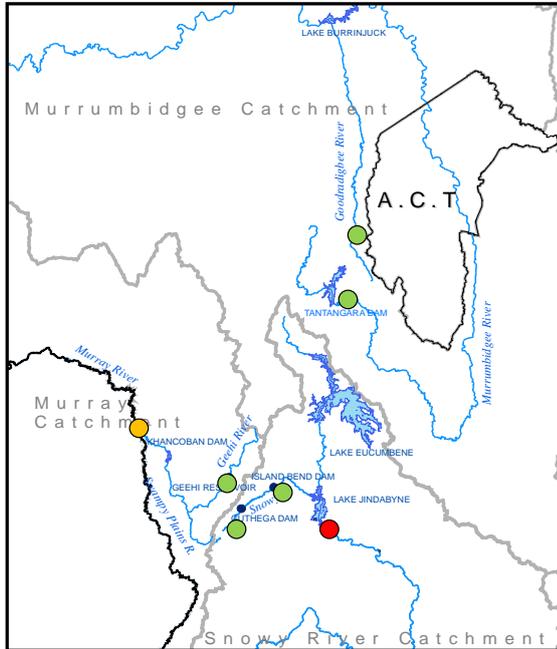


SNOWY RIVER RECOVERY: SNOWY FLOW RESPONSE MONITORING AND MODELLING PROGRAM

Strategy for the Snowy Montane Rivers Increased Flows 2014-15

The Snowy Initiative is an agreement for water recovery and environmental flows between the NSW, Victorian and Australian Governments, and is set out in the Snowy Water Inquiry Outcomes Implementation Deed 2002 (SWIOID 2002). The initiative provides three main environmental water programs as part of rebalancing the impacts of the Snowy Hydro Scheme on montane rivers. These three programs are increased flows for: (i) Snowy River, (ii) Murray River, and (iii) Snowy Montane Rivers (Figure 1). Five Snowy Montane Rivers are identified to receive environmental (Figure 1; Table 1).

Figure 1. Location of the Snowy Montane River release points (indicated by green icons).



- Snowy (SRIF)
- Snowy Montane (SMRIF) &
- Murray (MRIFs) River Increased Flows.

The SWIOID 2002 provides for Snowy Hydro Limited (SHL) to forego up to 150 Giga Watt hours (GWHrs) of electricity generation to allow

for environmental releases to be made, known as the Snowy Montane Rivers Increased Flows (SMRIF). This value of 150 GWHrs is converted into a volumetric allocation, but the conversion factor differs depending on the location of the releases in the Snowy Mountains Scheme. In some locations water released can be re-used to generate electricity so a smaller conversion factor is applied (Table 1).

Table 1. Snowy Montane Rivers annual targets and the conversion factor of lost energy generation to water allocation.

Snowy Montane Rivers Increased Flows	SWIOID Annual Target (GL)	Conversion factor
Murrumbidgee River @ Tantangara	27	1.94
Goodradigbee River*	12	1.94
Geehi	12	1.85
Snowy River- Island Bend	25	0.71
Snowy River- Perisher Range#	30	0.57

The water availability for SMRIFs is linked to the water availability for environmental flows to the Snowy River, which is determined by the water recovery in the western rivers and the climatic conditions.

The Snowy Montane Rivers Strategy differs from that for the Snowy River below Jindabyne, in that the release points are typically weirs (Figure 2) with the exception of the Murrumbidgee River at Tantangara Dam, and have limited capacity to actively manage releases. Typically the releases reflect the catchment inflows to the weir pool as it is not practical to prescribe a daily flow target. Accordingly, the Snowy Montane Rivers Increased Flows program sets annual, rather than daily flow targets for these weirs.

Additionally, as the SMRIF program is implemented, two key aspects are being considered: (i) maximising environmental outcomes and (ii) minimising changes to the existing SHL infrastructure (i.e. to allow water to pass downstream). Since the Snowy Water Inquiry, further work to implement the program has provided new information such as reductions water yields in the high country. Therefore, implementation of the SMRIF has been staged to ensure that environmental outcomes can be maximised.

Figure 2. SMRIFs to the Geehi River are delivered via Middle Creek Weir. Water is released by over topping the weir (Source S. Williams).



This fact sheet describes the 2014/15 SMRIF program and the intended environmental benefits.

Key aspects of the 2014-15 SMRIFs strategy

Four of the five locations identified in the SMRIFs program are currently receiving environmental water (Table 1). Only the Upper Snowy, in the Perisher Range remains to be implemented. This will require some additional technical analysis and minor infrastructure upgrades before the site(s) in this location can receive environmental water.

Table 2 outlines the 2014-15 annual targets for the Snowy Montane Rivers.

Table 2. Snowy Montane Rivers Increased Flows, SWIOD Target, Adjusted Target, and 2014-15 annual target.

Snowy Montane Rivers Increased Flows	SWIOD Annual Target (GL)	Average Annual Yield (GL)	2014-15 Annual Volume (GL)
Murrumbidgee River @ Tantangara	27	27	18.4
Goodradigbee River*	12	12	12
Geehi	12	17.5	17.5
Snowy River- Island Bend	25	18.9	18.9
Snowy River- Perisher Range#	30		

Note: The management options for the Perisher Range still requires further analysis in order to be implemented.

2014-15 SMRIFs strategy - Snowy Weirs

In the existing Snowy Montane Rivers the releases occur via weirs, and a long term average annual yield is targeted (Table 1). This means that over the long term the annual volume will average the nominated target. The flow will typically reflect the hydrology of the inflows. In wetter years the flow will exceed the long term target and in drier years the annual volume will be less than the target.

To achieve the long-term target each weir has been modified to either (i) allow all water to pass downstream (i.e. 'transparent releases') or (ii) in the case of the Goodradigbee River, allow a proportion of the daily inflows to be released (i.e. 'translucent' release). It is anticipated that the hydrological characteristics will reflect the hydrology of a Snowy montane river.

Ecological outcomes

The Snowy Water Inquiry Outcomes Implementation Deed 2002 sets a series of ecological objectives for the Snowy Montane Rivers. The SWIOD 2002 defines these broad objectives as follows:

- To protect endangered/ threatened species
- To maintain natural habitats
- To maintain wilderness and national parks values.

The SWIOD 2002 also requires these objectives to be further defined. For the Snowy Montane

Rivers, it is envisaged that the following ecological benefits will be realised by the releases:

- Provision of substantially increased wetted in-stream habitat, and the river channel better reflecting the natural hydraulic characteristics of a montane river.
- A thermal regime that better reflects a montane river.
- Regular scour of the river substrate.
- Improved hydrological and ecological connectivity along the water source.
 - Downstream provision of dissolved organic carbon, and dissolved silica.
 - Downstream provision of river bed sediment.
 - Downstream provision of plant prologues.
 - Downstream drift of aquatic macroinvertebrates.
- Reduction in the ingress of terrestrial vegetation in the channel, such as tea-tree.
- The ecological communities (i.e. benthic bacteria, periphyton, bugs, aquatic plants and fish) reflecting those of a Snowy Montane River.

2014-15 SMRIFs strategy- Murrumbidgee River below Tantangara Dam

Releases to the Murrumbidgee River are made from Tantangara dam, a much larger structure than the other release points, for which a gated release structure is available. Accordingly, the 2014-15 daily flow release strategy for the Murrumbidgee River differs from the other release points.

The 'flow scaling' approach used to set releases to the Snowy River has also been applied to the Murrumbidgee River. This approach uses the recorded flows in a nearby natural catchment (in a year where similar volumes of flow occurred) to set daily releases. For releases to the Murrumbidgee River from Tantangara dam, the initial daily flow targets for 2014-15 were set using the 1990-2000 flow sequence for the Murrumbidgee River above Tantangara (Fig 3).

Figure 3. The Murrumbidgee River above Tantangara Dam, was used as the hydrological surrogate to develop the 2014-15 release strategy (Source: S. Williams).



In 2014-15 the full allocation of 27GL (i.e. 30% of the Mean Annual Flow) is not available for release, given the drier conditions in the western rivers. Instead, an annual target of 18.4 GL was available for the Upper Murrumbidgee River below Tantangara Dam (Figure 4) in 2014-15.

Figure 4. Tantangara Dam on the Murrumbidgee River essentially acts as a large diversion weir and diverts water to the Eucumbene Dam for electricity production (Source: S. Williams).



The proposed daily flow pattern (Figure 5) attempts to include the key hydrological signals typical of a smaller mixed snowmelt - rainfall river system characteristic of the northern Snowy Mountains consistent with the volume available and the dam outlet capability.

The natural flow pattern of the Upper Murrumbidgee River varies from that of the Snowy River, as there are strong climatic gradients across the Snowy Mountains. Typically, the Upper Murrumbidgee River catchment is lower in elevation than the Snowy River Catchment and has substantially less catchment area above the snow line. Thus, the snow melt signal is not as pronounced as the Snowy River.

In a moderate allocation period, the 2014-15 flow strategy attempts to reinstate some of these montane hydrological cues, these include:

- A monthly flow pattern that reflects the winter-spring signal and includes four of these months (i.e. July-October) above 2 GL, with two months above 3 GL (i.e. August-September) (Figure 5).
- Reasonable daily flow variability during the winter-spring period, in this case with peak discharge above 200 ML/day on four occasions during winter-spring.
- A peak event of 350 ML/day to reflect a summer storm event in the Snowy Mountains.
- A base flow of 50 ML/day in late spring-early summer.
- A transition base flow discharge of 25 ML/day in early summer.
 - Two low flow trials of 25 ML/day (May-June and Jan-Feb) are being undertaken during the 2014-15 water year to test if these flows can be reliably delivered. This is the first time that flows as low as 25 ML/day have been attempted to be targeted.
- There will also be a period without releases between Feb-April 2015, as there is insufficient water available to maintain flows for every day of the year. This period corresponds with the driest period of the year.
- The 2014-15 flow sequence differs from the previous year and introduces daily variability between years.

Figure 5. Mean daily discharge pattern for the Murrumbidgee River below Tantangara in 2014-15 (blue).

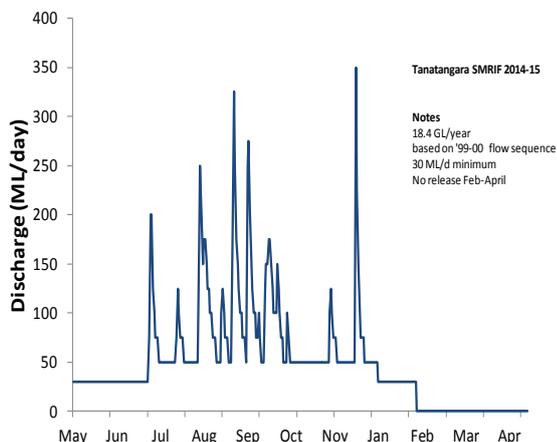
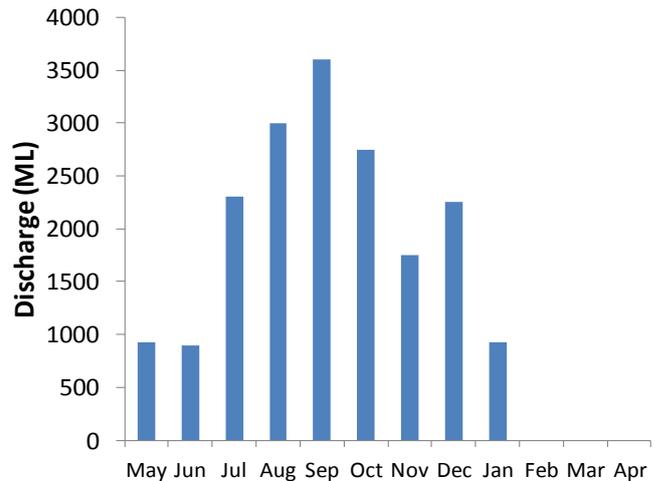


Figure 6. Total monthly discharge in the Murrumbidgee River below Tantangara Dam for 2014-15.



Overall long long-term rehabilitation of the upper Murrumbidgee River

The long-term objective for an environmental flow regime based on natural daily flow sequences in the Upper Murrumbidgee River is to facilitate the rehabilitation and evolution of the Murrumbidgee River below Tantangara Dam into a smaller but healthy river. Over decadal to century long time scales, environmental water releases scaled to the Upper Murrumbidgee River flows will allow the Murrumbidgee River to slowly develop a size, shape and perhaps condition, similar to that of a smaller but healthier Snowy Montane river.

The largest hydrological alteration has historically occurred between Tantangara Dam and the junction with Yaouk Creek, the first major perennial tributary with the Murrumbidgee River. It is anticipated that flows from Tantangara Dam will support the inflows from these smaller tributaries, and the ecosystem services provided via tributary contributions. It is expected that in this wetter part of the Snowy Mountains, that the tributaries will be a key mechanism to ecological recovery, but the dam releases will facilitate this ecological recovery.

The long-term objective implicitly recognises that:

- It is not possible to restore or maintain the Murrumbidgee River to its former size with less than one third of its former flow volume.

- The in-stream habitat needs to be improved in order for major secondary and tertiary ecological responses to occur. This forms the primary focus of the strategy in the early stages of the river recovery, where water is available.
- The releases will complement inflows from the major downstream tributaries to provide the opportunity for ecological recovery.

The allocation of 18.4 GL is seen as a moderate allocation and hence the primary objective for 2014-15 is primarily focussed on the maintenance of the existing improvements to the river since environmental water commenced in 2008.

Objective- Winter- Spring higher flows

The higher winter-early spring base flow interrupted by smaller regular events is designed to provide a low level of disturbance in the riffles (Figure 7) of the Murrumbidgee River. It is envisaged that the following ecological benefits are likely to be realised via the greater flow variability and peak flow rates:

- Slightly improve the physical habitat condition of the river riffles due to increased scour and water mixing.
- Improved riffle habitat condition will facilitate:
 - Increased opportunities for water and nutrient exchange in the riffles, and support improved heterotrophic primary productivity.
 - Sustain the aquatic macroinvertebrate fauna, by maintaining the current abundances of mayflies, caddies flies and stone flies.
 - Increased utilisation by Macquarie Perch
- Provide minor pulses of dissolved organic carbon by inundating lower benches and promoting heterotrophic primary productivity (Figure 8).

Figure 7. The quality of the bed of the Murrumbidgee River below Tanatagara Dam can be improved by the provision of higher magnitude flow events to scour the benthos. A prerequisite to encourage secondary and tertiary ecological responses to the SMRIFs. (Source: S. Williams)



Figure 8. Higher flow events in the Murrumbidgee River will inundate the lower benches and will (i) provide dissolved organic carbon and promote heterotrophic primary productivity and (ii) limit the ingress of terrestrial vegetation in aquatic habitats. (Source: S. Williams).



Objective- Aquatic vegetation

The increased winter-spring daily flow variability is designed to frequently wet the lower margins of the riparian zone and maintain moisture in the soil profile of the riverbank. It is expected that the proposed daily flow variability will favour the development of aquatic and riparian vegetation within a band just above the low water level of the Murrumbidgee River bank. Additionally, the daily flow variability will attempt to limit the ingress of terrestrial vegetation back into the river channel between the Tanatagara Dam and Yaouk Creek. The regular inundation will disadvantage these terrestrial vegetation types, by keeping the root zone wet.

Objective- Spring low flow riffle protection

The preservation of the low flow conditions (i.e. 50 ML/day) during spring is designed to provide minor protection of riffles. Flowing water habitats (i.e. riffles runs and glides) are the first in-stream habitat to be impacted by low flow periods. The protection is provided by maintaining water over the running water habitats such as riffles.

This will provide some protection of riffle dependent biota, such as aquatic heterotrophic bacteria, macroinvertebrates (i.e. mayflies, caddis flies and stone flies) and fish eggs such as Macquarie Perch (*Macquaria australasica*).

Objective- late spring-early summer peak flows

The two events in November and December 2014 provide an opportunity for Macquarie Perch (*Macquaria australasica*) to lay eggs in the river riffles. Fish such as Macquarie Perch need elevated water levels to gain access to the riffles. The higher flows aim to facilitate this access for the adult fish to breed.

Objective- Summer low flow riffle protection

The preservation of a very low flow of 25 ML/day trial attempts to provide a transition period to limit hydrological stranding of aquatic biota.

This very low period in January 2015 is designed to replicate the gradual drying of the river, and may provide the opportunity for aquatic biota to transition to a no-flow period between February and April 2015.

Acknowledgments

The document should be cited as Williams, S. (2014). Proposed flow release strategy for the Snowy Montane Rivers Increased Flows, 2014-15. Snowy Flow Response Modelling and Modelling program, NSW Office of Water, Sydney.

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