**WESTPOWER LTD PROPOSED WAITAHA HYDRO SCHEME**

**Public River Safety Following Commissioning**


**Report prepared for:** Westpower Ltd

**Report prepared by:** Martin Doyle

**Statement confirming compliance with the Environment Court's Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023**

As an expert witness or peer reviewer, I have read, and I am familiar with the Environment Court's Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023.

I have prepared my, or provided input into, an assessment of effects for the Waitaha Hydro Scheme in compliance with the Code of Conduct and will continue to comply with it in this Fast-track Approvals Act process. In particular:

- my overriding duty is to assist the decision-maker impartially on matters within my expertise;
- unless I state otherwise, my assessment is within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express; and
- I have not, and will not behave as, an advocate for the Applicants.

Declared interests are addressed in Appendix A.

**TABLE OF CONTENTS**


| | | |
|---|---|---|
| 1. | INTRODUCTION | 4 |
| 2. | EXECUTIVE SUMMARY | 5 |
| 3. | METHODOLOGY AND RESOURCES | 6 |
| 4. | EXISTING ENVIRONMENT | 8 |
| 5. | RIVER USERS | 9 |
| 6. | STOPPING AND STARTING GENERATION – EFFECTS ON RIVER FLOWS | 13 |
| 7. | STABLE GENERATION – EFFECTS ON RIVER FLOWS | 15 |
| 8. | RIVER SAFETY DURING A SUDDEN SHUTDOWN | 17 |
| 9. | RIVER SAFETY DURING CONTROLLED SHUTDOWNS AND STARTUPS | 25 |
| 10. | RECOMMENDED RAMP RATES | 29 |
| 11. | CONCLUSION | 30 |
| APPENDIX A – QUALIFICATIONS AND EXPERIENCE – MARTIN CHRISTOPHER DOYLE | | 31 |
| APPENDIX B – PHOTOS OF THE ABSTRACTION REACH | | 32 |
| APPENDIX C – REFERENCES | | 34 |

## 1. INTRODUCTION

1.1 Westpower Ltd (**Westpower**) proposes a run-of-the-river hydro-electric power scheme (**Scheme**) for the Waitaha River, approximately 60 km south of Hokitika on the West Coast of the South Island, New Zealand.

1.2 Westpower have commissioned a report describing safety considerations due to changes to river flow resulting from the Scheme. This report refers to the stretch of river from the top of Morgan Gorge to the coast.

1.3 The Scheme will be run-of-river with no instream storage. The proposed headworks include a low weir and intake structure situated at the top of Morgan Gorge that will divert water into a pressurised tunnel and desander. A pressurised water tunnel will convey the diverted water down to a Power Station below Morgan Gorge. Having passed through the turbines the diverted water will be returned via a tailrace discharging to the Waitaha mainstem in the vicinity of the confluence of Alpha Creek. The Scheme will divert up to a proposed maximum of 23 $m^3$/s, whilst maintaining a minimum residual flow of 3.5 $m^3$/s immediately downstream of the intake. The hydro design includes a 10 cumec bypass valve to maintain water flow following Power Station outages. The abstraction reach will include approximately 2,500 metres of the Waitaha River, including Morgan Gorge. Further effects from starting and stopping generation extend downstream of this point. Further detail on the project design and project background information is set out in the **Project Overview Report** and **Project Description**.

1.4 The Waitaha River is a large volume West Coast River. It frequently carries large flows, and its upper reaches are extremely steep with large boulders, falls, and entrapment hazards, requiring very strong outdoor skills to negotiate. There are potential serious consequences for any person crossing and being in the river, and these conditions exist whether the Scheme is operational or not.

1.5 Westpower commissioned this report to assess changes the Scheme will bring to river safety, specifically the periods of transition when generation is stopped and started. While the consequence of being in the river has not changed, the risk will alter for periods of rising flow, and these are described, quantified where possible, and the probability (likelihood) of these periods coinciding with a person being in the river is calculated to allow development of a safety plan.

1.6 Scope of this report

This report covers river safety issues resulting from the operation of Scheme. In particular it:

(a) explains the flow changes that will occur when the Scheme is stopped or started, referring to information from hydraulic modelling of these changes down the Waitaha River;

(b) describes the environment over which these changes occur and compares flow changes created by the Scheme against natural flow changes;

(c) assesses river safety against flow, velocity and depth measurements made by wading the Waitaha in a variety of locations over a 6-year period;

(d) discusses the risk versus likelihood of these events occurring;

(e) suggests mitigation to be considered by Westpower when it finalises its safety plan.

## 2. EXECUTIVE SUMMARY

2.1 During normal operation, the proposed Waitaha Power Station will not affect river safety at all. When the station starts or stops generation, however, either rising or falling flow changes are imposed on the river. A reduction of flow will have few, if any, safety considerations. An increase in flow however, particularly from an emergency or sudden stop, has the potential to make wading conditions difficult or impossible.

2.2 The use of a bypass valve removes risk when generation flow is less than 10 $m^3/s$, and reduces risk when generation is greater than this.

2.3 The joint probability of an emergency stop considered in conjunction with a person being in a critical section of river is exceedingly small. The hot pools in Morgan Gorge also have an extremely low joint probability for harm to occur from sudden shutdown.

2.4 It is recommended that the risk of emergency shutdowns while people are near or in critical sections of the river are addressed by:

(a) warning signage, including at the hot pools; and

(b) a warning siren at the Power Station.

2.5 During routine operation, a base level ramping rate of generation flow which does not exceed 0.5 $m^3/s/min$ is suggested for safety purposes, with variations to this at low and high flow.

2.6 A safety plan addressing public safety must be provided before commissioning, and adaptive management of ramping rates and the safety plan is strongly recommended following monitoring post commissioning of the Scheme.

## 3. METHODOLOGY AND RESOURCES

3.1 The hydrological record described in Doyle (2025) provides the basis for the analyses of river conditions including the natural flow regime, and changes that occur post construction. The hydraulic modelling report of AusHydro (2025) describes the downstream propagation of changes in flow rate after the generation rate is changed, and analyses the localised conditions at the hot pools. The recreation report of Greenaway (2025) describes backcountry recreational use within the Waitaha Catchment.

3.2 Experience gained from 110 flow gaugings carried out by wading in the Waitaha River and tributaries over a 6-year period provides more than 2,500 individual measurement points. This allows the comparison of flow, depth and velocity versus ease of wading to understand the hazard in variety of substrates, flows, visibility, temperatures and algal conditions. Multiple river crossings made in transit along Kiwi Flat, Whirling Water and the section below Morgan Gorge provide further observations of hazard and consequence. These observations are combined with wading safety assessments at many other locations, and are in turn related and compared to the wide-ranging wading ability of other Hydrologists and trampers (observed and in some cases documented) in a number of other New Zealand rivers.

3.3 The likelihood of an event is calculated from the joint probability of a flow change occurring within a given period, and the opportunity for that to occur within a critical flow range, also when a river user might realistically be expected to be there. Finally, mitigation controls are suggested to allow the development of a safety plan.

### River section names

3.4 The following names and descriptions relate to sections of river which will be referred to throughout this report:

| | |
|---|---|
| Kiwi Flat: | The section above Morgan Gorge and below Waitaha Gorge |
| Abstraction reach: | The section from the intake to the Power Station |
| Morgan Gorge: | From the intake downstream to the bottom of Morgan Gorge |
| Boulder Garden: | From bottom of Morgan Gorge to the Power Station |
| Below Power Station: | From the Power Station to the braided section |
| Braided section: | Starting 1 km below Macgregor Creek confluence until just above the road bridge |
| Coastal section: | From just above the road bridge to the coast |

**Scheme components relevant to this report**

3.5 The following diagram provides a simplified schematic of the critical scheme components relating to this report, being the intake, the penstock, the generation units and bypass valve. It also shows the river section above the Power Station and the location of the hot pools.

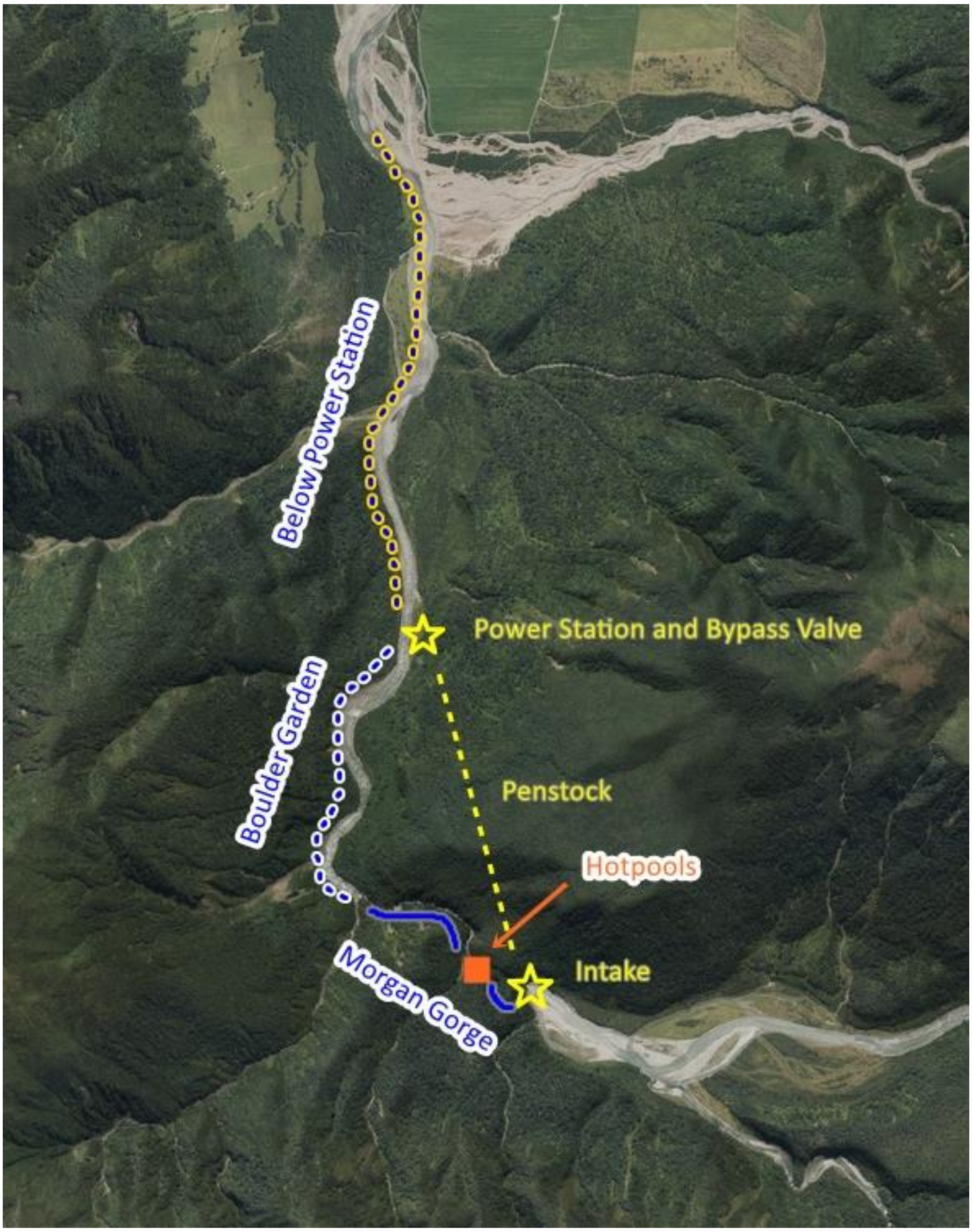


**Figure 1 - Components of the Scheme**

## 4. EXISTING ENVIRONMENT

4.1 The river environment of the Waitaha is typical of many rivers in South Westland draining the main divide with high rainfall, snow and glacial melt creating changeable flow conditions. These range from low, clear winter flow through to a boisterous and turbid flow period during the meltwater season, with frequent large powerful floods occurring at any time. The river at various locations flows through gorges, steep bouldery sections or shallow gradient flats. Changes in flow vary from gradual recessions and slow increases from melting snow and ice, to rapid rises due to intense rainfall.

**The nature of the river throughout various sections**

4.2 On Kiwi Flat, the river flows through a series of fast runs and small rapids, with substrate ranging from sand and gravel to large boulders. This section is upstream of the Scheme and not affected by it, but is mentioned for comparison. At lower flows wading is relatively easy for a competent backcountry traveller.

4.3 Below the proposed intake and within Morgan Gorge, sheer rock walls enclose a narrow canyon, with pools, drops, aerated water and entrapment hazards combining with extreme difficulty to escape that environment. This means the gorge has been traversed only by a small number of extreme kayakers. Here the river drops approximately 80m over 1,200m of river distance.

4.4 Through the Boulder Garden section immediately downstream of Morgan Gorge, the river progressively loses gradient with distance downstream, but remains steep compared to most rivers. As is typical, the substrate also changes with gradient, from very large boulders below the gorge to large boulders by the Power Station location, creating difficult wading conditions and entrapment hazards. The section is essentially one long turbulent bouldery rapid, with several pools becoming obvious at lower flow. Velocities remain fast at higher flows and turbulence from the large boulders is typical throughout.

4.5 Below the Power Station the river gradient continues to shallow, and while large boulders are common down as far are Macgregor Creek, the bed material becomes smaller in size as the gradient shallows, finally becoming predominantly cobbles, gravels and sand near the coast. Below Macgregor Creek the river splits into braids for much of the distance to State Highway 6, these braids in turn consisting of rapid, run and pool sections. Near the coast the river is single threaded and is boosted by the Kakapotahi River.

## 5. RIVER USERS

5.1 The report of Greenaway (2025) provides detailed information on recreational use within the Waitaha Catchment. While the pursuits near the mouth of the Waitaha River are ‘’gentler’ in nature, the activities above the power station location require people who are strong and experienced in backcountry travel, and sometimes extreme skills are required. Regarding the potential for river safety issues arising from the Scheme, the following river uses are considered.

### Hot pools

5.2 People walking to and bathing in the hot pools are likely the most common users of the Boulder Garden section (above the Power Station). They typically travel up the Waitaha River from Macgregor Creek and wade the river through the Boulder Garden section or swim one of several pools below the bottom of Morgan Gorge. From here a sidling track takes them to the hot pools. Other people may walk up the rough track on the true right to the swing bridge at Kiwi Flat and then travel downstream on the true left to the hot pools, perhaps as part of another activity such as canyoning in Whirling Water. At the hot pools there is a need to climb down a steep rock face and many people would use a rope for this latter section. Accessing the pools therefore, requires a person to have experience and strength in river crossing, rough back country travel and either some confidence with rock climbing, or rope skills.

### Hunting

5.3 Limited hunting opportunity exists on the river banks above the Power Station and below Morgan Gorge, and most hunters instead walk into Kiwi Flat up the true right bank. Some limited hunting, probably at the goodwill of farm owners, takes place on the flats below the power station but this doesn’t require crossing the river. It is reasonable therefore to expect very few hunters to be crossing the river in the residual flow reach, unless they were carrying a rifle opportunistically en-route to the hot pools.

### Fishing

5.4 Very little fishing takes place in the river below the Power Station, and virtually none above. Some fishing occurs at the coastal margin. People who regularly fish rivers, like kayakers, become attuned to river conditions, and by their very activity are continually looking at depth, velocity, substrate and eddies.

### Jet Boating

5.5 Some limited jet boating occurs in the lower river, and very occasionally through the area which will become the residual flow reach. It is extremely unlikely a jet boat will be able to travel through the residual flow reach when the residual flow is a 3.5 $m^3/s$, the river being too shallow and bouldery.

### Kayaking

5.6 Kayaking is outside of the scope of this report. The key issue relates to kayakers traversing Morgan Gorge and this is a specialist topic and covered by a separate agreement between Westpower and the kayaking community. Kayakers may launch below Morgan Gorge after portaging the Gorge, or as a separate trip.

**Canyoning, tramping and alpine travel/climbing**

5.7 Canyoners walk into Kiwi Flat via the rough track up the true right of the Waitaha River to access its tributary Whirling Water. Trampers and climbers also travel up the true right to Kiwi Flat and beyond. This does not bring them into conflict with river safety issues from the operation of the Scheme. No record can be found of any canyoner attempting Morgan Gorge, the gorge being an extreme water challenge rather than one for canyoners to abseil through.

**Picnicking, occasional swimming etc**

5.8 Some people access the gravel beach near the State Highway 6 bridge, or near the coast from Beach Rd. While there are several paper roads accessing the Waitaha River down the main flats below the Power Station, none of these appear to be formed. Consequently, there is little casual access to the river outside of the coastal area.

**White baiting**

5.9 The Waitaha is not known as a premier white baiting river, nevertheless, it sees some people fishing for whitebait near the river mouth.

**Existing river safety for river users**

5.10 This report considers river safety only from the perspective of unforeseen rises in river flow, this being the element that changes if the Scheme is constructed. The nature of river safety in natural conditions is discussed below.

5.11 The Waitaha is a high-volume West Coast River. It carries large flows at times, and is often turbid, even at relatively low flows. River use is most common in the upper catchment or close to the coast. Like virtually all West Coast rivers, there are heavy consequences for bad decisions made crossing the river and tributaries of the upper catchment, but this is self-regulating in effect, as only very strong back country travellers are able to access these locations. Near the coast, like all West Coast rivers, care is needed at the river mouth.

5.12 The Waitaha River flow rises relatively quickly. Usually, these rises will be signalled by widespread rainfall, but some moderate rises occur from snowmelt. On occasion, sudden rises will occur in small tributaries from localised convectional rainfall (the West Coast has more of this activity than anywhere in New Zealand) and these can create very rapid rises in smaller rivers. These localised rises in flow reach the mainstem river, but the large volume of that channel quickly attenuates that effect. **Figures 2 and 3** show the rate of natural river rise at the bottom of Kiwi Flat. The data is derived from the flow record at the top of Kiwi Flat and adjusted pro rata for Whirling Water, and as such, it will underestimate the rate of rise at the intake and below, as Whirling Water, Glamour Glen and Anson Creek will all at times push a sudden surge of flow into Morgan Gorge.

5.13 The two plots show river rise as an absolute value ($m^3/s$), and a percentage rise. No analysis is provided for high flows, as normal recreation is impossible in these conditions, and the effect the Scheme has on high background flows is very small in any case (kayaking is not considered in this report). While they illustrate natural conditions, these rates of rise are less useful for considering river safety at low flow in a big river. Unless someone remained in a particular spot at the edge of their wading ability, and also had dangerous downstream conditions, the extra flow is diluted across a broad cross section and just restricts their current activity.

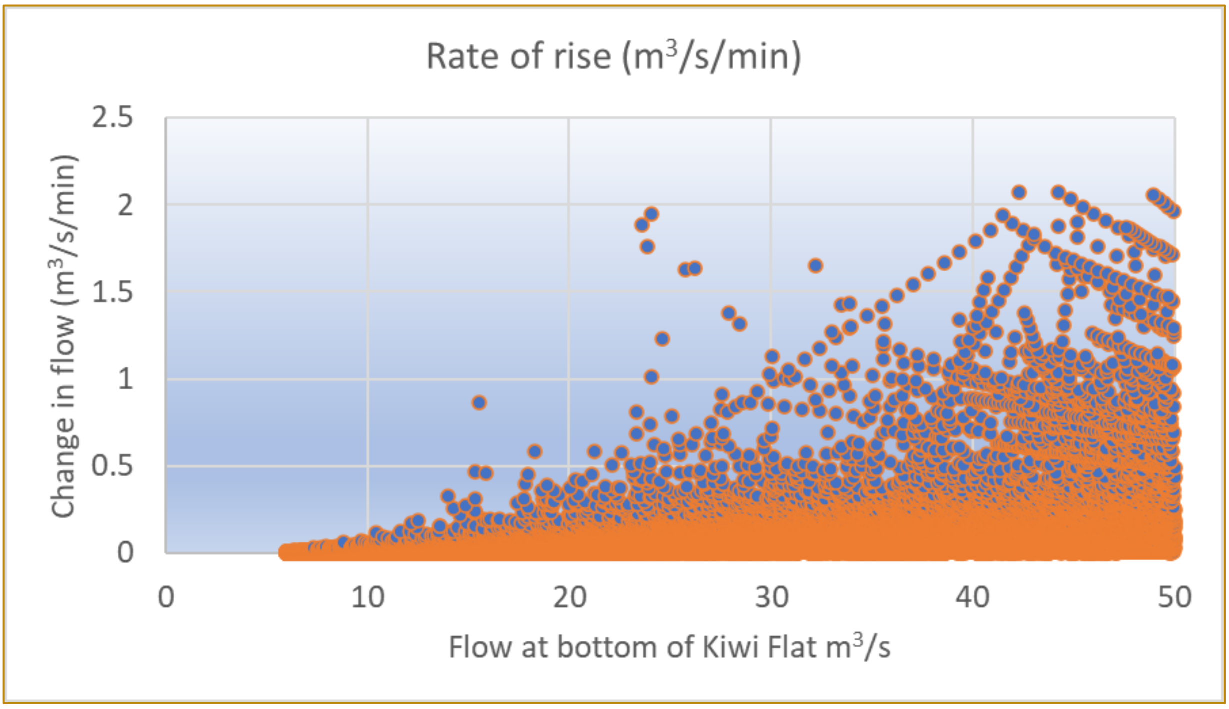


**Figure 2 - Natural rates of rise (m³/s) as measured at the bottom of Kiwi Flat**

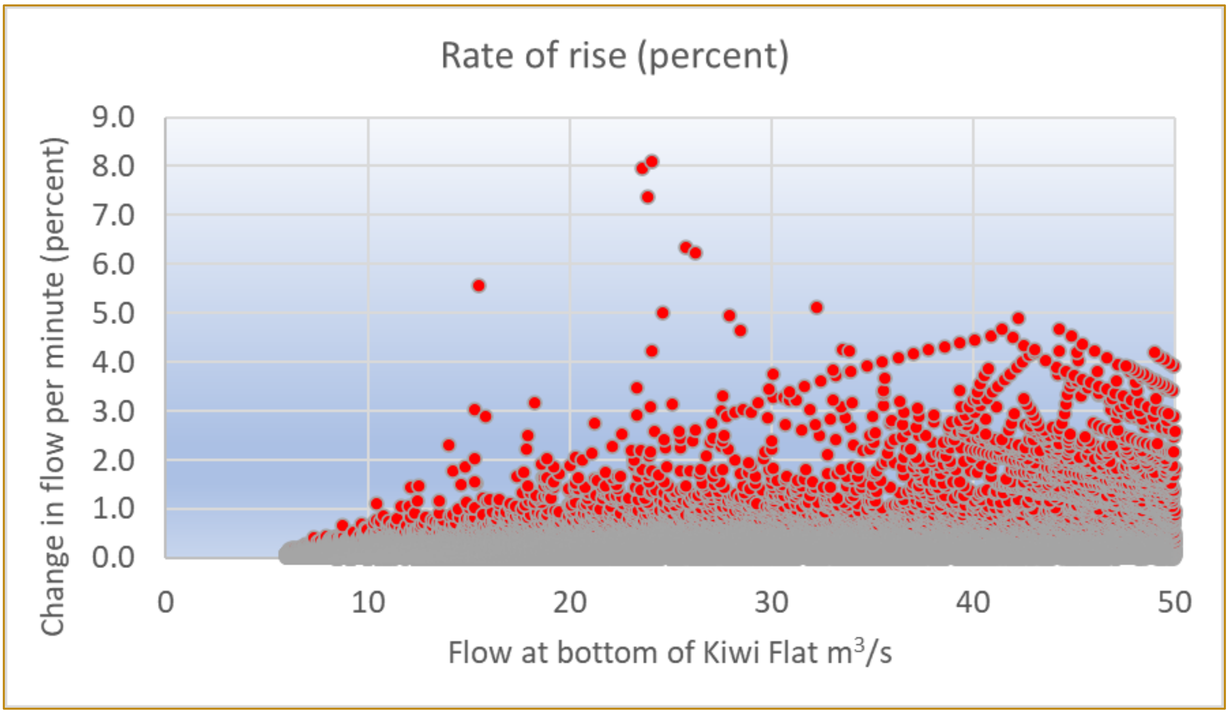


**Figure 3 - Natural rates of rise (%) as measured at the bottom of Kiwi Flat**

5.14 The report of AusHydro (2025) uses a diagram (**Figure 4**) to illustrate Depth versus Velocity (D.V.) thresholds for people's stability in flowing water. What is not shown in the D.V diagram, are the components outside of depth and velocity that allow a person to maintain their footing in a river, these including substrate and turbulence, with slippery substrate increasing the hazard, and turbulence providing surges or 'pushes'. Importantly, the D.V. diagram does not consider consequence such as downstream runout and entrapment danger. The Waitaha River typically has substrate which is not slippery, but turbulence can be high, and in addition the water is often dirty, restricting the view of the river bed. While these aspects are not shown in Figure 3, it provides a useful backdrop to any discussion in this report.

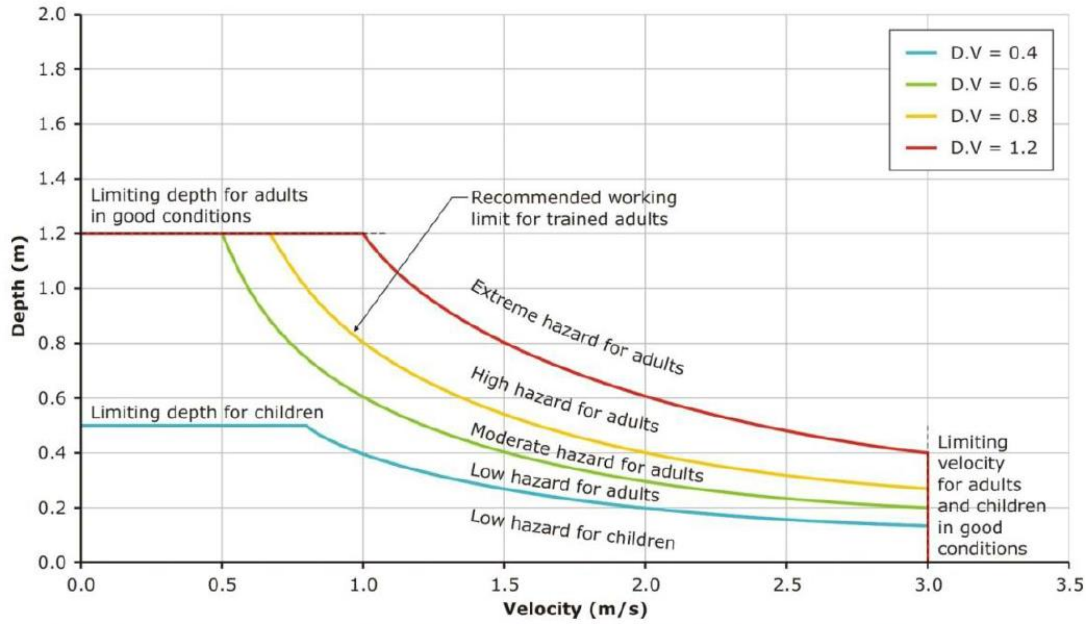

*Figure 6-16: Thresholds for people stability in floods (from Smith et al (2014), after Cox et al. (2010)).*

**Figure 4 - Stability thresholds for people in flowing water – from AusHydro (2025)**

5.15 The D.V. curves shown above are specific to a single location point, and they cannot easily be used to model hazards along a long reach of river. Instead, this report uses wide experience across many New Zealand rivers and a hydrological understanding of the changes that will occur through each reach. In addition, considerable time both standing in and crossing the Waitaha River and tributaries provides a basis for translating theoretical estimates of hazard to wider wading safety for this report, all in the context of a rising river – this being the change that the Scheme brings to river safety.

## 6. STOPPING AND STARTING GENERATION – EFFECTS ON RIVER FLOWS

6.1 Periods of stable generation create conditions which only alter the flow in the residual reach, and other parts of the river continue to flow as before. The residual flow reach is stable for around 66% of the time, and for the remainder of time changes in sympathy with natural flow changes.

6.2 Either stopping or starting generation, however, introduces a change in timing and storage of water throughout the system. The pressure tunnel and penstock are a closed system and remain full of water and are able to react nearly instantly to any change in generation – much like a garden hose with a fitting on the end that can be turned on and off. The natural system, however, is an open system and will take some time to reach a balance. This contradiction between the closed pipeline and the open river system introduces an effect on the river from the intake to well below the Power Station. When the Scheme stops operation there will immediately be less water in the river below the Power Station for a period, and when the Scheme starts operation, conversely there will be extra flow for a period. At the same time the opposite effect occurs upstream; when the Scheme stops operation more water begins to flow below the intake, and when it starts, there is less flow in the residual flow reach.

6.3 Routine changes in generation flow will ramp up or down slowly with muted effects on the river. Occasionally an emergency stop is required, however, such as when the transmission load is removed from the power network, with this occurring approximately 4 times per annum. During an emergency shutdown the reduction in generation flow occurs very quickly, typically over about 1 minute, introducing much faster changes to flow in the river. These changes in river flow following a change in generation flow propagate downstream from the intake in different ways depending on the nature of the change (increase or decrease, rate of change).

6.4 The process of starting and stopping generation is a necessary part of operating a hydro power station, and the resulting increases and decreases in flow are common across most hydro power stations worldwide. The changes can be mitigated by the use of bypass devices, warning devices and signage. Unless warning is provided, these changes in flow have the potential to catch a river user unawares.

### Bypass valve

6.5 To reduce the effects of stopping the Power Station during an emergency shutdown or during a routine startup, a bypass valve will be installed at the Power Station which can pass a flow of 10 $m^3/s$. This has the following beneficial effects during a sudden shutdown:

(a) When the generation flow is less than 10 $m^3/s$, that flow can be completely controlled by the valve thus creating a controlled transition.

(b) When the generation flow in greater than 10 $m^3/s$, the valve will reduce the effect of the change in state, with the worst-case situation creating a flow change in the river of 13 $m^3/s$.

6.6 The valve also allows flow to be introduced to the river downstream of the Power Station prior to a startup, reducing the time required to bring the station up to full generation, and reducing the magnitude of the temporary flow change downstream.

**Hydraulic modelling**

6.7 To help understand the effects on the river system due to changes in generation rate from starting or stopping generation, hydraulic modelling was carried out and is described in AusHydro (2025). The permutations are enormous, and despite the detailed and thorough nature of the report, the results can only give examples for some situations and locations to build a sense of what occurs elsewhere, and this must be combined with intuition, experience, and hydrological data to provide advice.

## 7. STABLE GENERATION – EFFECTS ON RIVER FLOWS

7.1 For the vast majority of time, the Scheme will create stable flow conditions downstream of the intake. For the section from the intake to the Power Station, the flow will remain at 3.5 $m^3/s$ for around 2/3 of the time, bolstered by smaller tributaries. As the natural flow increases, so do the tributary inflows, and once the natural flow exceeds 26.5 $m^3/s$ above the intake, 'excess' flow begins to flow over the intake. As natural flows increase above this level, so does the proportion of flow bypassing the intake, until a point is reached when residual flow closely approximates natural flow. Above 250 $m^3/s$ generation stops and natural flow exists throughout the full river system.

7.2 Below the Power Station the river flow will be in balance with what is occurring above the intake and apart from a slight shift in timing, will behave in its natural state. Any effects of the Power Station on river safety when generation is stable are therefore too small to be noticed, and any issues only arise when the Scheme stops and starts operation. If the generation flow is altered to match river flows, this will occur in sympathy with the river, and therefore doesn't introduce additional safety issues.

7.3 River conditions during stable generation are briefly described below for a variety of locations:

(a) Morgan Gorge

A description of conditions within the Gorge is outside of the scope of this report, except for the location at the hot pools. Otherwise, safety in the Gorge is considered in an agreement between WWNZ and Westpower, this requiring specialised knowledge and being very specific to the kayaking community. It's worth noting, however, that travel of any sort in the gorge requires specialised and extreme skills.

(b) Boulder Garden

The Boulder Garden is within the residual flow reach and will remain at 3.5 $m^3/s$ for 66% of the time, broken briefly by frequent floods and freshes. In comparison, natural flow conditions below 8 $m^3/s$ occur only 6% of the time naturally, with none recorded in summer months. This river section is continually boosted by flows from small side creeks, and at median flow, these side creeks provide an additional 0.7 $m^3/s$ of flow.

When the residual flow occurs, the Boulder Garden will be easier to traverse for a competent outdoors person. The relative lack of flow during these periods means the dry river edge will be wider, and wading the stream will be possible in many places - the water will be less fast, less deep, and less turbulent, and the river bed will be visible for much longer periods of time. Even so, traversing this section of river is only suitable for a competent and experienced river user. An upper boundary of 15 $m^3/s$ is suggested as wadable (with caution) at carefully selected locations near the Power Station (again, for a competent and experienced river user). **Appendix A** shows photos through this section for flow conditions ranging from 8.5 to 25 $m^3/s$.

(c) Downstream of the Power Station

During periods of stable generation, the river conditions downstream of the Power Station mimic the natural flow regime. The river can be waded at lower flows, but still requires skill and care, with an estimate of 15 $m^3/s$ (as measured at the intake) also being the upper boundary for a competent and experienced river user. This flow or less occurs for 35% of the time. The actual flow in this immediate downstream location is some 3.5 % greater than this due to tributary inflows, but the reference to the intake allows comparison to flow statistics. Not far below the Power Station several tributaries boost flow even further by some 15%, reducing the ability to wade the river.

(d) The braided section

Through the braided section the environment becomes more forgiving, and flow conditions are stable and predictable while generation is occurring. While this section still requires care, the hazards are far less than in the residual flow reach. At the lower end of this section Ellis Creek provides a boost in flow, only significant during periods of low flow.

(e) The coastal section

The river becomes a single thread through this section, and flows have increased due to groundwater contribution and the input of the Kakapotahi River near the coast. Compared to the upper catchment, the river is less steep and conditions are relatively benign in lower flows, and stable generation ensures no surprises. Near the coastal margin the ocean comes into play, with a bar present, and ocean surges able to come into that margin.

## 8. RIVER SAFETY DURING A SUDDEN SHUTDOWN

8.1 When the flow through the Power Station is altered due to an emergency stop, rapid changes in river flow are possible and require management. **Section 5** describes why these changes occur, and detailed information on this aspect is provided in the hydraulic river modelling report of AusHydro (2025). Examination of the natural flow record (**Figures 2 and 3**) did not find any occurrences of sudden rises in flow of the magnitude expected by a sudden shutdown, except when the river was already flowing high. The latter is not a fair comparison in any case from a safety viewpoint, the natural rises being a rainy-day situation when they could reasonably be expected, whereas an emergency stop could well occur on a sunny day, although many of these are indeed caused by bad weather

8.2 The Mountain Safety Manual "*Bushcraft – Outdoor Skills for the New Zealand Bush*" describes the effects of sudden rises in flow as they occur naturally, in a river user context. Pages 241 - 242 refer to the situation "When rising waters arrive at a location". The following italics are taken from the manual and provides the below examples of who this could be dangerous for:

- *A fisher who is on an island or in the main body of water*
- *A person negotiating a confined gorge without escape routes*
- *An inexperienced kayaker on a river*
- *A large group making a slow river crossing*

*A rise like this is unlikely to catch an alert person or a small experienced group unawares while making a single river crossing, unless it was a particularly difficult and slow crossing.*

8.3 The effect on the river when the Power Station stops over a short period results in a relatively quick *increase* in flow past the intake, potentially as much as 13 $m^3/s$ after mitigation by the bypass valve. The flow increase propagates downstream, arriving at the Power Station some 25 – 30 minutes later and persisting much of the way to the coast, although it attenuates and become less pronounced as it moves downstream. **Figure 5** shows the change in river flow downstream of the Power Station for a worst-case situation. The line of interest is the orange line which incorporates the use of a 10 $m^3/s$ bypass valve. Initially, the flow in the river drops as there is no generation flow, and then after a period the flow increase over the intake arrives at the downstream location. This effect repeats, as the bypass valve then needs to be shut down, and this is shown by the dotted orange line.

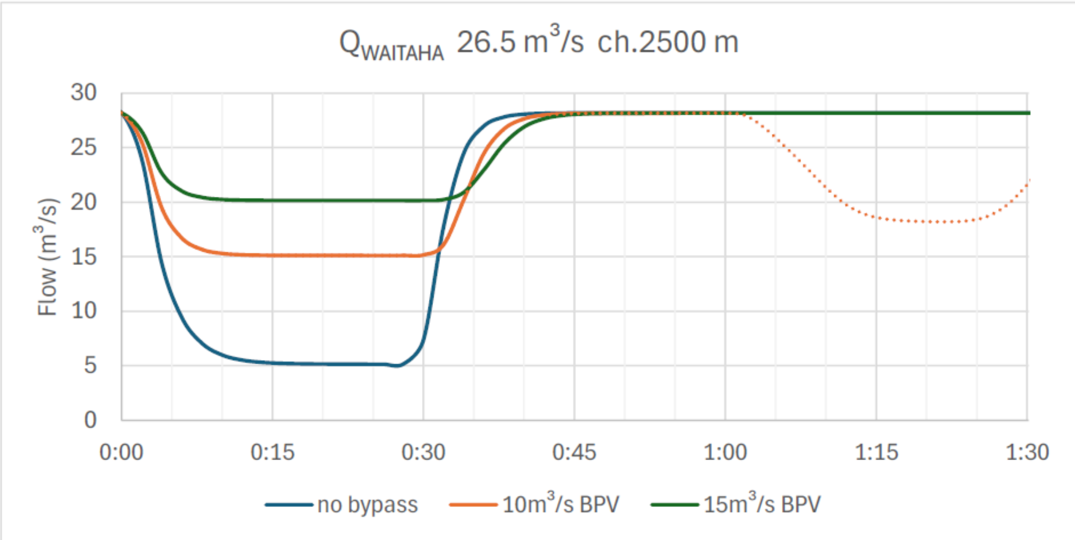


*Figure 5-1: Modelled flow in Waitaha River at model chainage 2500 m (100 m downstream of power station) for three power station flow rejection scenarios, $Q_{WAITAHA}$ = 26.5 m$^3$/s*

**Figure 5 - The effect of a sudden shutdown (flow rejection) on river flow below the Power Station for the worst-case situation. Taken from AusHydro (2025)**

8.4 The effect of an emergency stop is best considered over three reaches of river and excludes Morgan Gorge except for one specific location, the hot pools. The increase in flow in Morgan Gorge is part of discussions between Westpower and the kayaking community. This is addressed in the Project Overview and Recreation Reports.

**Hot pools**

8.5 The hydraulic modelling of AusHydro describes the nature of the changes in flow down a long length of river and quantifies various aspects such as timing and depth changes at general locations. It was also used to quantify the direct effect of an emergency stop at a *specific* location – the hot pool ledge. This required modelling to see the magnitude of change and the nature of the risk at this location, including the flow range at which a change would begin to inundate the hot pool ledge. From combining the hydraulic modelling with the hydrological data, the following conclusions are drawn:

- A flow at the hotpools of about 50 m$^3$/s is required before inundation of the ledge occurs. AusHydro's work suggests the worst-case situation is a residual flow of 42 m$^3$/s (natural flow above intake 65 m$^3$/s).
- This worst-case situation would see an increase of 13 m$^3$/s over a period of 4 minutes, with the bypass valve having reduced the flow 'spilled' from 23 to 13 m$^3$/s.
- The window of risk is the natural flow range 50 – 65 m$^3$/s and this occurs for 7% of the time. This halves to 3.5 % when daylight hours are considered (that is, night time is excluded), and can be further reduced due to bad weather or external factors that deter visitors or it is reasonable to assume no one would visit.
- Furthermore, the hot pools cannot practically or safely be accessed via the route up through the boulder garden at these flows.

- It is a short distance to escape the hot pool ledge, should a person be there when an emergency stop occurred and flow across the ledge began.
- The first stage of inundation of the ledge is not particularly dangerous for competent people, considering the depth and velocity that would occur. Only agile and competent people can realistically access the ledge.

8.6 There is a brief period when the river rises at the hot pools that is a potentially dangerous aspect created by the operation of the Scheme. The probability of someone being at the hot pools when this occurs can be calculated as follows:

- About 4 emergency shutdowns are expected per annum, assume 2 per annum in daylight hours.
- Each rise in flow lasts about 4 minutes, so on average there are a total of 8 minutes of hazard in daylight per annum which is 0.00003, or 0.003% of time.
- The window of flow when inundation of the ledge can occur is 0.03 (< 3.5 % of time)
- Assume a generous 20 visits per annum to the pools, each lasting 2 hours, giving a total of 2,400 minutes per annum which is 0.009, or 0.9% of time.
- These probabilities can be combined as follows:

Probability of a station induced surge arriving at the ledge while a person is there

$= 0.00003 \times 0.03 \times 0.009 = 8 \times 10^{-9}$ (or, 0.0000008 %)

This probability is extremely small, and to put this into perspective, the risk of at least one 200-year flood occurring each year for a given river location is 0.005, or 0.5 %. This is a typical design level to which stopbanks are built to protect townships.

8.7 Mitigation to address the extremely small risk someone is on the hot pool ledge during an emergency shutdown is considered below.

The risk at the hotpools if a sudden rise in water arrived from an emergency shutdown can be mitigated as part of a safety plan for the operation of the Scheme. Consideration includes signage and education of the hot pool community via websites (e.g. Westpower, DoC, and NZHotPools.co.nz). There are a number of natural points for signs that can be considered such as on the rough track just before the hot pools, the start of the track to Kiwi Flat, at Kiwi Flat hut, at the natural choke point created by the Power Station, and the track from the swing bridge to the hot pools. While a siren will be utilised at the Power Station, it’s unlikely to be heard at the hot pools.

**Boulder Garden**

8.8 Through the Boulder Garden, the river is still relatively steep and even at lower natural flows has velocities strong enough to be dangerous. Large boulders create eddies and other turbulence and entrapment hazards exist, meaning the consequence of the hazard is high at any time. When the residual flow of 3.5 $m^3/s$ is occurring however, it will be much easier for people to cross the river at selected locations through this section for long periods. There are two positive aspects to this: the consequence of losing your footing, at least in the lower sections, will be much less serious, and there will be a very obvious transition between seeing the river can be crossed relatively easily, to a strong sense of "stay well away from this river". The matter of consideration then, is the period when a sudden change in flow occurs, and can people be reasonably informed that this might happen, and warnings be provided when it does.

8.9 Normally, with natural flow the river through the lower part of this section could be crossed by wading up to 15 $m^3/s$ for a competent river user (around 30% of the time), and some people swim the river at a longish pool, which is likely possible for 60% of the time, although many people would consider this to be risky at the upper range of this flow. With generation occurring this will open the opportunity to wade or swim the river for 66% of the time for less competent people. This increases the opportunity for people who are less capable in the outdoors to visit the hot pools. This in turn may create the situation where people have crossed the river while generation is occurring, and then find they are unable to return if generation stops (and the residual flow increases markedly). There could be pressure to attempt to swim back, with the alternative to remain on the opposite bank, possibly without adequate warm clothing etc, or walk upstream to the bridge and down the true right of the river.

8.10 Without mitigation in the form of signage and a warning siren, if someone happened to be crossing the river on the extremely infrequent occasions when an emergency stop occurred, there is potential for them to be swept off their feet through this section. If the 'worst case' 13 $m^3/s$ increase in river flow from a sudden shutdown occurred, the rise would take place over some 6 – 8 minutes. While this may seem relatively slow, if someone was unaware of the change and was caught at a critical point of crossing, there would be a risk of them losing their footing.

8.11 The bypass valve removes or reduces risk of surge through this section. If the generation flow is less than 10 $m^3/s$, no increase will occur in the residual flow, except maybe for very small changes. For larger flows it means the flow change is slower to arrive, slower to build, and less severe in effect.

**Quantifying the risk**

8.12 The nature of the flow change and its impact on river safety can be considered as an increase relative to the natural flow upstream of the intake and the residual flow. This is shown in Figure 6. The bottom axis shows natural river flow above the intake. These flow values are selected so that each vertical line equals 5% of time on average. The left axis relates to the additional flow that will arrive after a sudden shutdown (orange line), and residual flow (blue line). The right axis relates to the yellow line and this shows the flow increase relative to what the residual flow is at any time. Use of a 10 m3/s bypass valve is assumed in these calculations. To provide examples from the plot, the following can be seen:

- Should a sudden stop in generation and resultant 'surge' occur when the natural flow is 25.7 m³/s, the flow will increase by a factor of 2.8 above the residual flow at that time. This ignores attenuation of the surge, which will reduce this factor.
- The increase factor exceeds 1 (residual flow is doubled) for 7 vertical lines, or 35% of the time that a shutdown occurs.
- The increase factor exceeds 2 (residual flow is tripled), for 2.5 vertical lines, or 12.5% of the time a shutdown occurs.
- The flow range of high risk is determined by a doubling of the residual flow from 3.5 to 7 m³/s at the lower end, and residual flow exceeding 15 m³/s at the upper end, after which you wouldn't expect anyone to be crossing the river.
- This flow range when difficult conditions are created for someone in the river, unless they are in shallow water, is for natural flows between 17 and 42 m³/s. This covers about 42% of all time a surge could occur.
- The probability of a surge occurring, is far, far less than this and must be considered with the probability of someone being in the water at that very time.

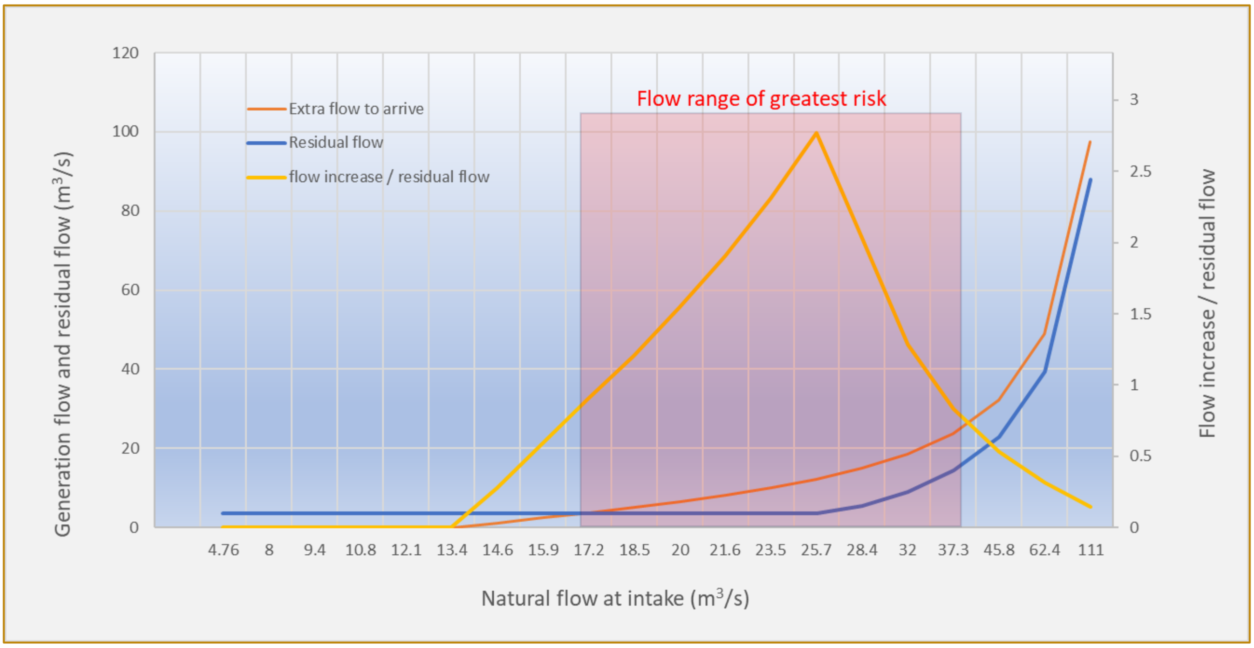


**Figure 6 - Flow and percentage of time when wading risk in the Boulder Garden is greatest for an emergency shutdown situation.**

8.13 The probability of a surge arriving when a person is wading the Boulder Garden is considered below

The probability of a surge occurring is extremely small, with about 2 daylight occurrences per annum, spanning a total of 14 minutes of rising water in the Boulder Garden. If we assume there are 20 occasions per year where people traverse the Boulder Garden, and each time they spend 3 minutes crossing the river, there are 60 minutes per annum of exposure time to river conditions. Additionally, the probability that the flow range is in the risky range is 42%, and the three probabilities are then calculated on an annual basis:

- Periods of rising surge will occur 14 minutes out of 262,800 daylight minutes = 0.00005, or 0.005% of time
- Person in river is 60 minutes out of 262,800 daylight minutes = 0.0002 or 0.02% of time
- Risky flow range is 0.42 (42%)

The three possibilities are independent and can be combined into a joint probability:

Probability of a station induced surge arriving when a person is crossing the Boulder Garden

$$= 0.00005 \times 0.0002 \times 0.42 = 4 \times 10^{-9} \quad \text{(or, 0.0000004 \%)}$$

As for the hot pools, this probability is exceptionally small, and the overall risk potential is less than this again, as more emergency shutdowns occur in bad weather when people cannot reasonably be expected to be crossing the river.

(a) Mitigation

Despite this low probability of occurrence, the risk of being caught by a sudden rise in water when crossing the river through the Boulder Garden section can be mitigated by signage and warning siren(s). The public need to pass the Power Station to walk up the river above that point, and this creates a natural 'choke point' for walkers and provides the opportunity to warn of potential sudden rises. A siren placed at the Power Station and triggered upon an emergency stop, will provide ample warning for people to leave the river, as any rise in flow will arrive some 15 – 30 minutes later depending on location. Other tools such as education through user groups can further reduce the risk. The use of an electronic sign to warn of an impending and planned shutdown or startup is recommended, particularly for the startup phase which will always be managed. It may be beneficial to anonymously record the passage of people past this location by use of a swing gate or an overhead time lapse camera or similar.

**All sections below the Power Station**

8.14 Contrary to the residual flow section which has an *increase* in flow after a sudden shutdown, the effect on the river below the Power Station will firstly be a *reduction* in flow, or even no change if the bypass valve can full compensate. After a period of some 25 – 30 minutes, flow will arrive from the intake, and will then begin to *increase* river flow again to the conditions experienced before the shutdown. Compared to the Boulder Garden, the increase is attenuated and more muted, with the attenuation increasing as the flow change travels downstream.

8.15 From the Power Station to the start of the braided section the river remains in one thread, velocities are relatively high and substrate, while reducing in size, remains large. Public can access this part of the river but little recreational use is made of his section.

8.16 Below Macgregor Creek, the river braids and flow is often split across a number of channels with riffles, runs and pools, and the size of substrate reduces further. Access to the river is heavily curtailed and river use is low, with fishing being the only likely activity, and that of low frequency. Fishing people are highly attuned to the river environment and generally understand river hazards, and this, along with the increasingly benign nature of any surge the further downstream the pulse of water goes, means the risk through this section is greatly reduced. It's worth noting that many rivers across New Zealand that are controlled by hydro power stations are popular fishing spots.

8.17 Just upstream of State Highway 6 there is access to the river bank on the true left, but use is low. The effects of a sudden stop in generation will be very muted by this point. Nevertheless, the visibility of the river from the bridge and proximity to the State Highway may tempt inexperienced people to the river banks. Access is via one track and allows for signage to be placed to capture all visitors.

8.18 Below the State Highway, Beach Road leads to the coast where white baiting occurs in season along with some fishing (e.g. Kawahi). This is a dynamic environment, and the Waitaha River has been swelled by the input of the Kakapotahi River which will 'dilute' the effect of any flow changes, although hydraulic modelling indicates these are unlikely to be visible at this location in any case.

8.19 For the worst-case situation, just below the Power Station the drop in flow occurs over 7-8 minutes and the subsequent increase takes 8-9 minutes, the rise starting 30 minutes after the station shutdown. At the start of the braided section another 2.5 km downstream, the decrease takes 20-25 minutes to occur and the rise takes 12 minutes. This reduction in effect (flow change) continues downstream, and AusHydro conclude that the flow changes will be imperceptible by the time they reach the coast. **Table 1** is taken from AusHydro report, and the worst-case situation is highlighted. It shows the rate of change of flow for the following distances below the Power Station – 0.5km, 2.5km, 5.0km, and 10 km. The coast is 22.5km below the Power Station. It can be seen that just below the Power Station the maximum rate of change of flow increase is 2.1 $m^3$/s/min, and reduces to 0.4 $m^3$/s/min at a point 10km below the Power Station. The latter rate is within the natural rate of rise of the river.

**Table 1 - Rates of change of flow increase down the river – taken from AusHydro (2025)**

*Table 5-3: Maximum rate of change of flow **increase** in Waitaha River following load rejection ($m^3$/s per minute)*

| River Flow $Q_{WAITAHA}$ | Power Station | Downstream headworks | Downstream station | Start of braiding | Model extent |
|---|---|---|---|---|---|
| | | ch. 500 | ch. 2500 | ch. 5000 | ch. 10000 |
| 16.5 $m^3$/s | No bypass | 4.3 $m^3$/s/min | 2.5 $m^3$/s/min | 1.4 $m^3$/s/min | 0.5 $m^3$/s/min |
| | 10 m/s BPV | 0.7 | 0.3 | 0.2 | 0.1 |
| | 15 m/s BPV | - | - | - | - |
| 26.5 $m^3$/s | No bypass | 6.9 | 5.2 | 2.7 | 0.9 |
| | 10 m/s BPV | 4.3 | 2.1 | 1.1 | 0.4 |
| | 15 m/s BPV | 2.6 | 1.2 | 0.6 | 0.3 |
| 36.5 $m^3$/s | No bypass | 7.2 | 4.2 | 2.2 | 0.8 |
| | 10 m/s BPV | 4.2 | 2.1 | 1.0 | 0.4 |
| | 15 m/s BPV | 2.4 | 1.1 | 0.6 | 0.3 |

8.20 Risk, probability and consequence

Throughout the section from the Power Station to the coast, the exposure to risk from a rise in flow is less than the Boulder Garden, which is extremely low. This is based on the following factors:

- Only two sudden shutdowns are expected per annum in daylight hours on average;
- Any surge in flow is increasingly attenuated as it travels downstream, eventually becoming benign;
- Any rise in flow in preceded by a drop in flow – alerting river users to unusual conditions;
- Use of the river is very limited, and where higher use may occur near the coast, the transitory surge from the Power Station will be unnoticeable, or at worst extremely muted.

The probability of a person being in the river when hazardous conditions are created from an emergency shutdown are therefore less than through the Boulder Garden, and as these probabilities are extremely low, for this reason they are not recalculated for the lower river.

The consequence of losing one's footing throughout this section is much less than the Boulder Garden, although at some specific spot locations the hazard is as high. Consequence of a river user losing their footing remains the same whether the Scheme is built or not.

8.21 Mitigation

While the probability of a person being caught by a sudden rise in water when crossing the river is increasingly less the further downstream they are through this section, the risk should still be mitigated by signage. There are relatively few access points to the river from the top of Waitaha Valley Road to the coast, and a safety plan should identify these and ensure appropriate warning signs are placed at each location.

## 9. RIVER SAFETY DURING CONTROLLED SHUTDOWNS AND STARTUPS

### Controlled shutdown

9.1 When a planned shutdown of the station occurs, effects similar to that described for a sudden shutdown will occur, but will be controlled and much more muted. The ability for a river user to react safely to the change in flow is greatly improved, but the potential for someone to be stranded on the wrong river bank remains the same. An increase in flow will be seen in the residual flow reach, and initially, a reduction of flow downstream of the Power Station, but this reduction will then rise back to levels prior to the shutdown.

### Controlled startup

9.2 When the Power Station commences generation, this will result in a reduction in flow above the station, and hence no increase in risk occurs for the hot pools or Boulder Garden section. Below the Power Station however, flow will increase slowly by as much as 13 $m^3/s$ (utilising the bypass valve until the upstream reduction in flow arrives) for a period, before returning to the natural flow conditions of the day. This ramping of flow will occur over an extended period, giving a river user more ability to safely react to the change in flow. None the less, a person in the river, beside the river, or someone who has belongings by the river's edge could easily be affected by the rising water.

### Ramping rates

9.3 There are no hard guidelines for determining the rate at which generation should be ramped up or down to reduce safety concerns. This varies depending the nature of the river section considered, the background flow before the change, the time of day, and must be considered along with environmental and engineering constraints.

9.4 The existence of a bypass valve provides the ability to minimise any changes, particularly if the generation flow is 10$m^3/s$ or less. The valve can be operated in the following way:

- During startup after a period of maintenance, it is possible to open the valve in advance of generation to maximise the time taken for flow to change in the river while minimising the time over which the generation flow is increased;
- Equally, during shutdown the bypass valve will reduce the effect on the river by continuing to operate once the station is shutdown.

9.5 The valve operation can take into consideration the timing differences for water to arrive at the Power Station from changes at the intake, to help offset downstream changes.

**Ramping rate for a controlled shutdown**

9.6 The hydraulic modelling report of AusHydro shows several ramp-down scenarios based around a worst-case situation of 26.5 $m^3$/s natural flow at the intake, with ramp-down rates of 30, 45 and 60 minutes. These were shown for two locations, immediately below the Power Station and 2.5 km downstream of the Power Station and are provided in **Figure 7**. The scenarios did not incorporate a bypass valve so they overstate the effect on the river.

9.7 The first period, that showing a reduction in flow, can be ignored from safety considerations (noting it does provide a 'warning' of something unusual happening to downstream users), and instead, it is the following recovery that is more important. This results from extra flow over the intake arriving at the Power Station and continuing downstream.

9.8 Considered below the Power Station, the rise will be attenuated by having travelled from the intake, and thus a maximum rise of 13 $m^3$/s over 30 minutes equates to a ramp rate of 0.43 m3/s, which is less (more forgiving) than natural rates of rise seen when the river exceeds a flow of 20 $m^3$/s. Based on personal observation and experience, this will allow a river user to react to the change in flow – particularly if they are aware through signage of the potential for that change, or if close to the Power Station, a warning is sounded. It is also important to note that further downstream, the rate of change in flow will be much less.

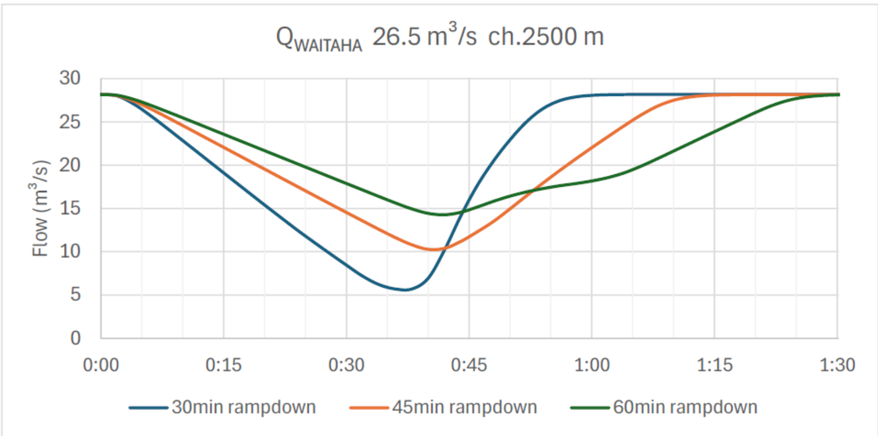


*Figure 5-2: Modelled flow in Waitaha River at model chainage 2500m (immediately downstream of power station) for three power station controlled shutdown scenarios, $Q_{WAITAHA}$ = 26.5 $m^3$/s*

**Figure 7 - The effect of a controlled shutdown on river flows immediately downstream of the Power Station, for shutdown scenarios occurring over 30, 45 and 60 minutes - taken from AusHydro (2025). The bottom axis is time.**

9.9 No analysis of magnitude of *flow* change further downstream is provided, but AusHydro (their Figure D-4) do show that *depth* at the start of the braided reach will increase by 0.11m (11 cm) over a period of about 20 minutes, when a change of 16.5 $m^3$/s is implemented at the Power Station over a 30-minute period. Note that no analysis was done with a bypass valve in place, so this 11cm change overstates the maximum possible from a 13 $m^3$/s change with the bypass valve in operation. While a rise in depth of this magnitude shouldn't be under estimated, this is an acceptable change in river conditions over a 20-minute period that allows any river user to recognise the change and react, especially given the consequence in the downstream section is far less than that seen above the Power Station.

**Ramping rate for a controlled startup**

9.10 Again, the hydraulic modelling report of AusHydro discusses several scenarios, this time for ramp-up, based around a worst-case situation of 26.5 $m^3$/s natural flow at the intake. Above the Power Station these scenarios manifest as a reduction of flow through Morgan Gorge and the Boulder Garden, and therefore safety is not considered through this location for controlled start-ups.

9.11 Below the Power Station AusHydro consider a ramp-up rate of 10 and 30 minutes, for a worst-case generation flow of 23 $m^3$/s. The scenarios did not incorporate a bypass valve so they overstate the effect on the river. These were shown for two locations, immediately below the Power Station and 2.5 km downstream of the Power Station. **Figure 8** is taken from their report and shows the change immediately below the Power Station, with the 30-minute ramp-up giving a much-reduced peak flow compared to the 10-minute ramp-up. The reason for this is that the reduction in flow seen over the intake has propagated downstream and has combined with and reduced the rise immediately below the Power Station, the magnitude of the rise being limited to around 18 $m^3$/s instead of the full 23 $m^3$/s that has been injected. At the start of the braided section the rise in flow is limited to about 16 $m^3$/s over 30 minutes.

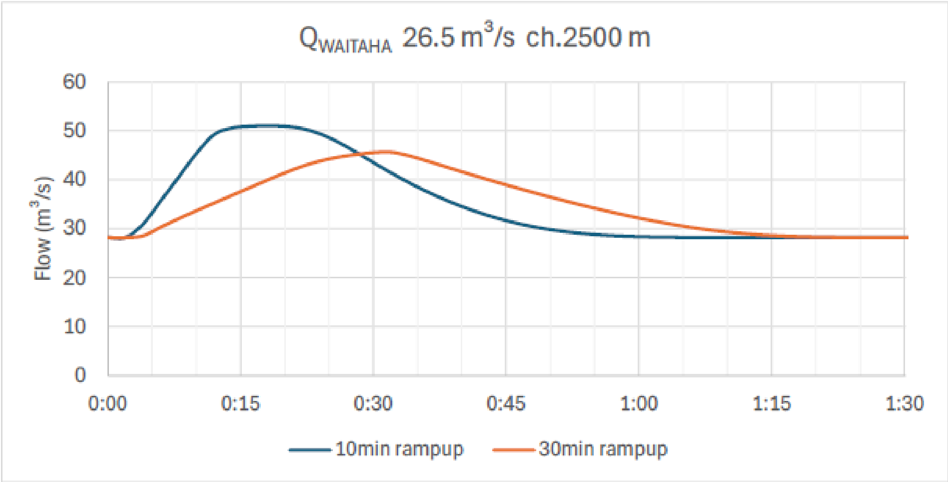


*Figure 5-11: Modelled flow in Waitaha River at model chainage 2500m (100 m downstream of power station) during station startup, $Q_{WAITAHA}$ = 26.5 $m^3$/s*

**Figure 8 - The effect of a controlled startup on river flows immediately downstream of the Power Station, for startup scenarios occurring over 10 and 30 minutes - taken from AusHydro (2025). The bottom axis is time.**

9.12 There was also a 'change in depth analysis' carried out by AusHydro. This uses a flow change of 16.5 $m^3$/s which is closer to the actual 13 $m^3$/s worst-case situation with a bypass valve. This resulted in a depth increase of about 0.12m (12 cm) over about 40 minutes at the start of the braided section.

9.13 As for the controlled shutdown situation, while a rise in depth of this magnitude shouldn't be under estimated, I consider this to be an acceptable change in river conditions over a 40-minute period that allows a river user to recognise the change and react, especially given the consequence in the downstream section is far less than that seen above the Power Station.

## 10. RECOMMENDED RAMP RATES

10.1 A generation flow change of 0.5 $m^3$/s/minute is recommended for normal flow conditions as the base maximum ramp-up and ramp-down rate for managed flow changes, from a safety perspective. Other requirements such as environmental or engineering considerations may require these rates to be slower than this.

10.2 When considered against the range of flow that a river user could realistically be in the river, and alongside the periods of less consequence at low flow, a range of ramp rates is provided in **Table 2** to also cover low and high flow situations. This will provide flexibility for the operation of the Power Station.

**Table 2 - recommended ramp rates for changes in generation flow - river safety**

| Generation flow range ($m^3$/s) | River flow above intake ($m^3$/s) | Recommended rate for changes in generation flow |
|---|---|---|
| **0 – 5** | < 8.5 | Ramp the change to the river flow over a 10-minute period. The bypass valve can be used to fully control this change, allowing a more rapid startup or shutdown of generation within or after this period. |
| **5 – 10** | 8.5 – 13.5 | The change to the river flow should not exceed 0.5 $m^3$/s/minute. The bypass valve can be used to fully control this change, allowing a more rapid startup or shutdown of generation within or after this period. |
| **10 – 23** | 13.5 – 40 | The change in generation flow should not exceed 0.5 $m^3$/s/minute. The bypass valve can be used to partially control this change, allowing a more rapid startup or shutdown of generation but the combined effect should stay within the ramp rate. |
| **23** | 40 - 180 | The change in generation flow per minute should not exceed 1.3% of the river flow above the intake. The bypass valve can be used to partially control this change, allowing a more rapid startup or shutdown of generation but the combined effect should stay within the ramp rate. |
| **23** | 180 or more | No restriction on ramp rate. |

**Adaptive management**

10.3 Once the Scheme is operational, monitoring of river levels at several key locations should be carried out for a period of 1 year to confirm the extent, magnitude and timing of flow changes from Power Station operation. From this, the process of adaptive management is recommended to finalise ramping rates and alter the river safety plan as needed, in conjunction with Council through the consenting process. Approximate river level monitoring locations suggested include the Power Station, above the braided reach, and the State Highway 6 bridge.

## 11. CONCLUSION

11.1 The Waitaha River is a high-volume West Coast river. It carries large flows, but also has periods of very low flow in autumn and winter. River users are most common near the coast, and in the rugged upper catchment. Much of the lower river flats below the Power Station have little or no easy access to the river.

11.2 During normal operation, the proposed Waitaha Power Station will not affect river safety at all. When the station starts or stops generation, however, either rising or falling flow changes are imposed on the river. A reduction of flow will have few, if any, safety considerations but a rise in flow does.

11.3 During routine stopping and starting of the station, the use of a bypass valve allows for management of these effects. An emergency or sudden stop, however, creates more sudden flow changes.

11.4 The joint probability of an emergency stop considered in conjunction with a person being in a critical section of river is exceedingly small. The hot pools in Morgan Gorge also have an extremely low joint probability for harm to occur from sudden shutdown.

11.5 A natural choke point for upstream travellers at the Power Station can be used to funnel people past warning signage. It may be beneficial to anonymously record the passage of people past this location by use of a swing gate or an overhead time lapse camera or similar. A warning siren also offers plenty of time for river users to react to a sudden change in flow. The use of an electronic sign could warn of an impending and planned shutdown or startup.

11.6 All access points to the river from the intake to the coast should be identified and appropriate signage installed. Education of neighbouring landowners, and the fishing and hot pooling communities can further reduce the risk. The fishing community are usually highly attuned to the river environment, and are considered lower risk.

11.7 To reduce effects on the river during routine operation, a base level ramping rate of generation flow which does not exceed 0.5 $m^3$/s/min is suggested for safety purposes, with variations to this at low and high flow.

11.8 Adaptive management of ramping rates and safety plans is strongly recommended following monitoring post commissioning of the Scheme.

**APPENDIX A – QUALIFICATIONS AND EXPERIENCE – MARTIN CHRISTOPHER DOYLE**

I have 45 years' experience monitoring and analysing river flow, rainfall, snow and ice across the South Island of New Zealand, Antarctica and the Solomon Islands, working variously for the Ministry of Works and Development, DSIR, NIWA, Nelson Catchment Board and Tasman District Council; with specific experience in the hydropower industry including compliance monitoring, and assessing and reporting on effects. In addition, I have consulted with the hydropower industry completing feasibility studies, monitoring and analysis.

Wider hydrological experience consists of virtually all aspects of hydrological monitoring, analysis and reporting, and preparing and assessing applications to take and discharge water for many purposes. I have been active in, or have led, many initiatives within the national hydrological community including the development of standards for measurement accuracy and consistency, safety procedures, guidelines for hydrological analysis, and software improvement and development.

My current role is Principal Hydrologist, Tasman District Council

Relevant memberships and associations include:

- Steering Group member for the development of National Environmental Monitoring Standards
- Led the working groups to develop National Environmental Monitoring Standards for Water Level Measurement, and Stage-Flow rating curves
- Member of the MetService Reference Group
- Currently Chair the National Flood Warning Steering Group
- Member of the Severe Weather Science Advisory Panel
- Member of NZ Hydrological Society

Qualifications:

- NZCS Water Technology
- Grad. Dip. Engineering Hydrology
- Dip. Field Hydrology

**Declared Interests**

I, Martin Doyle, declare the following interests:

- I am the co-consent holder (with [redacted] of RC05216 for a small hydro-electric scheme in Macgregor Creek. [redacted] has provided a letter on our behalf stating that the consent can be fully exercised alongside the Waitaha Hydro Scheme;
- I have a business relationship with Westpower Ltd through the Amethyst Hydro Ltd. I am a co-director of Hari Hari Hydro Ltd, which has a 12% share and Westpower owns 88%. My share in Hari Hari Hydro Ltd creates a minority 6% share in the Amethyst Hydro Scheme.

**APPENDIX B – PHOTOS OF THE ABSTRACTION REACH**

**Figure 1 - Looking downstream, top end of Boulder Garden, approximate flow of 14 $m^3/s$**

**Figure 2 - Looking upstream, top end of Boulder Garden, approximate flow of 14 $m^3/s$**

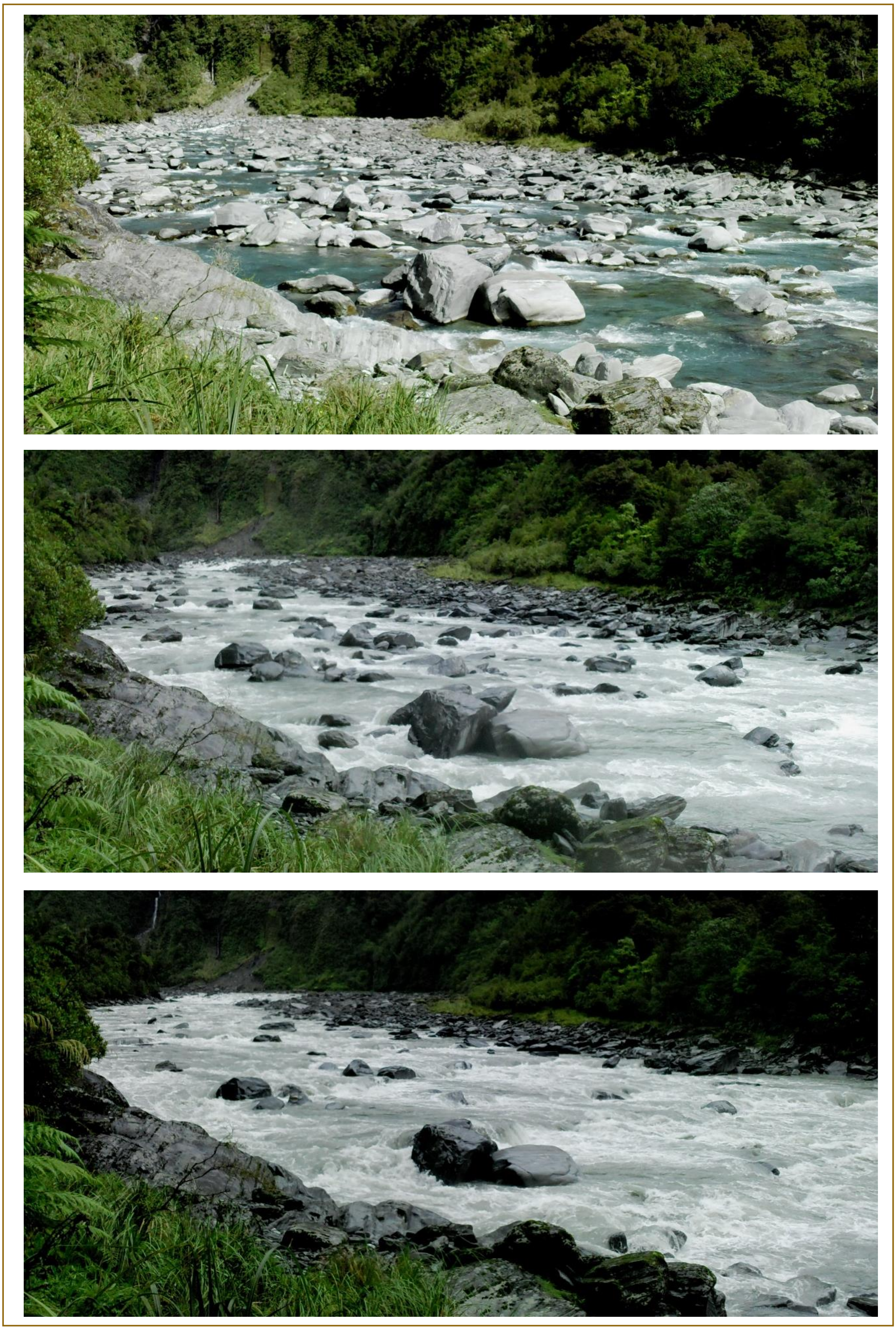

**Figure 3 - Looking up from the power station flat, with flows of 8.5 m³/s (top), 15 m³/s (middle) and 25 m³/s (bottom)**

## APPENDIX C – REFERENCES


AusHydro. (2025): Waitaha Hydro Project – Downstream Flow Modelling, May 2025.

Doyle (2025): *The hydrology of the Waitaha Catchment*, Report for Westpower Ltd, July 2025.

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