluation process.

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Appendix A. Environmental flow concepts, management levers and flow ecology relationships

Environmental flow concepts

The **magnitude**, **frequency**, **timing**, **variation**, and **duration** of flows, particularly extreme high and low flows, act as key drivers in structuring biodiversity in riverine ecosystems (Mims & Olden, 2013; Poff et al., 2007; Tickner et al., 2020). Aquatic species respond differently to varying flow regimes and have adopted diverse life history strategies.

A flow regime is the range of flows needed to maintain and support different river and floodplain health and connectivity. Restoring flow regimes may influence fish diet, habitat, life history and population outcomes (Ellis et al., 2022). Flow regimes that may be ecologically significant and are commonly referred to when managing flows, comprise of:

- **Cease to flow**: refers to periods of no flow when either ephemeral rivers (short periods) or some intermittent streams (long periods) reduce to disconnected pools or end up drying completely during long periods of drought. Cease to flow can cause poor conditions for fish species at the lower levels of the food web, and extended periods of cease to flow has a positive correlation with poor water quality and low food supply availability, hence resulting in fish kills.

  Under natural conditions upland systems like the Cotter and upper Murrumbidgee Rivers would rarely be intermittent (cease-to-flow) (Kennard et al., 2010). Under modelled scenarios the upper Murrumbidgee River was not recorded as having cease-to flow events from 1980-2022 at either the Mittagang Crossing (NSW near Cooma) or below Lobbs Hole (upstream within ACT).

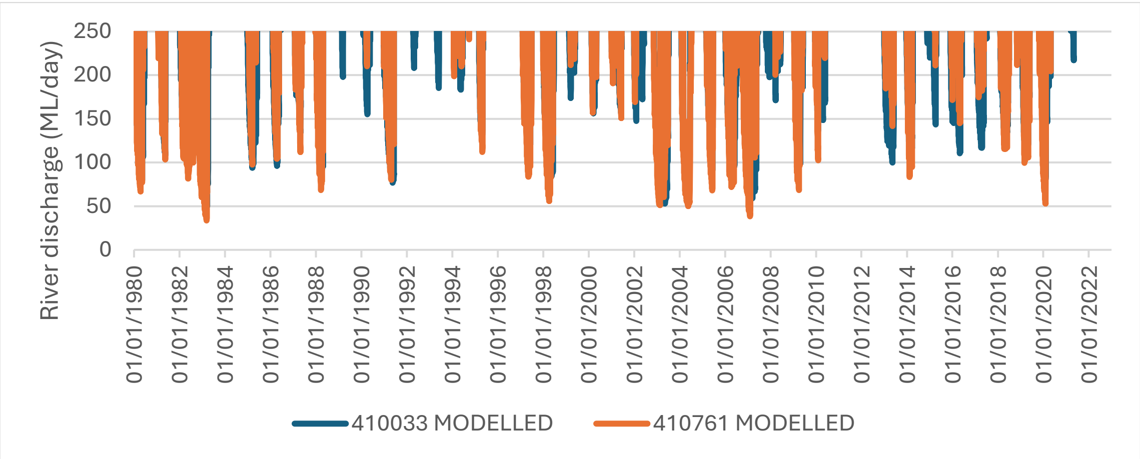


Figure A.1. Flows reported below 250ML/day at Mittagang Crossing (Gauge 410033) and below Lobbs Hole (Gauge 410761) under modelled scenarios.

- **Base flows**: base flows are low in-channel flows (flows that are exceeded 80% of the time) that provide connectivity between pools and riffles during periods of no rainfall. Base flows can also be connected to groundwater (MDBA, 2019). In perennial systems, base flows may provide longitudinal connectivity and opportunities for fish dispersal. Other benefits might include refuge maintenance during drought and sustaining plant and invertebrate communities in river channels. They may also promote nutrient dilution and other important accumulation during dry periods.

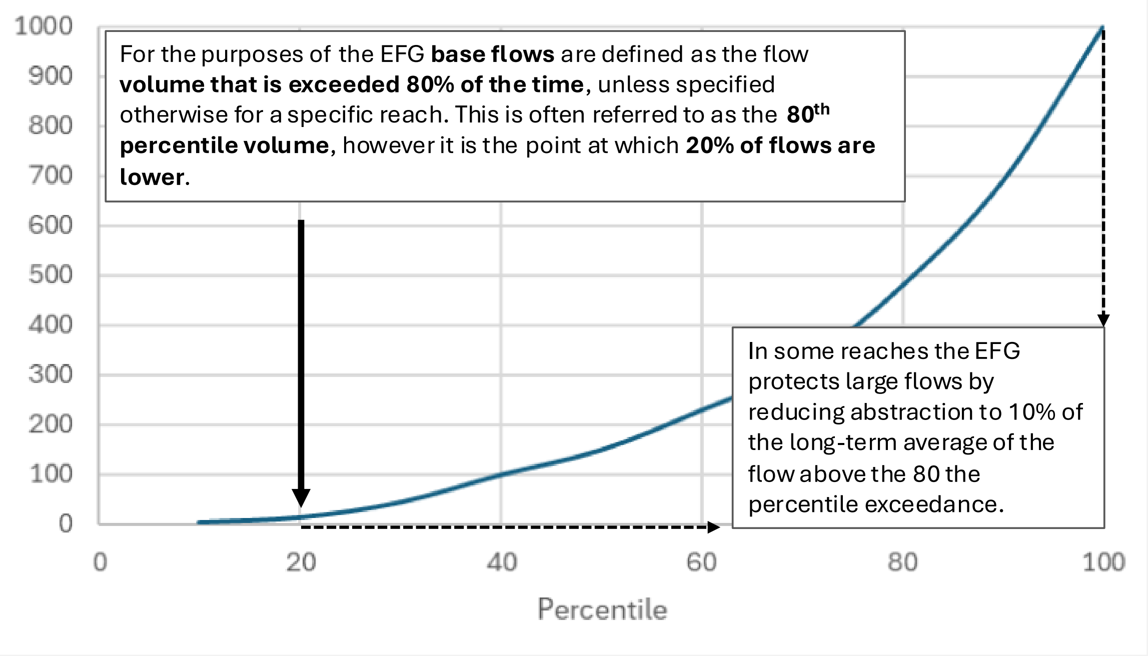
  Both the Cotter and Murrumbidgee rivers would naturally rely on variable base flows to provide critical ecosystem functions. Regulation has significantly reduced inflows into the upper Murrumbidgee River, which has resulted in base flows not being maintained during drought conditions. This loss of base flows is expected to have had detrimental impacts on the condition of native fish populations through loss of key ecosystem functions.

  In the Cotter system, impacts of river regulation on base flows have been different to the Murrumbidgee River. Movement of water for consumptive purposes means that flows are sometimes higher than natural base flow levels. The impacts of this on achieving long-term ecological objectives is somewhat unclear and requires further investigation.

Percentile flow

Base flows are commonly calculated as the 80th percentile flow. A percentile is a value between 0 and 100 that indicates the proportion of measurements that fall above the percentile value. The 80th percentile flow is the flow that is exceeded 80% of the time. That is, base flows are the commonly occurring low level flows.

A visual representation of 80th percentile flow and how they are used in the Guidelines is shown in **Error! Reference source not found.**.



- **Small freshes** are in-channel pulses that contribute to small flow increases over a short period and can help increase productivity by providing longitudinal connectivity. Among their key benefits is contribution to water quality improvements and maintaining aquatic habitat, including moving sediment from riffles.

  In the Cotter system, small freshes have previously been defined as riffle maintenance flows – flows that are necessary to keep riffles clear of fine surficial sediment.

- **Large freshes** are large in-channel pulses that are faster flowing than small freshes and contribute to higher flow increases. They provide habitat benefits including moving sediment from pools and riffles and increasing productivity by providing longitudinal connectivity that delivers water to connect a range of habitats. High in-channel flow velocity not only helps nutrient exchange, but it can also promote crucial fish life-history elements such as dispersal, recruitment, and potentially trigger spawning among some species.

  In the Cotter system, large freshes have previously been defined as pool maintenance flows – flows that are necessary to keep pools clear of sediment. In the Murrumbidgee system, the protection of low flows (80 – 90th percentiles) is accepted as more ecologically important than higher flows.

- **Bankfull** occurs when water fills a river channel and begins to spill out onto the adjacent floodplain surface. Bankfull flows are important for controlling channel and moving the bulk of the river's sediment. They are important for the water dependent ecosystems in and lining the channel, comprising various aquatic and semi-aquatic species, and vegetation communities. These events also: provide opportunities for fish and other animals to move between the river and connected off-channel environments; support river forming processes that maintain pools, riffles, and other in-channel features; and facilitate the transport of nutrients, sediments, and organic matter down the river.

  In the Cotter system, bankfull flows have previously been defined as channel maintenance flows – flows that are necessary to maintain channel morphology. Norris & Nichols (2011) identified a decrease in bankfull cross-sectional area of the Cotter River of up to 75% because of reduced flows. In the Murrumbidgee River, bankfull flows are an important mechanism to promote the establishment of aquatic and riparian vegetation, however it is difficult to achieve bankfull flows in many parts of the upper Murrumbidgee River where the system is confined by large rocky gorges.

- **Overbank flows** are substantial flow events that spill onto the low-level parts of the floodplain and replenish local groundwater. They are important for the water-dependent ecosystems situated on the floodplain, comprising depressional wetlands and riparian vegetation communities. These events also provide opportunities for fish and other animals to move along the river and can trigger spawning. Large-scale nutrient, carbon and sediment cycling between the river and the riparian zones is an important benefit from these types of events.

The waterways of the ACT are not characterised by large floodplains, though flooding events in the ACT can be ecologically critical to the maintenance of the channel and riparian floodplains and the functioning of their component ecosystems. Floods in the ACT tend to be of shorter duration and associated with high power/velocity compared to other Murray-Darling Basin riverine systems.

- **Flow variability** is an important characteristic of upland river systems. Static or constant flows (such as constant low flow) can have a detrimental effect on in-stream biota in the Cotter River system (Norris & Nichols, 2011; White et al., 2012) and likely in other local streams. Varying flows daily, where the variability of flows downstream of an impoundment are based on inflows or flow in an adjacent unregulated tributary, is likely to provide the greatest benefit to the river.

  However, there are times when variability should be limited or carefully managed to support life-history requirements of some species. Rapid changes in flow levels (either decreasing or increasing flow volumes) during spring can have detrimental impacts on eggs for species such as Murray Cod, Trout Cod, Two-spined Blackfish and Macquarie Perch.

In addition to natural flow regime characteristics, the following flow concepts are important for flow management in the ACT:

Temporary requirements or special purpose flows
In any sub-catchment, there may be circumstances in which it is necessary to reduce the volume of environmental flows for a limited time. The types of incidents that could trigger the need for reduced flows could be:
- algal blooms (including blue-green algae), oil spills or other contamination within the catchment requiring the cessation of releases;
- infrastructure failure, planned maintenance or upgrades requiring reduction or short-term cessation in flow downstream of a dam;
- landslides affecting water quality;
- to meet competing environmental objectives, such as maintaining Cotter Reservoir at a level suitable for fish passage by drowning out barriers; or,
- other incidents such as fire in a specific sub catchment area.

Conversely there may be times when additional environmental flows are identified for ecological purposes. Environmental flow volumes and duration have been determined based on best available science or expert opinion. However, it is possible that, as further understanding is gained, a need for a particular short-term flow component is identified. Examples of increased flows for ecological purposes could include:
- additional small fresh or large fresh flows following storm events;
- drown out of fish migration barriers to facilitate access to spawning areas; or,
- other ecological requirements.

Flows required to meet both these sorts of requirements are termed temporary requirements or special purpose flows. Temporary requirements or special purpose flows are not intended to apply to drought situations, and it is envisaged that changes to flows would apply for a limited period until the incident or situation was resolved. For these flows to be implemented, the Environment Protection Authority must be satisfied of the need for the change to flows.

Impoundment drawdown levels for urban lakes and ponds
Urban lakes and ponds are constructed water features, designed to protect downstream reaches from the effects of urban run-off and for urban amenity to provide local benefits, including cooling and greening. A primary use can also be flood mitigation. The water levels in lakes and ponds influence the survival and recruitment of submerged and emergent macrophytes, which play an important role in ecosystem processes. If the water level of urban lakes and ponds is lowered too far below spillway level for a significant period, macrophyte zonation may be significantly changed, compromising the ecological values of those waterbodies and their capacity to support other environmental functions. If drawdown of lakes and ponds occurs too far or too fast it can also result in fish kills, which not only have ecological impacts but also are an amenity and public health issue.

However, waterbodies with a water level regime that fluctuates within a reasonable range at the right frequency and seasonality can support a diverse and resilient macrophyte community with beneficial zonation. Stable water levels can result in static and fragile macrophyte communities whilst dramatic water level variations can result in very limited or no macrophyte communities. A drawdown level of up to 0.60 - 1 metre has been found to have a low risk to macrophytes and fish health when it aligns with seasonal variation.

Water supply drought flows
A water supply drought is defined for the purpose of these Guidelines as occurring when the water supply utility initiates temporary water restrictions (refer to the Utilities (Water Restriction Scheme) Approval 2010 (No 1)). During a period of a water supply drought, different environmental flow requirements termed water supply drought flows, will apply to ensure security of the ACT's water supply (see section 3 of the Guidelines). The implementation of permanent water conservation measures is not considered to be water restrictions for the purposes of the Guidelines (refer to the Utilities Water Conservation Measures Approval 2010).

Water supply drought flows will be applied in two stages, reflecting the stages of temporary water restrictions placed on domestic water consumption:

- Water supply drought flows under stage 1 restrictions.
- Water supply drought flows under stage 2 or more severe restrictions.

The water supply drought flows may also need to be altered under agreement with the Environment Protection Authority if other external factors are at play. For example, under stage 1 restrictions a bushfire occurs, and more strict changes are required, under request by Icon Water.

Water supply drought flows only apply to water supply catchments and have different requirements for each reach within the catchment.

Management levers for environmental flows in the ACT

The management levers used to achieve environmental flow protection or delivery as set in these Guidelines vary for the different waterbodies (Table). Water supply ecosystems are the only waterbodies where environmental flows can be actively delivered. Urban lakes and ponds in the ACT do not currently have capacity to deliver environmental flows because releases are only possible from off-takes at the bottom of the storage which presents a water quality risk, and inability to modify volumes released from these structures.

In the Murrumbidgee River, the active release of environmental water from Tantangara Dam is specified within the Snowy Water Licence held by Snowy Hydro, which sets the volume and timing of water released. Ongoing work is required to ensure effective environmental flow releases from Tantangara Dam in the future. Protection of flows from consumptive take between Tantangara and the ACT is also essential and occurs through compliance with NSW Water Sharing Plan rules as enforced by the NSW Government.

For most ACT waterbodies, environmental flows are protected through the limits on abstraction, as set under the *Water Resources Act 2007* (ACT) and in the ACT Water Resource Plan. For all Water Management Areas except Cotter and Googong, maximum surface water available for taking is 10% of the flow greater than the 80th percentile. In the Cotter and Googong, the 80th percentile is protected, and available take is total flow less the 80th percentile flow (refer to the ACT Water Resource Plan).

Table A.1. Management levers for protecting or delivering environmental water in ACT aquatic ecosystems.

Category of Aquatic Ecosystem	Management levers
Natural ecosystems (Conservation catchments)	Environmental water can be protected through abstraction rules set in the ACT Water Resource Plan.
Water supply ecosystems (Water Supply catchments)	Delivery of environmental flows from Corin, Bendora, Cotter and Googong reservoirs.
Modified ecosystems (Conservation catchments, Drainage and Open Space catchments)	Limit abstraction of surface water and groundwater as per rules set in the ACT Water Resource Plan.*
Urban ecosystems (Drainage and Open Space catchments and Urban Areas)	Limit abstraction of surface water and groundwater as per rules set in the ACT Water Resource Plan.

* The opportunity to secure environmental water releases from Tantangara Dam for ACT purposes is not currently available but would provide a management lever for the upper Murrumbidgee River that could result in delivery of environmental water.

Flow ecology relationships

Flow ecology relationships underpin the identification of environmental water requirements. These relationships are complex and can vary spatially and between catchments whilst being influenced by factors external to flow. Over recent years significant research has improved the understanding of flow-ecology relationships, however significant gaps still exist.

For native fish and other water-dependent fauna, different flow components play various roles in supporting life history requirements. For example, some species require a flow pulse to trigger spawning, whilst others spawn independent of flow but require flow pulses to enhance condition prior to spawning and to support recruitment success.

Known flow-ecology relationships for providing life history requirements of key species are shown in Table A.2. Flow-ecology relationships relevant to other priority ecosystem functions are shown in Table A.

Table A.2. Known flow-ecology relationships in relation to PEF 1 - providing critical life history requirements for key species. Note that grey boxes indicate no existing evidence sources

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
Cease to flow	Can survive short cease-to-flow if quality habitat maintained (Ellis et al., 2022).	Can survive short cease-to-flow if water quality and habitat maintained (Ellis et al., 2022).	-	Limited knowledge on specific flow requirements – maintenance of quality habitats should be prioritised (PEF 3).	Cease to flow events should be avoided (Hawke et al., 2019; Hawke et al., 2021).	Cease to flow events should be avoided (CEWO, 2021).	Cease to flow events should be avoided (CEWO, 2021).	Specific flow requirements unclear – maintenance of quality habitats should be prioritised (PEF 3).
Base flows	Base flow support condition maintenance of habitat and water quality (Ellis et al., 2022)	Base flow support winter conditioning, maintenance of habitat and water quality (Ellis et al., 2022).	Maintain connection with groundwater which may provide some benefits to riparian condition.		Limited knowledge on specific flow requirements – maintenance of quality habitats should be prioritised (PEF 3).	Limited knowledge on specific flow requirements – maintenance of quality habitats should be prioritised (PEF 3).	Specific flow requirements unclear – maintenance of quality habitats should be prioritised (PEF 3).	
Small fresh	Recruitment of larvae and juveniles is enhanced from a secondary peak event which boosts productivity to support	A late summer – autumn Small Fresh may promote juvenile dispersal movements. Small Freshes would occur two to three times per year in	Maintain connection with groundwater which may provide some benefits to riparian condition. May also benefit species that utilise					

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
	larval growth (Ellis et al., 2022). **Timing – at least one in spring**	perennial systems (Ellis et al., 2022). **Timing – late autumn to summer**	hydrochory as a dispersal mechanism.					
Large fresh	Large within-channel fresh will support regular small scale spawning events, which are necessary to sustain local populations (Ellis et al., 2022). Large freshes are associated with clearing sediment from breeding areas in upland reaches and	Large within-channel fresh to occur every 1-2 years (in addition to overbank flow events) to support regular annual recruitment (Ellis et al., 2022). Gradual recession (within natural rates of variability corresponding to the position within a catchment) can assist with egg dispersal and may also support subsequent spawning (Stuart and Sharpe, 2020).	May increase soil wetness in the most inner parts of riparian zone. May also benefit species that utilise hydrochory as a dispersal mechanism. May also help to keep non-obligate and weedy species out of the river channel.	A late winter fresh could support a rapid decline in water temperature, which would trigger mating. **Timing – late winter**	High discharge prior to the breeding season supports condition and reproductive success (Serena and Grant, 2017). **Timing- February to April**			

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
	providing connectivity in the Cotter system. However, a fresh during nesting season can be detrimental to egg survival (Ellis et al., 2022). **Timing – early spring**							
Bankfull and overbank flows	Overbank flows support nutrient cycling and increase organic material in the system which boosts productivity to enhance large scale spawning	First post winter overbank or bankfull flows enhances pre-spawning condition. Rapid rise in flow between spring and autumn cues spawning. Connection with wetland habitat provides nursery habitat.	Overbank flows are essential for supporting amphibious native species, setting seed beds and mitigating incursion of terrestrial weeds (Catford et al., 2011). Overbank flows are important to maintaining	-	Bankfull flows in late November to early January reduce recruitment success of platypus (Hawke et al., 2021) **Timing – mimicking natural spring floods is recommended.**	Rakali require healthy riparian zones which will be supported by bankfull and overbank flows (McKenna & Lovett, 2024).	Frogs require overbank and bankfull flows (categorised as wetland flows) for habitat (Hale et al., 2020). Wetlands are required to be inundated for a minimum of 4 months	Turtles require overbank flows and flooding to create and maintain diversity of habitat suitable for the differing needs of the individual species (Francis et al., 2022).

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
	and recruitment events. However, a pulse during nesting season can be detrimental to egg survival. Ideally overbank flows occur 2-3 times per decade. **Timing – early spring**		obligate riparian species diversity. Flood depth is the most influential hydrological variable in reducing exotic weeds, with a minimum of 2 days at peak height recommended (Catford et al., 2011). **Timing – mimicking natural spring floods is recommended**		High discharge prior to the breeding season supports condition and reproductive success (Serena and & Grant 2017). **Timing - February to April**		duration to allow sufficient time for tadpoles to complete development (Hoffman, 2018). **Timing – Summer and Autumn**	
Flow Variability	Flow variability (including base flows, small and large freshes) enhances growth and	Flow variability (i.e. large or small freshes and variable base flows) enhances growth and condition of larvae and juveniles by maintaining	-	-	-	-	-	-

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
	condition of larvae and juveniles by maintaining aquatic habitat, providing connectivity for dispersal between habitats (particularly river channels and low lying off-channel habitat) and promoting ecosystem productivity. **Timing - maintaining water levels and avoiding rapid fluctuations essential to supporting nesting species in**	aquatic habitat, providing connectivity for dispersal between habitats (particularly river channels and low lying off-channel habitat) and promoting ecosystem productivity. Flow peaks need to be maintained for greater than 7 days to allow for egg development and hatching followed by a gradual recession. **Timing – Sept - Feb**					-	-

Component of the flow regime	River specialists	Flow pulse specialist	Riparian vegetation	Murray River Crayfish	Platypus	Rakali	Frogs	Turtles
	Spring – Summer.							
Integrity of flows (the distance in which flows should continue through the system)	Integrity of flow events needs to be maintained over moderate distances (10s to 100s of km) to maximise response (Ellis et al., 2022).	Integrity of flow events need to be maintained over long distances (10s to 100s of km) to maximise the capacity for instream spawning, downstream dispersal by drifting eggs and larvae and movements by adults and juveniles (Ellis et al., 2022).	-	-	-	-		

Table A.3 Known flow-ecology relationships in relation to priority ecosystem functions.

Component of the flow regime	PEF 2 - Provide longitudinal connectivity	PEF 3 - Provide quality in-stream habitats	PEF 4 - Enhance in-stream productivity	PEF 5 - Movement and dispersal
Cease to flow	Cease-to- flow events are not common in systems like the Cotter and Murrumbidgee (Kennard et al., 2010). Modelling for the Murrumbidgee has demonstrated that under natural systems cease-to-flow events are very unlikely, however because of river regulation cease-to-flow events do occur, for example a cease to flow event occurred in the Murrumbidgee River in 2019. This event was a result of altered flow regimes (insufficient flow volumes and timing of flow delivery) caused by upstream water resource management outside of the ACT. For environmental flow planning cease-to-flow events are not considered an important flow component for any of the PEFs, however the increased frequency and duration of cease to flow events would impact PEFs and water management should be conducted to avoid flow cessation. Given the characteristics of the Cotter River as an upland system it is expected that cease-to-flow would impact PEFs and water management should be conducted to avoid flow cessation. In upland streams, flow cessation can be associated with poor fish condition for riffle-specialist species, particularly for species at lower trophic levels. This is because riffle-specialists' diversity and abundance depend on flowing water. These conditions may initially favour predatory species higher in the food web, as refuge habitats reduce, however as conditions worsen during extended periods of cease to flow, availability of food supply and suitable water quality also decrease (Bond et al., 2008; Koehn et al., 2020).			
Base flows	Base flows are critical for maintaining connectivity between pools and riffles.	Base flows sometimes present ideal conditions for certain aquatic species and can help retain pool refuges and provide habitat for opportunistic and generalist species (Ellis et al., 2022; Tonkin et al., 2021).	Base flows can allow for the accumulation of allochthonous carbon and vegetation on higher benches and dry river channel sediments, which then contribute to ecosystem productivity during subsequent flow events. They also contribute to nutrient dilution during wet periods or after a flood event. Small variations in flow within the base flow band can mimic natural variability and promote productivity during base flow periods.	Base flows provide connectivity between pools and riffles.

Small freshes	Small freshes enhance longitudinal connectivity and can drown out small barriers to movement or dispersal e.g. log, sand slug, rock or fallen trees.	Small freshes support in-stream habitat, improving water quality and nutrient flow through the system, and moving sediment through riffles.	Low magnitude flows such as small freshes, may provide opportunities for riparian plant species to recruit (Poff et al., 1997). Other benefits of small freshes may include its contribution to maintain the conditions such as water quality and habitats that are suitable to support the generation of diverse heterotrophic biofilm. This provides food supply of greater nutritional value to organisms higher in the food web (Ellis et al., 2022).	Increases longitudinal connectivity, may support movement or dispersal events.
Large freshes	Large freshes further enhance longitudinal connectivity and drown out larger barriers.	Large freshes support in-stream habitat, improving water quality and nutrient flow through the system, and moving sediment from pools. Large freshes may also submerge structural habitat.	Large within-channel freshes release low-lying carbon stored into the river increasing productivity (Mallen-Cooper & Zampatti, 2018). However, rapid river flow variations in some Australian systems have also been associated to negatively impact spawning and larval period (Tonkin et al., 2021).	Increases longitudinal connectivity, may trigger movement or dispersal events.
Bankfull and overbank flows	Bankfull and overbank flows fill the channel capacity, maximising longitudinal connectivity and drowning out barriers.	Bankfull flows will flush sediment through the system submerging structural habitat and enhancing productivity. Bankfull flows and overbank flows will benefit riparian habitat condition.	Bankfull and overbank flows are the most important flow components for drawing terrestrial sources of organic carbon into the system and increasing productivity (Gregory et al., 1991; Junk et al., 1989). Flooding has also been attributed to fish movement, increased spawning activity as well as habitat and food availability for larvae, and maintenance and germination of riparian plants (Tonkin et al., 2021).	Bankfull and overbank flows drown out barriers, increasing lateral connectivity. Overbank flows provide for lateral connectivity to floodplain habitats.

Appendix B. Background, methods and rules for determining environmental flow requirements

The 2023 review of the Guidelines identified that data was largely insufficient to determine if the flow requirements set in the 2019 Guidelines were effective for achieving ecological outcomes. As such, the rules set in the 2019 Guidelines have been maintained with the intention of testing them with improved monitoring effort over 2025-2029. However, as part of the 2023 review, those rules have been applied to calculate actual flow volumes for specific gauges.

Box A - Assuring protection of planned environmental water

The volumes set in the Guidelines for the Cotter River and the Murrumbidgee River are taken from the Icon Water licence following a quality assurance process which confirmed that the volumes were calculated in line with the Guidelines' flow requirements and that they have remained the same since 2013.

For the Cotter, base flow volumes that are now defined in this document are calculated using Icon Water's Water Balance method applied to the 1910-2013 gauge data to determine 75% of the 80th percentile flows.

In the Murrumbidgee, the base flow set in the licence were checked against the Guidelines flow requirements for the Murrumbidgee which are to maintain 80th percentile flows during November – May and 90th percentile flows during June-October. 80th and 90th percentile flows were calculated using gauge data from 1980-2012 (representing pre-Basin Plan) at two-gauge sites, Lobbs Hole and Mt MacDonald. At both sites the licence volume was higher than the calculated volume.

	Lobbs Hole	Mt McDonald
Licence	884 ML/year	1802 ML/year
1980-2012	883.9 ML/year	1562.6 ML/year

The flows set in the Guidelines provide a minimum flow volume to ensure planned environmental water in the Cotter River is protected in line with the Basin Plan.

Background to determining environmental flow volumes in the ACT

Base flows and freshes

In the 1999 Guidelines the 80th percentile flow was accepted as the threshold of base flows based on approaches used in other jurisdictions. The review of the 1999 Guidelines concluded that protection of low flows, as defined by the 80th percentile flow, had demonstrated benefits for fish and macroinvertebrates in the water supply catchments, and this flow, together with other flow components, could maintain aquatic ecological values with moderate confidence (Ogden et al. 2004).The review of the 2006 Guidelines gave further support to the 80th percentile flow giving an appropriate base flow volume. During the drought various base flows, below the 80th percentile, were trialled in water supply ecosystems. The monitoring and assessment of those lower base flows indicated that the 80th percentile flow gives a low-risk volume for sustaining ecological processes even though other flow volumes could be used for similar outcomes albeit with higher risk and requiring more intensive monitoring. As such, use of the 80th percentile flow has been maintained in the Guidelines.

In the Cotter River, for operational purposes, only 75% of the 80th percentile was released on a daily basis as the base flow during the initial part of each month, with the remaining volume released at the end of the month as small and large freshes. This informal base flow regime maintained aquatic ecosystems in the Cotter River and was the basis for changing the guideline base flow to 75% of the 80th percentile with the 2006 Guidelines.

For the Murrumbidgee River, the base flow is defined as the 80th percentile of stream flow in the months November to May inclusive, and the 90th percentile of stream flow in the months June to October inclusive. These flows also ensure the Murrumbidgee to Googong (M2G) environmental requirements are met as specified in the conditions of the Public Environment Report from the Commonwealth Government and the Development Application from the ACT Government, following the M2G Environmental Impact Assessment process.

Base flows requirements in the Murrumbidgee recognise that the Murrumbidgee has become an important source of water for contingency domestic water supply and will become an ongoing source of domestic supply, that is through Icon Water being able to take up to 100 ML/day (the capacity of the M2G system) from flows greater than the base flows. This is established on the assumption that within this large river, lower base flows can be accepted in the wetter months of the year without significantly compromising the processes supporting aquatic ecosystems. In the winter months the absolute volumes are greater and consequently a 90th percentile flow will still ensure that key riffle habitats are inundated, and connectivity is provided. The information supporting this approach for a differing percentile for summer/winter flows in certain systems is from research and experience in Victoria (Department for Natural Resources and Environment, 2002).

Past versions of the Guidelines have referred to **pool maintenance flows** and **riffle maintenance flows**. These terms have been changed in this version to **small freshes** and **large freshes** to be consistent with language used across the Murray-Darling Basin. Whilst the terminology has changed the purpose of these flows remains the same.

In the water supply catchments, small freshes have been designed to specifically achieve ecological outcomes rather than mimic natural flows. As such, regular freshes have been designed to flush sediment from riffles and pools to achieve the outcome normally provided by the irregular flushing flows that would occur naturally. The volume of freshes in the Cotter River has been determined from the monitoring of condition in the Cotter River before and after a series of experimental flows (Norris & Nichols, 2011).

Protection of large flows

To ensure naturally high flows are protected, abstraction will be restricted to a long-term average of 10% of the flow above the 80^{th} percentile flow. This requirement operates at the level of water planning and allocating water in the catchment, not at an instantaneous flow specification. In non-water supply catchments, an individual licensee does not have (in terms of infrastructure) the capacity to harvest flooding flows. However, there is a potential for all licensees to impact a flooding flow if their total combined volume was not restricted. This threshold was set using the best available scientific advice on the provision of habitat diversity and quality, nutrient and sediment cycling, movement of biota and connectivity between aquatic and terrestrial habitats. The knowledge gained by research on the effects of flushing flows of a range of volumes in the water supply areas indicates that the provision of such volumes of water is a low-risk approach.

Impoundment drawdown levels for urban lakes

In the 2006 Guidelines a maximum drawdown limit of 0.20 m was set for urban lakes to protect macrophytes as an important ecological component of such systems. A drawdown of this extent would expose approximately 2–3 m of the lake shoreline and the macrophytes in this zone, which poses a low risk to existing macrophytes. Recent research and investigations into drawdown levels in Canberra’s urban ponds indicates that a higher drawdown level of up to 0.60 m represents a low risk to macrophytes. The 2017 review extended the potential fluctuation of water level in urban ponds, lakes, and wetlands to 0.60 m where this aligns with seasonal variation.

There is already a significant demand for use of water from urban waterbodies for such purposes as irrigation of parklands and playing fields, and for irrigation of golf courses. If ponds are drawn down excessively and repeatedly, then the macrophytes may diminish or disappear over time resulting in declining water quality. More flexible drawdown limits than provided by these Guidelines can be applied to abstraction activities if they are accompanied by a specific monitoring and assessment program. In the absence of monitoring and assessment, having a precautionary limit of 0.60 m on the drawdown level of lakes and ponds is an effective and efficient approach for the protection of urban lakes and ponds.

Methods and rules (non-drought conditions)

Table B.1. Rules and methods used for determining environmental flow volumes.

Note: This table does not cover all reaches of the Guidelines. Flow requirements for other reaches are specified in section 3 of the Guidelines.

	Rules	Method for determining flow volume	Notes
Cotter	**Base flows** – Maintain 75% of the 80th percentile of the monthly natural inflow, or inflow, whichever is less. Small fresh – volumes specified as rule. **Large fresh** – volumes specified as rule.	**Base flows** - Icon Water's water balance method is used with 1910-2013 gauge data to model natural inflow and calculate base flows. **Small fresh** – research (Norris and Nichols 2011). **Large fresh** – research (Norris and Nichols 2011).	The method for calculating the small fresh and large fresh provision were developed with research. These flow requirements should again be tested in the 2029 review of the Guidelines to ensure they are still sufficient for achieving short-term ecological outcomes and long-term ecological objectives.
Murrumbidgee	**Base flow** - Maintain 80th percentile monthly flow November –May, and 90th percentile monthly flow June – October. **Small fresh** – volumes specified as rule. Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.	**Base flow** – Icon Water licence following calculation of base flows (80th and 90th percentiles) using 1980-2012 data at Lobbs Hole and Mount MacDonald to confirm planned environmental water is protected (See Box A). **Small fresh** – unclear.	The method for calculating the small fresh provision is unclear. This flow requirements should be considered in depth in the 2029 review of the Guidelines.

	Rules	Method for determining flow volume	Notes
Generic rules for other reaches (some reaches may vary – refer to section 5 for specific reaches)	Maintain 80th percentile monthly flow in all months. Abstraction will be restricted to a long-term average of 10% of the flow above the 80th percentile flow.	Calculated using a minimum of 30 years of gauge data or all available gauge data to determine the flow point at which 80% of flows are higher.	In some cases, gauges are not available and therefore volumes cannot be defined.