SRIF - Assessment of interim Jindabyne release arrangements

Andrew Little[1], Ross Hardie[1], Colby Lawton[1], Lee Davis[2]

1 Alluvium, Melbourne, Victoria, 3121, info@alluvium.com.au

2 Natural Capital Economics, Melbourne, Victoria, 3121, info@alluvium.com.au

Key Points

- Investigations were undertaken into the environmental flow and power generation implications of decommissioning the Mowamba River aqueduct and returning flows to the Mowamba River
- Adjustment of pre-planned releases from Jindabyne Dam will be required to offset losses from the proposed reinstatement on flows in Mowamba River
- Reinstating environmental flows in the Mowamba River can be achieved without impacting environmental outcomes for the Snowy River or power generation.

Abstract

The Mowamba River is a right bank tributary of the Snowy River. While the tributary is located downstream of Jindabyne Dam, flows from the Mowamba River have been diverted via a weir and diversion channel to Lake Jindabyne. The cessation of diversions from the Mowamba River has been proposed as a means to improve the connectivity of the Mowamba River to the Snowy River. However, releases from Jindabyne Dam to the Snowy River will need to be reduced to offset the lost inflow to Lake Jindabyne from the Mowamba River. Snowy Hydro operates a mini hydro-electric plant on the outlet of Jindabyne Dam. This mini hydro-electric plant can only operate within a limited operating range or window. This paper describes the development of an interim Lake Jindabyne operating arrangement, to accompany the cessation of Mowamba River Diversions to Lake Jindabyne, that achieves improved outcomes from available environmental water while limiting the financial impact of lost hydroelectricity production.

Environmental flow releases from Lake Jindabyne are planned up to 12 months in advance. The investigation applied adjustments to the planned releases from Jindabyne Dam based on Mowamba River flows for the period 2011 to 2021. The investigation simulated a live application whereby the planned daily Jindabyne Dam releases are known for the year in advance, but the actual Mowamba River flows are not. Initial preemptive reductions were applied to Lake Jindabyne releases based on mean historic seasonal flow rates from the Mowamba River, then secondary corrections applied based on actual flows in the Mowamba River. Alternate Lake Jindabyne operating arrangements or scenarios were created and tested based on combinations of several variables, including the (1) reconciliation interval (yearly, quarterly, or monthly) to account for actual Mowamba River flows, (2) whether corrections were applied immediately over a two week period after the close of the reconciliation period or applied (gradually) over the entire subsequent reconciliation period, and (3) whether the hydroelectricity generation window was fully or partially protected for the purpose of any reduction in Jindabyne Dam releases. Finally, a tool was developed so the adjustment mechanism could be applied to future planning.

There are administrative and legislative controls that limit the extent of change that can be achieved. Within these constraints, we found that changing release arrangements from Jindabyne Dam to allow for the decommissioning of the Mowamba Weir while limiting impact on the environment values downstream of Jindabyne dam and energy production from Lake Jindabyne is possible. We found that proposed changes to the Mowamba River can be achieved without adversely impacting the environmental values immediately downstream of Lake Jindabyne and that the environmental benefits to the Mowamba River can be achieved without a loss in hydro-electric power production.

Keywords

Snowy River Improved Flows, Mowamba River, Hydroelectricity, operating arrangements

Introduction

This paper provides analysis relevant to two actions arising from the 2018 Review of the Snowy Water Licence (the Licence) concerning the Snowy River Improved Flows (SRIF): Action 7 (Mowamba River) and Action 8A (flow flexibility). These two actions were subject to a preliminary feasibility assessment on a set of expert panel recommendations. The preliminary feasibility assessment identified several investigations that will facilitate the implementation of the expert panel recommendations and identify/mitigate any impediments and risks to implementation (Alluvium 2023).

As part of these two actions, an investigation was conducted pertaining to Investigation No. 1: An assessment of preferred interim operating and water management arrangements to facilitate the overtopping and/or decommissioning of Mowamba Weir.

The Mowamba River is a right bank tributary of the Snowy River. While the tributary is located downstream of Jindabyne Dam, flows from the Mowamba River are diverted by a weir and via a diversion channel (aqueduct) to Lake Jindabyne as part of the Snowy Mountains Scheme.

The Snowy Mountains Scheme provides hydroelectric power and diverts the waters of the Snowy River westward, past the continental divide, into the Murray and Murrumbidgee Rivers to augment irrigation supply (DCCEEW, 2024). From the completion of the Jindabyne Dam Project in 1967 until 2002, the Snowy Mountains Scheme reduced flows in the Snowy River downstream of Jindabyne Dam to an average of one percent of natural levels (Independent Panel, 2022). Commencing in 2002, the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) specified requirements for environmental releases to the Snowy River that build to a target of an average of 212,000 ML per year (21 percent of average natural flows) (Cwlth, NSW, Vic, 2022 - SS 7.3(1)(b)). These environmental flow releases are known as Snowy River Increased Flows (SRIF). The overall objective for SRIF is to facilitate the rehabilitation and evolution of the Snowy River below Jindabyne Dam into a smaller but healthy montane river.

The cessation of diversions from the Mowamba River has been proposed to improve the connectivity of the Mowamba River to the Snowy River and in doing so contribute to the broader program to assist the evolution of the Snowy River to a smaller but healthier montane river. However, releases from Jindabyne Dam to the Snowy River will need to be reduced to offset the lost inflow to Lake Jindabyne from the Mowamba River. Snowy Hydro operates a mini hydro-electric plant on the outlet of Jindabyne Dam. This mini hydro-electric plant can only operate within a limited operating range or window, with no power production at releases less than 100Ml/day, increasing power production up to 180ML/day, and no additional power production for releases greater than 180ML/day.

This paper describes the development of an interim Lake Jindabyne operating arrangement, to accompany the cessation of Mowamba River Diversions to Lake Jindabyne, that achieves improved outcomes from available environmental water while limiting the financial impact of lost hydroelectricity production.

Study overview

The purpose of the investigation was to identify a preferred water management (operating) arrangement for Lake Jindabyne to allow for the overtopping of Mowamba Weir to improve outcomes from SRIF. Flows in the Mowamba River are currently, and largely, diverted to Lake Jindabyne by the Mowamba Weir via the Mowamba Aqueduct. Varying flows to deliver a combination of releases from Jindabyne Dam and unregulated flows from the Mowamba River will improve ecological outcomes by reintroducing Mowamba River as a natural headwater for the Snowy River and increasing natural variability in the environmental flow pattern. Under this proposal, the net SRIF delivery remains unchanged.

The project sought to develop a water management arrangement that achieved four (4) primary goals (listed in order of assessment and not a reflection of perceived priority):

1. Not result in the SRIF exceeding a 10 percent difference in the volume of SRIF for that water year (SWL 10% rule) as required by the Snowy Water Licence (The Licence). The Licence requires the Licensee (Snowy Hydro) to release from Jindabyne Dam a total volume of water that is within 10 percent of the volume of the SRIF for that water year (refer Section 12.1 (1) of Schedule Three of the Licence)

2. Limit the administrative and operational burden required to implement the operational changes.

3. Maximise ecological outcomes (not adversely impact on ecological outcomes) in the Snowy River downstream of Jindabyne Dam.

4. Not adversely impact on hydroelectric generation capacity and maintaining operational time of the Lake Jindabyne mini hydroelectric plant.

Environmental flow releases from Lake Jindabyne are planned up to 12 months in advance. The investigation applied adjustments to the planned releases from Jindabyne Dam based on Mowamba River flows for the period 2011 to 2021. The investigation used a 'blind simulation' method to test alternate approaches to the reduction in planned daily Jindabyne Dam releases.

Method

A preferred water management arrangement was developed through a spreadsheet model. The model was established to test alternate approaches for reducing Jindabyne Dam releases to offset the flows that pass through Mowamba Aqueduct and are supplied Lake Jindabyne but would, if implemented, be discharged directly to the Snowy River via the Mowamba River. The approaches were tested using historical data to determine if flows could be returned to Mowamba River and the net SRIF delivery remain unchanged, while not impacting on hydroelectric production and not creating an excessive administrative burden to implement.

As set out in the introduction, daily planned releases for Jindabyne Dam are developed and known for the water year ahead. However, the actual flow rate and contribution of the Mowamba River to this flow regime is not known. Initial preemptive reductions were applied to Lake Jindabyne releases based on mean historic seasonal flow rates from the Mowamba River, then secondary corrections applied at the end of nominated reconciliation periods (intervals), based on actual flows in the Mowamba River. Alternate Lake Jindabyne operating arrangements or scenarios were created and tested based on combinations of several variables, comprising:

(1) The reconciliation interval (yearly, quarterly, or monthly) to account for actual Mowamba River flows,

(2) Whether corrections were applied

   a. immediately after the close of the reconciliation period or

   b. applied (gradually) over the entire subsequent reconciliation period, and

(3) whether the hydroelectricity generation window was fully or partially protected for the purpose of any reduction in Jindabyne Dam releases.

The variables were compiled into scenarios that were tested using historical flow data. A simulated blind method was used where the approach to flow reduction was applied assuming planned releases were known but the flows through Mowamba Aqueduct were not known ahead of time. This allowed the method to be tested in manufactured conditions replicating the intended use.

This investigation encompassed a series of steps, including:

1. Categorisation of planned Jindabyne Dam releases to identify the releases that could be reduced and degree of permissible reduction including consideration of

    - Hydroelectric generation

        i. Fully protecting (not changing) planned releases within the hydroelectric operating range

        ii. Partially protecting releases within the hydroelectric operating range by not reducing release rates below 100ML/day

    - Environmental flow requirements

        i. Not lowering releases below minimum flow rate of 40ML/day

2. Modelling of each scenario (i.e. combination of reconciliation period, rate of correction and degree of hydroelectric power generation protection) comprising

    Step 2.1: Preemptive reduction of flows from Jindabyne, based on seasonality data for the Mowamba River and the release rates available for adjustments.

    Step 2.2: A periodic check (reconciliation) on performance of the reductions against the actual Mowamba Aqueduct flows to determine if the changes had been reflective of the actual Mowamba River flow rates. The period of the reconciliation check was a variable tested across multiple scenarios.

    Step 2.3: Reflect difference between preemptive reduction (step 2.1) and actual Mowamba flow rates (Step 2.2) over the next reconciliation period up to the next reconciliation test. If the first reduction, step 2.1 was less than Mowamba Aqueduct flows step 2.2, then further reductions are made in the next reconciliation period. If the initial reductions (step 2.1) exceed the actual Mowamba Aqueduct flows (step 2.2) then some reduction to the preemptive (initial) reductions are made.

3. Review of the proposed Jindabyne release arrangements for each scenario and identification of feasible arrangements based on

    - Comparison of the Mowamba flows and the total reductions made for the year to date to identify if the changes have over- or under-drawn on the Jindabyne Dam releases. This step relates to the SWL 10% rule, and the goal is that the net SRIF delivery remains unchanged.

    - Review of the administrative burden associated with each scenario

    - An ecological and geomorphological review of the scenarios to identify preferred water management arrangements for further consideration.

4. An economic of evaluation of feasible arrangements

    - Initial economic assessment: Identify the expected changes in electricity generation and revenue associated with each the feasible arrangement and potential enhancement of generation / revenue outcomes.

    - Refined rules assessment: Explore the further refinement of the feasible arrangements to identify economic opportunities that could be realised to offset any reduction in electricity generation. The changes were made by raising releases that are between 90-100ML/d (where flows are close to generating electricity but do not exceed the threshold). This was done by raising such releases to 100ML/d (Change A) or adding

10ML/d to such releases to maintain some flow/ release variability (Change B). Such increases in discharge need to be offset by reductions in other releases outside the operating range

5. Identification of the hydrological regime for the preferred water management arrangement, by selecting a scenario that best meets the requirements for the environment and for economic outcomes for generation and revenue without adding unreasonably burdensome expected administration.

A series of ten scenarios / arrangements were tested through combinations of three (3) variables:

1. The level of protection of the window that the Jindabyne Mini Hydro Station can operate. This was through either
    a. full protection of the 100-180ML/d window based on guidance from Snowy Hydro (e.g., no reduction of flows within 100-180ML/d window), or
    b. partial protection of the generation window (e.g., some flows to be reduced within the window without ever going under the 100ML/d threshold required for operation).
2. Frequency of reconciliation checks as outlined in step 6 of the method. Options of yearly, quarterly and monthly reconciliation checks were tested.
3. The approach to reconciling the differences found when reconciliation checks were made. The options used were immediate correction, where the difference was recovered as soon as possible (2-week period after the close of the reconciliation check), or a gradual correction, where the correction was spread over the full duration of the subsequent reconciliation period.

The resulting set of scenarios tested is shown in Table 2.

Results

Feasibility assessment

The modified release arrangements for each scenario were assessed against the four (4) primary goals.

SWL 10% rule

The assessment against the SWL 10% rule found that the less frequent the (reconciliation) checks of releases against actual Mowamba flows, the higher the risk that the modified scenario would break the 10% threshold. This is not unexpected, as the more frequent reconciliation checks allow more frequent adjustments to the modified flows. The result was that the annual check approach was not considered feasible.

Administrative and operational burden

The administrative and operational burden presented by the scenarios was tested for feasibility of application. This focused on discussions with Snowy Hydro and DCCEEW, as well as reviewing consultation from prior activities. Ultimately the findings were that the monthly reconciliations were not administratively possible, resulting in those scenarios being removed from consideration.

Note that this was found midway through the scenario development process, so only the immediate reconciliation process tested the monthly checks.

Ecological outcomes

The ecological outcomes of each of the scenarios was tested through an expert review of the results.

The expert panel that reviewed the results recommended that a flow regime be chosen from the scenarios that does not greatly impact river flow variability and leave extended periods of low and stable flow, mainly in the reach upstream of the Mowamba confluence.

Each of the options has a relatively marginal ecological impact on the stretch of the Snowy River below Jindabyne Dam compared to the current status quo. As a result, the ecological panel noted the following recommendations:

- Avoiding a flatline flow is preferable and would help prevent the occurrence of isolated pools that become stagnant and are at a higher risk of algal blooms.
- Significant spikes and drops in flow should be avoided.

The arrangements that provided for the full protection of the hydro electric operating range had a greater adverse impact on the desired environmental release patterns from Jindabyne Dam than options that provided for the partial protection of flows in the hydroelectric power generation range.

Feasibility assessment

Based on the results of the above only 2 scenarios were taken to an economic evaluation, these scenarios comprised:

- Scenario 8: Quarterly reconciliation, gradual reconciliation over duration of the next reconciliation period, full protection of hydroelectric power generation range
- Scenario 10: Quarterly reconciliation, gradual reconciliation over duration of the next reconciliation period, partial protection of hydroelectric power generation range

Hydroelectric generation

An initial economic evaluation was conducted on the feasible Scenarios 8 and 10 to create a preliminary understanding of the economic impact the changed releases could have (using the 10-year historical data as a test case).

The method used in this initial analysis was then able to be applied to further iterations of the release regimes to refine the rules used for amending planned releases. Spot price data and Renewable Energy Certificate (REC) values were also applied to the electricity generation value of the flows of Scenario 8 and Scenario 10.

Based on this evaluation, it was found that Scenario 8 resulted in no change to Snowy Hydro revenue (due to the full protection of flows that generate electricity), while Scenario 10 resulted in a $12,300 reduction in revenue across the 10-year period.

Table 1 shows the additional revenue that can be generated by increasing releases that are marginally below the hydroelectric generating range to that within the operating range. We found that potential to recover costs or reduce revenue losses via the minor increases to releases in the operating range of the mini hydro plant. Table 1 also shows the average yearly additional water required for such opportunistic electricity generation. The additional volumes required is important as these will require removal from flows outside the operating range.

Table 1. *Results of economic opportunities test.*

Scenario	Additional Revenue ($;000 per year)	Additional volumes (ML per year)	Scenario	Additional Revenue ($;000 per year)	Additional volumes (ML per year)
8	0	-	10	-12.3	-
8A	14.8	37.7	10A	4.3	42.3
8B	15.6	102	10B	5.2	111

Conclusions

Previous studies have identified the ecological benefits of decommissioning the Mowamba River infrastructure and reintroducing the Mowamba River as a headwater for the Snowy River. The return of the Mowamba River can increase natural variability and productivity in, and provide bed load sediment for channel building to, the downstream Snowy River.

This investigation has identified that these outcomes can be achieved with minimal impact on the ecological and geomorphic position in the Snowy River immediately downstream of Jindabyne Dam. The investigation has also revealed that reductions in SRIF discharges from Jindabyne Dam to offset SRIF delivered directly to the Snowy River via the Mowamba River can be achieved in a manner that limits the impact on hydro-electricity production from the Mini Hydro Station at Jindabyne. Further, the investigation has identified that additional refinement of the Jindabyne Dam releases can achieve increased power generation that can help offset the cost of any additional operational demands on Snowy Hydro arising from the return of stream flow from the Mowamba River to the Snowy River.

The studies undertaken have reached the following findings:

1. Improved ecological outcomes can be achieved by reintroducing Mowamba River as a natural headwater for the Snowy River,
2. Natural variability in the environmental flow pattern can be increased by reintroducing Mowamba River as a natural headwater for the Snowy River,
3. The above can be achieved with minimal impact on the ecological and geomorphic outcomes in the Snowy River downstream of Jindabyne Dam, and,
4. Offsetting of flows that (under the base case) would have arrived in Jindabyne Dam through the Mowamba Aqueduct can be achieved in a way that limits the impact on hydro-electricity production from the Mini Hydro Station at Jindabyne.

The changes made under Scenario 10B were identified as a preferred arrangement for adjusting the flows from Jindabyne Dam and allowing the benefits from the reinstatement of flows through Mowamba River to be achieved. This arrangement provides:

- No adjustment to releases less than 40 ML/da
- Quarterly reconciliations
- Adjustments of reconciliations over the duration of the subsequent reconciliation period
- Partial protection of the hydroelectric operating range
- Increase is releases in the 90-100Ml/day range by 10ML/day and provide for offset of these increases within the constraints of the above criteria

While the analysis investigated changes made to historic flows (rather than predicted future flows), in this scenario (10B) the likelihood of adverse outcomes was best balanced across all study criteria.

Table 2. *Scenarios tested and assessment results.*

Scenarios	Degree of power production protection	Reconciliation frequency	Correction	SWL 10% rule	Environmental	Geomorphic	Administrative	Economic (initial & opportunistic)
1	Full protection	Yearly	Immediate	Fail	Fail (flatlining)	Pass	Pass	
2	Full protection	Quarterly	Immediate	Fail	Fail (flatlining)l	Pass	Pass	
3	Full protection	Monthly	Immediate	Pass	Fail (flatlining)	Pass	Fail	
4	Limited protection	Yearly	Immediate	Fail	Fail (flatlining)	Pass	Pass	
5	Limited protection	Quarterly	Immediate	Fail	Fail (flatlining)	Pass	Pass	
6	Limited protection	Monthly	Immediate	Pass	Fail (flatlining)	Pass	Fail	
7	Full protection	Yearly	Gradual	Fail	Pass	Pass	Pass	
8	Full protection	Quarterly	Gradual	Pass	Pass	Pass	Pass	No Change
8A	Full protection	Quarterly	Gradual	Pass	Fail (flatlining)	Fail – high flows reduced too far	Pass	Pass
8B	Full protection	Quarterly	Gradual	Pass	Pass	Fail – high flows reduced too far	Pass	Pass
9	Limited protection	Yearly	Gradual	Fail	Pass	Pass	Pass	
10	Limited protection	Quarterly	Gradual	Pass	Pass	Pass	Pass	No additional generation, some reduction
10A	Limited protection	Quarterly	Gradual	Pass	Fail (flatlining)	Pass	Pass	Pass
10B	Limited protection	Quarterly	Gradual	Pass	Pass	Pass	Pass	Pass

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