

Flow Options for Arrow River and Wakatipu Basin Aquifers –  
Assessment against Kāi Tahu Values

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### **The Arrow River**

The Arrow River flows approximately 50 km from its headwaters to the south of Arrowtown and the east of Lake Hayes, running alongside the terraces of the Wakatipu Basin to its confluence with the Kawarau River. The headwater hills are the Harris Mountains, Mt Soho and Mt Cardrona. Soho Creek, Eight Mile Creek and the Rich Burn are significant tributaries. Bush Creek joins the Arrow River at Arrowtown.

#### **Key facts:**

Maf: 1.43 To 1.44 cumecs.

Takes: 22 surface water, four above the flow recorder.

Volume of takes:

Deemed permits: 15.

The river is approximately three times over-allocated.

Water is used for irrigation, community supply, rural-residential development and tourism.

There would probably be longfin eel in the Arrow River were it not for the Roxburgh and Clyde dams acting as barriers. A single record for a koaro in a tributary exists.

## Kāi Tahu Assessment

	Unacceptable outcome
	Marginal outcome
	Adequate outcome
	Desired outcome or better

Values	Objective	Minimum Flow Options			Comments from Kāi Tahu Values Report, Interviews and Iwi Management Plans
		800 l/s	900 l/s	1000 l/s	
<b>Cultural landscape values</b>	Maintain flow connectivity Remove weeds and exotics Avoid algal growth				<p>The continuous flow of the river was identified as very important to Kāi Tahu. A continuous flow supports life supporting capacity, recreational and cultural use.</p> <p>Planting programmes on river margins, fenced off waterways, wetlands, tussocklands and shrubland areas are valued.</p> <p>Poplars and willows need to be controlled. Weed and grass are undesirable.</p> <p>Desire to see the natural environment that tūpuna would have seen... “I’d like to see the integrity of the landscapes restored.”</p> <p>Allowing the river to function in its natural state. “Just let it be a river.”</p>
<b>Te kōunga o te wai<sup>1</sup></b>	Maintain / enhance water quality				No decline in water quality from current state. Whanau perceptions of water quality affected by presence of periphyton.
	Water temperature				Water temperatures suitable for indigenous fish species.
<b>Mahika kai - plants<sup>2</sup></b>	Maintain/restore life supporting capacity of mahika kai plant species				Aruhe/bracken fern root; tī/cabbage tree taken historically.

<sup>1</sup> Assessment of te kōunga o te wai based on ORC assessment for periphyton.

<sup>2</sup> This section has not been colour coded, as Kāi Tahu has not worked through the requirements of these species for water.

Values	Objective	Minimum Flow Options			Comments from Kāi Tahu Values Report, Interviews and Iwi Management Plans
		800 l/s	900 l/s	1000 l/s	
<b>Mahika kai – birds (as per footnote 2)</b>	Maintain/restore life supporting capacity of mahika kai bird species				Historically, moa, water fowl, weka, koreke (New Zealand quail) were taken. The Arrow Valley was an original birding area.  Buff weka programme now on Motatapu, Mount Soho, Glencoe and Coronet Peak stations.
<b>Mahika kai - fish</b>	Maintain/restore life supporting capacity of mahika kai fish species				No tuna records but they are likely to have existed in the Arrow in the past; tuna are present in Lake Wakatipu. Contact Energy working on fish passage. The Arrow is largely devoid of fish; trout numbers are relatively low. Could the translocation of Upper Clutha galaxias be possible?  “If whānau see slime they won’t get in, they won’t gather.”
<b>Taonga species</b>	Maintain/restore life supporting capacity of taonga species				A single record for a koaro exists.
<b>Ara tawhito<sup>3</sup></b>	Protect cultural landscapes in consultation with Kāi Tahu. Access to traditional lands and resources.				Seasonal hapū/whānau heke were undertaken. “The original Māori trail which followed up the Cardrona valley was later well trod by goldminers either up over Fox’s Gully into the Arrow or through the Roaring Meg, down to the Nevis”
<b>Evidence of occupation/heke/ tuhituhi neherā/wāhi ingoa – place names (see footnote 3)</b>	Protect cultural landscapes in consultation with Kāi Tahu. Access to traditional lands and resources.				Rock shelters, caves, rock art, pā site are present. “A well-developed track alongside part of the Arrow River near a distinctive rock shelter containing Māori rock art. Further downstream, a pā site from the Ngāi Tahu period sits up on a ridge.”

<sup>3</sup> Ability to gather mahika kai along the ara tawhito would be a key factor. However, these boxes have been left blank as the relationship between the contemporary use of the ara tawhito and the ability to gather mahika kai at different flows has not been determined.

Values	Objective	Minimum Flow Options			Comments from Kāi Tahu Values Report, Interviews and Iwi Management Plans
		800 l/s	900 l/s	1000 l/s	
<b>Wetlands<sup>4</sup></b>	Preservation of remnant wetlands. Restoration of wetland areas.				Biodiversity values in wetlands.
<b>Recreational use</b>	Naturalness, access, absence of slime				Walking, spotting fish, spending time with whānau. Related to water quality and the presence or absence of periphyton.
<b>Te rahinga o te wai</b>	Connectivity and cultural landscape values. Flows that provide for taonga / mahika kai species, and disallow algal growth.				Concern if river were allowed to flow lower than present levels. Guided by ORC assessment on connectivity aspect.
<b>Tourism</b>					Whanau do not agree that the ORC assessment for tourism at 1000l/s should be orange.

<sup>4</sup> Relationships between flow levels in the river and wetlands have not been determined yet.

**ORC Assessment – Arrow River flow options**

	Unacceptable outcome
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	Desired outcome or better

Values	Objective	Minimum Flow Options			Comments
		800 l/s	900 l/s	1000 l/s	
<b>Natural character</b>	Maintain flow connectivity				The continuous flow of the river was identified as being very important to the community and region. A continuous flow supports recreation use and tourism and all options will achieve an adequate or desired outcome.
<b>Water quality</b>	Maintain / enhance water quality				Water quality is very good in the Arrow and expected to remain the same across the options.
	Water temperature				Indication is that water temperatures within the river will be suitable for all fish species, and effects between the flow options will be small.
<b>Life-supporting capacity - Periphyton</b>	Avoid nuisance growth of Periphyton – <i>Phormidium</i>				Habitat quality was predicted to be similar to that at the naturalised MALF, and hence differences in effects between the flow options will be small.
	Avoid nuisance growths of Periphyton – Didymo				Habitat quality was predicted to be similar to that at the naturalised MALF, and hence effects differences between the flow options will be small. Didymo has been present.
	Avoid nuisance growths of Periphyton – long filamentous algae				A flow of 800 l/s is predicted to increase significantly the risk of proliferation of long filamentous algae (136% of habitat retention), compared with 1000 l/s (119% of habitat retention).
	Avoid nuisance growths of Periphyton – short filamentous algae				A flow of 800 l/s is predicted to increase significantly the risk of proliferation of short filamentous algae (150% of habitat retention), as a result of increased rate of accrual resulting from more favourable habitat conditions. Habitat retention at 1000 l/s is expected to be 133%.
	Avoid nuisance growths of Periphyton – diatoms				Habitat quality for diatoms is predicted to decline with decreasing flows. However this assessment represents desirable, native diatoms, so higher levels of habitat retention are environmentally better with higher flows (59%, 67% and 74% respectively across the flow options).
<b>Life-supporting capacity – macroinvertebrates</b>	Maintain biodiversity				Macroinvertebrate communities dominated by mayflies, stoneflies and caddis flies are considered to be more desirable than those dominated by snails and midges. The former are better food for fish such as trout. All flows support this.

Values	Objective	Minimum Flow Options			Comments
		800 l/s	900 l/s	1000 l/s	
	Maintain food-producing habitat				Across the three flows a similar amount of food-producing habitat measured by habitat for the common mayfly <i>Deleatidium</i> is predicted to occur.
<b>Life supporting capacity – native fish</b>	Maintain Koaro habitat				Only 1 species of native fish present in catchment (koaro), very limited distribution and uncommon. Generally the higher the flow the greater the available habitat for koaro.
<b>Habitat for sports fish (trout)</b>	Brown trout (adult)				Known habitat for trout in Soho Creek and below the confluence, all the flows will support habitat retention.
	Juvenile Trout				Known spawning & rearing habitat for trout and all the flows will support habitat retention.
	Adult Trout (Wilding)				Reflects the slightly different habitat requirements between Brown and Rainbow Trout. Rainbow trout appear to be restricted in distribution to the lower reaches of the Arrow River.
<b>Water surety (irrigation season) – based on ORC data</b>	Average seasonal surety for the years 2013-2017				The average seasonal surety was above 95% for all flows (98.3%, 97.3%, 96.1% respectively).
	Average seasonal surety for a dry season (2015/16)				Seasonal surety would have dipped below 85% , reflecting 84.4% under option 1000 l/s.
	Average number of days below flow a wet season (2016/17)				100% surety is achieved across every flow option during a wet year.
<b>Recreation use</b>	Water based activities (ie swimming, gold panning, fishing)				The greater river flows will result in a reduction of the habitat supporting periphyton, and an improvement in food-producing macroinvertebrates which supports fishing. Hence, the higher minimum flows better support recreation activities such as paddling, swimming and fishing.
	Land based activities (walking, tramping, picnics, social gathering)				The value of river flow to land based activities is reflected in how the flow contributes to the natural character. All flows will support natural character and the recreation activities associated with it, although the higher flow of 1000l/s is moving closer to naturalised MALF and hence better reflects the physical character identified in the values. .
<b>Tourism</b>	The iconic nature of The Arrow River as it flows behind Arrowtown.				Tourism relates to the recreation activities which the natural character and flow of the river support, with activities including fishing, walking, tramping etc. Tourism also relates to being able to take water from the river to support uses such as the golf resorts. Hence there is potentially an opposing requirement for different areas of tourism, particularly at the higher flow. All flow options would achieve a desired outcome, but with potential increased risk of lower water availability for irrigation during a dry year at a minimum flow of 1000 l/s.

