

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by TrustPower Limited to the Westland District Council and West Coast Regional Council for resource consents to operate and maintain the Kaniere Forks Hydro-Electric Power Scheme, and enhance, construct, operate and maintain the McKays Creek Hydro-Electric Power Scheme

STATEMENT OF EVIDENCE OF GREGORY IAN RYDER

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QUALIFICATIONS AND EXPERIENCE

1. My full name is Gregory Ian Ryder.
2. I am a Director of Ryder Consulting Limited (Ryder Consulting), an environmental consulting business with offices in Tauranga, Christchurch and Dunedin. Prior to this, I held positions at the Otago Regional Council and the University of Otago.
3. I am a water quality scientist and aquatic ecologist and hold BSc. (First Class Honours) (1984) and PhD. (1989) degrees in Zoology from the University of Otago.
4. For approximately 25 years, I have conducted a wide variety of studies on freshwater ecology and water quality throughout New Zealand. I have been project manager for major studies on New Zealand river ecosystems and have had a lead role in a number of multidiscipline studies involving aquatic and terrestrial ecosystems. Regional councils and government departments have engaged me to peer review environmental studies and resource consent applications, and I have held the position of an independent commissioner on a number of major resource consent hearings including marine farms, impoundments, water abstractions and wastewater discharges.
5. In 1995 I designed, and for a number of years ran, Environment Southland's State of the Environment Freshwater Monitoring Programme and I am currently engaged to analyse the data generated by this programme since monitoring commenced in the mid-1990s. I have assisted both Environment Southland and Otago Regional Council in developing their respective regional water plans, and was the principal author in developing water quality standards for Southland's Draft Regional Water Plan (Ryder 2004), which received relatively few challenges in the submission process. I was also involved in the analysis and reporting of West Coast Regional Council's (WCRC) state of the environment data monitoring data for the period 1998-2003.
6. I am familiar with West Coast lake and river ecosystems, and have been involved with several studies of West Coast catchments with hydro-electric power schemes (Arnold/Brunner, Dillmans/Kumara and Wahapo). The work associated with all of these schemes included surveys of fish populations and assessing fish passage options at scheme structures and within reaches of streams with modified flow regimes.
7. I have read the Code of Conduct for Expert Witnesses (Rule 9.43, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

SCOPE OF EVIDENCE

8. I have been asked by TrustPower to assess and prepare evidence on the effects of reconsenting of the existing Kaniere Forks Hydro-Electric Power Scheme and the reconsenting of and proposed enhancement to McKays Creek Hydro-Electric Power

Scheme (hereafter referred to as the 'enhanced scheme') on aquatic ecology and water quality. This includes:

- a. A summary of the existing information on aquatic values in the area;
 - b. An assessment of the potential effects of the enhanced scheme on the identified aquatic values;
 - c. Recommendations for mitigating adverse effects on aquatic values;
 - d. Recommendations on monitoring;
 - e. Comments on submissions and the Reporting Officer's section 42A report; and
 - f. My overall conclusion.
9. In presenting this evidence, I acknowledge the work of my colleagues, Dr Ruth Goldsmith¹ and Mr Ben Ludgate,² who undertook large parts of the survey work. Dr Goldsmith and I have used data generated by those surveys to develop relationships between flow and instream habitat available to fish, benthic macroinvertebrates and algae.
10. As part of the consenting process, TrustPower wishes to enhance the McKays Creek scheme to improve the scheme's efficiency. The enhanced scheme is described in detail in the evidence of Rob Shelton and includes the following key changes:
- a. Maintain existing abstraction to Kaniere Race at 1 cumec;
 - b. Increase abstraction to the McKays Race (at McKays weir) from 5 cumecs to 8 cumecs;
 - c. Improve the McKays race through deepening / heightening or widening; and
 - d. Increase the existing McKays Creek Power Station capacity and discharge from 6 cumecs to up to 9 cumecs (to account for existing additional 1 cumec from Blue Bottle Creek).

DESCRIPTION OF THE AQUATIC ENVIRONMENT

11. In this section of my evidence I describe the existing aquatic environment within which the existing schemes sit. My colleagues and I at Ryder Consulting reviewed all the existing information on aquatic ecology and supplemented this data with site-specific surveys of areas within or downstream of the existing schemes. Site-specific surveys were undertaken in 2010 and all this information was presented in reports that accompanied the Assessment of Environmental Effects (Goldsmith and Ryder 2010).

¹ Dr Ruth Goldsmith, BSc., PGDipWLM., PhD. – freshwater ecologist, over 10 years experience.

² Mr Ben Ludgate, BSc., MSc. — freshwater ecologist, over 10 years experience.

12. The Kaniere River drains a sub-catchment of the Hokitika River inland from Hokitika. The upper catchment is dominated by Lake Kaniere, a deep lake (maximum depth of 197m) surrounded by a relatively small but mountainous catchment (area of approximately 54.5km²). Inflows to the lake come from numerous streams and have combined mean and median inflows of 7.0 and 5.6 cumecs, respectively (Palmer 2010). The lake covers an area of 14.7km² and has a minimum operating level of 1.2m below the crest of the control weir at the lake outlet. The existing lake level operating range is not proposed to be altered to provide storage for the enhanced scheme.

Existing McKays Creek and Kaniere Forks Schemes

13. Water for the Kaniere Forks scheme is taken into the Kaniere water race through a control and intake structure at the Lake Kaniere outlet (Kaniere River). The existing consent provides for a minimum flow of 0.2 cumecs in the Kaniere River below the intake, although actual minimum flows rarely reach this level. Up to 1 cumec can be taken into the race. The race follows the course of an old gold mining channel, which has been improved, and conveys water approximately 9km to the Kaniere Forks Power Station. From here it is discharged to the Kaniere River (Figure 1: Location Plan, Kaniere HEPS and McKays HEPS AEE).
14. Water for the McKays Creek scheme is taken from the Kaniere River approximately 7km downstream of Lake Kaniere at McKays weir. Up to 5 cumecs is taken at the weir, with a minimum flow of 0.2 cumecs maintained in the Kaniere River downstream of the weir.
15. Additional water (up to 1 cumec) is provided to the McKays water race from Blue Bottle Creek and other tributaries, and the water is conveyed through to the McKays Creek Power Station. From the station, the water (up to 6 cumecs) is discharged to a tailrace where it travels a further 1km to enter the Kaniere River. I note that as the intake for the McKays Creek scheme is located upstream of the discharge from the Kaniere Forks Power Station the two stations currently operate in isolation of each other.
16. The Kaniere River flows 16km from Lake Kaniere to the Hokitika River. The majority of the flow between the lake outlet and the Kaniere Power Station (9km downstream) is diverted for generation. The presence of the McKays weir 7km downstream of the lake outlet, which diverts water to the McKays Power Station, effectively divides the river into two sections based on differing flow characteristics and partial barriers to fish passage. All water is returned to the Kaniere River below the McKays Power Station tailrace.

Lake Kaniere

17. The water quality of Lake Kaniere influences that of the Kaniere River and that conveyed by the scheme and so is of interest. Water temperature in the upper portion of the lake column is particularly important as it strongly influences downstream water

temperatures, and other water quality parameters, regardless of flow. The lake acts as buffer to ambient water temperature.

18. Lake Kaniere receives inflows from a catchment that is relatively unmodified and retains a good deal of native vegetation. Consequently, its water quality is good and characterised by good clarity (despite having a slight tannin-stained look), low suspended sediments and low nutrients. The lake is monitored by WCRC for contact recreation and in 2005 it was reported that Lake Kaniere's water quality was adequate and had the highest water quality for contact recreation of those monitored in the region (WCRC 2005).
19. The shore of Lake Kaniere has been described by Single (2011) as predominantly a boulder shore, with a narrow steep zone that is sometimes inundated. Up to 37 species or sub-species of plant have been identified from the lake bed, almost all of which are indigenous with only three non-indigenous species recorded. Two of the indigenous species are identified as threatened, *Isolepis fluitans* and *Ranunculus limosella*, being ranked as in 'gradual decline' (Hitchmough *et al.* 2007).

Aquatic Plants

20. The aquatic plants have been found at depths of up to 9.3m although most are found in the depth range of 0-3.5m. Most species grow at a depth range that extends over several metres. The aquatic plant profile is similar to other West Coast lakes (i.e., Brunner, Mapourika and lanthe). The maximum depth at which submerged plants are found in Lake Kaniere is slightly higher than that of the other lakes, and I expect this is probably due to higher water clarity in Lake Kaniere allowing greater light penetration and thus increasing the depth at which some plant species can grow. Macrophyte communities of all these lakes are similar. A lake submerged plant indicator scoring system (LakeSPI) developed for New Zealand lakes by NIWA ranked Lake Kaniere and Lake lanthe the same and both above Lake Mapourika, suggesting that the macrophyte community of the lake has not been adversely affected by existing water level fluctuations.

Fish

21. Lake Kaniere supports both native and introduced fisheries. Native fish include common bully, giant kokopu, longfin and shortfin eel. The giant kokopu fishery is significant and important in terms of its size. It appears the common bully and giant kokopu populations in Lake Kaniere are self-sustaining and land-locked, although juveniles may still undergo downstream migration. Giant kokopu are classified as an at risk species ('declining') although there is no evidence that the population is declining in the Kaniere catchment.
22. Introduced species include brown trout, Chinook salmon, perch and rainbow trout. The salmon fishery is minor, but brown trout are common as are perch.

Conclusion

23. In general, Lake Kaniere supports a diverse range of flora and fauna typical of that found in other West Coast lakes. The surrounding catchment and lake environments are relatively unmodified and consequently, the water quality is good and a significant proportion of the species found are native to New Zealand. In my opinion, as I describe later in my evidence, the only attributes of the lake environment that may be potentially adversely affected by the existing scheme are fish populations that rely on access to and from the sea to maintain a normal population structure.

Kaniere River

24. My colleagues and I supplemented existing information on the Kaniere River with surveys of benthic algae (periphyton), benthic macroinvertebrates (an important food item for fish), fish and water temperature³. We also assessed the physical environment (e.g., substrate character, water depth and velocity) at sites along the river to consider how this may influence the abundance and distribution of aquatic communities. We used this information to assess the state of the existing environment and to predict how the enhanced scheme may affect ecological values.

Water quality

25. Although there is limited information on water quality within the Kaniere River, from the information available, and the moderate amount of land disturbance in the catchment, I expect water quality to reflect that of the lake, which is clear with low nutrient concentrations and low bacterial contamination. Water temperature monitoring undertaken as part of our information gathering found temperature in the residual river below McKays weir exceeded 20°C on several days during February 2010 and exceeded 21°C on occasions in February 2012. A maximum temperature of 23°C was recorded in February 2010. While these temperatures are elevated, in my experience they are typical of that found around this time of the year in the West Coast region. Even the surface waters of Lake Kaniere near the outlet regularly exceed 20-21°C in late summer.

Benthic algae

26. Benthic algae (or periphyton) grows on the hard surfaces of river beds (e.g., cobbles and gravel) in response to nutrients and sunlight among other environmental variables. While periphyton provides food for many benthic invertebrates, which in turn are a food source for fish, it can reach nuisance proportions under certain conditions (nutrient enrichment, stable flows and elevated temperatures). Lake outlet rivers typically support higher periphyton biomass than rain-fed rivers due to the stable flow and high clarity nature of the water.

³ See Appendix 1, Figure 1 for a map detailing the survey sites.

27. Our surveys found periphyton was clearly visible at all sites surveyed along the Kaniere River. Long filamentous green algae, which is a particularly conspicuous type of periphyton and generally an undesirable attribute when found in abundance, were present at all sites. Cover of these algae slightly exceeded Ministry for the Environment aesthetic/recreation guideline levels at one site, upstream of McKays weir. The flow in this reach was approximately 5 cumecs, having been reduced by the 1 cumec Kaniere intake upstream. In my experience, it is unlikely that this small 1 cumec flow reduction would have caused algae cover to exceed guideline levels, and natural catchment features (including the presence of a lake upstream resulting in a relatively stable flow regime) and habitat conditions at the time would have had a greater influence. Thick algae mats were also present at all sites, but aesthetic/recreation guideline levels for cyanobacteria/diatom mat forms were not exceeded.

Benthic macroinvertebrates

28. Surveys have found the benthic macroinvertebrate community of the Kaniere River to be comparable to that of similar river habitats in the West Coast region. A total of 40 macroinvertebrate taxa were identified in our survey of six sites in the river. Two species were identified as threatened: the freshwater mussel (kākāhi) and freshwater crayfish (koura), which are both ranked to be in 'gradual decline' (Hitchmough *et al.* 2007). Common macroinvertebrate taxa included, *Aoteapsyche* net-spinning caddisflies, *Potamopyrgus* snails, Elmidae beetles, *Oxyethira albiceps* cased caddisflies and *Deleatidium* mayflies. The dominant taxa varied somewhat depending on the distance of a site downstream from the lake. Macroinvertebrate community health indices were generally indicative of 'fair' to 'good' quality invertebrate habitat. Such 'average' scores in an environment with good water quality is not unexpected in my experience and merely reflects the stable nature of a lake outlet river that provides favourable habitat for high algae and plant biomass (these components generally cause macroinvertebrate health indices to decrease relative to river beds with clean stones free of such growths).

Fish

29. The range of native fish species present in the Kaniere River catchment is similar to that of other West Coast rivers, with dwarf galaxias and upland bullies (both non-diadromous species) the only native species recorded in neighbouring rivers that are not present in the Kaniere River. Fish diversity is high compared to the neighbouring Kokatahi and Styx Rivers, although this may be due to a relatively large amount of sampling effort within the Kaniere catchment.
30. A recent threat ranking process has been applied to New Zealand freshwater fish (Allibone *et al.* 2010). Bluegill bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortjaw kokopu and torrentfish are all classified as 'declining', with the

qualifiers of 'partial decline' for giant kokopu, and 'data poor' for bluegill bully, inanga, lamprey and shortjaw kokopu.

31. Our fish surveys found an obvious difference in fish communities upstream and downstream of McKays weir. Only longfin and shortfin eel were found in the river mainstem upstream of the weir. Shortfin eel had not previously been recorded in the Kaniere River between the lake outlet and McKays weir. Most individuals caught were elvers (juvenile eels), and given the timing it is likely that they were migrating upstream.
32. Similar densities of longfin and shortfin eels were recorded upstream and downstream of McKays weir.
33. Four native fish species were found at the two survey sites in Butchers Creek, upstream of McKays weir (redfin bully, koaro, shortjaw kokopu and longfin eel) (sites B1 and B2 Appendix 1, Figure 1). Butchers Creek was the only location where our surveys found shortjaw kokopu.
34. A further four native fish species and one introduced species were identified in the Kaniere River mainstem at sites downstream of McKays weir. Bluegill and redfin bullies and torrentfish were captured at all downstream sites, while common bully and a single brown trout were found only at site K5 (Appendix 1, Figure 1).
35. Six native fish species were found in Kennedy Creek, downstream of McKays weir (bluegill bully, common bully, redfin bully, koaro, longfin eel and torrentfish) (site Ken, Appendix 1, Figures 1 and 2). Except for koaro, all were also found at nearby sites in the Kaniere River.
36. Five fish species were found in Blue Bottle Creek, downstream of McKays weir (brown trout, bluegill bully, redfin bully, koaro and longfin eel) (sites BB1-BB3, Appendix 1, Figures 1 and 2). Redfin bullies were the only species found downstream of the Blue Bottle Creek intake that were not also found upstream during our survey, although they have been recorded upstream of the intake previously.

Conclusion

37. In general, the existing ecology of the Kaniere River system is characterised by a diverse native fishery including several species with conservation threat status. The abundance and distribution of these species appears to be controlled by the size of the physical habitat (i.e., generally small streams with limited instream habitat) and barriers to upstream migration caused by structures associated with the McKays/Kaniere schemes. The trout fishery of the river is minor and this reflects the limited habitat available to adult trout. I address this issue in more detail in subsequent sections of my evidence.

38. Other aspects of the Kaniere River system ecology are what I would expect to find in a West Coast stream that has an intact native vegetation catchment and a lake with good water quality buffering outflows.

EFFECTS OF SCHEME OPERATION

39. The effects on aquatic ecology and water quality associated with the schemes can be broken down into several categories based on flow diversion affecting instream habitat and structures affecting fish passage.
40. In my opinion, it is clear that the McKays weir and the Lake Kaniere outlet control structure in the Kaniere River mainstem, and to a lesser extent the weir on Blue Bottle Creek, are already adversely affecting the distribution and abundance of native fish species in the wider Kaniere River catchment. These, and alteration to the flow regime of various sections of the Kaniere River, are the primary aquatic ecological-related issues associated with the continued operation of the existing schemes and enhanced McKays scheme that need to be considered.

Effects of scheme structures on downstream fish passage

41. All of the native fish species found in the Kaniere River catchment are diadromous (except brown mudfish), and so require access to and from the sea to complete their lifecycle. I note, however, that the common bully and giant kokopu populations in Lake Kaniere are land-locked, and appear to be self-sustaining (based on population structure and microscopic analysis of the otolith bone which indicates whether a fish has been to sea or remained in freshwater all of its life), although juveniles of these species may still undergo downstream migration. The two intake and control structures within the Kaniere River mainstem associated with the scheme (i.e., McKays weir and Lake Kaniere outlet control structure) can therefore potentially limit upstream passage and downstream fish passage when water is not flowing over them.
42. At the scheme intakes there is also a risk that downstream migrating fish may become entrained within the races associated with the scheme.
43. These effects are occurring under the existing scheme and will continue to occur under the enhanced scheme unless they are remedied or mitigated.
44. The bar spacing of the trash racks in the Kaniere water race and at the intake to the McKays race are not narrow enough to exclude any native fish species. Most fish would pass through the trash rack to enter the race, but approach velocities are such that adult eels may instead become impinged against the bars. Migrating adult eels, however, tend to move downstream during freshes or floods and it is likely that they would travel in the main flow of the river, towards the middle of the channel. I would therefore expect them to be less likely to encounter the intakes to the water races, but instead bypass over McKays weir and continue downstream.

45. There is suitable fish habitat within the McKays/Blue Bottle Creek and Kaniere water races for some distance downstream of each intake and fish have been observed in each of these water races. However, further downstream the water eventually enters penstocks to be conveyed to each power station. There is a second trash rack in the Kaniere race immediately upstream of the Kaniere Forks penstocks. It has a bar spacing of 45mm, which is also not sufficient to exclude native fish. The trash rack at the McKays Creek penstocks has a bar spacing of 25mm, which should be sufficient to exclude large adult eels, but not smaller fish. Most diadromous fish that enter the races as part of their active downstream migration will therefore ultimately encounter the power station turbines.
46. Under the enhanced scheme the capacity of the existing McKays intake and water race would be increased. Without adequate screening of the enhanced McKays intake and the existing Kaniere Forks intake and the provision of a return flow, fish will continue to be entrained into the scheme and, ultimately, will be drawn through the power station turbines.
47. Fish mortality due to turbines has been well documented. Large fish (like adult eels) have a very low chance (<10%) of surviving passage through a turbine whereas small fish (like trout fry (30mm long)) have a high (>90%) chance of surviving. Passage through the existing and proposed McKays Creek and Kaniere Forks power station turbines is therefore likely to result in mortality for some fish, particularly larger individuals, which includes threatened native fish species.
48. I have recommended to TrustPower that the power station intake is screened and consequently a draft consent condition requiring the installation of fish exclusion screens with bar spacings of no less than 20mm width and, where necessary, return channels, in order to exclude migrating adult eels from the intakes associated with the existing Kaniere Forks scheme and the McKays scheme enhancement.⁴ Consequently, effects on downstream fish passage have in my opinion been adequately addressed and represent an improvement over the status quo.

Effects of scheme structures on upstream fish migration

49. There are currently two structures associated with the existing scheme that may hinder upstream fish passage.
50. Immediately downstream of the Blue Bottle Creek intake is a small weir approximately 1m high, formed by the placement of boulders across the channel. There is no minimum residual flow in the creek downstream of the intake, and under low flow conditions there

⁴ See: West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Land Use Consent RC10001/2, condition 1; and West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Land Use Consent RC10001/19, condition 8.

is very little water flowing over the weir. Only climbing native fish species (e.g., eels, koaro, lamprey, and redfin bullies) appear able to pass, with poorer climbers (e.g., bluegill bullies and torrentfish) prevented from passing. However, existing fish distribution records and our recent survey confirm that all of the native fish present downstream of the intake weir are also present upstream (including brown trout, bluegill and redfin bully, koaro and longfin eels) and so passage must be possible at higher flows.

51. There will be no change from the existing situation under the enhanced scheme.
52. The McKays weir on the Kaniere River is a low concrete weir, which at typical flows is overtopped. At lower water levels no water flows over the weir and the current residual flow (0.2 cumecs) is maintained through an underwater notch on the true left side of the weir. In my opinion, when the weir is spilling, upstream passage should be possible for large salmonids (i.e., trout and salmon) and climbing native fish species; however, poorer climbers may be prevented from passing.
53. There are two channels at the Lake Kaniere outlet. The true right channel leads directly to the intake and control gates for the Kaniere water race. Continuous passage for upstream migrating fish is available to the lake provided that fish are able to swim upstream against the high water velocity through the gates, or climb around the moist sides, as climbing native fish are able to do.
54. The second channel has a concrete weir and control boards between the river and the lake outlet. Depending on the lake level there is a drop of approximately 0.5m from the lake over the weir and control boards into this channel. Lake level records indicate that under the existing scheme the lake spills over the concrete weir greater than 40% of the time, more so during October to January (Palmer 2010). As at the McKays weir, this overflow should, in my opinion, allow upstream passage for fish species that are good climbers, however, poorer climbers may be prevented from passing.
55. At lower lake levels, however, there is no surface discharge from the lake to the true left channel. Under the enhanced scheme, spills will reduce from 38% to 10% of the time and in doing so reduce opportunities for upstream fish passage from the river to the lake.
56. Whether upstream fish passage is possible at the control structures in the Kaniere River at the lake outlet is therefore dependent on the flows in the river (and over the structures) during the upstream migration period for each fish species.
57. The fish distribution records indicate that McKays weir is hindering upstream passage, and limiting the distribution of bluegill bullies, lamprey and torrentfish in the middle and upper reaches of the Kaniere River catchment. Upstream passage of common bully and giant kokopu is also hindered, but both species have developed land-locked populations in Lake Kaniere. Redfin bullies and shortjaw kokopu have been recorded upstream of

the weir, however, it appears they are not present, or present only in low numbers, in the upper catchment.

58. Under the enhanced scheme there will be no change to the Blue Bottle Creek intake. The Lake Kaniere outlet gates and Kaniere Race intake will be modified and minor changes will be made to McKays weir, however, these changes are unlikely to improve fish passage. Any existing effect of these structures on upstream passage will therefore continue unless mitigated. I address mitigation measures further on in my evidence.

Effects of the scheme's flow regime on fish passage

(i) Kaniere River

59. The timing of downstream spawning migrations for some native species (e.g., eels and shortjaw kokopu) is associated with floods or elevated flows (Charteris 2006). Sufficient flow is also required during periods of upstream migration to ensure that connectivity is maintained to allow upstream passage within the mainstem and also to access tributaries.
60. Flow simulations were undertaken to predict how flows in several locations in the Kaniere River will change under the enhanced scheme relative to the existing situation. These are described in the evidence of Mr Lennie Palmer. Relative to the existing situation, minimum flows in the upper river (from the lake outlet to McKays weir) will decrease and median flows will increase. In the reach from McKays weir to downstream of Kaniere Forks Station, minimum flows will increase slightly and median flows will decrease, and downstream of McKays Creek Station minimum flows will decrease and median flows increase. In general, relative to the existing situation, the enhanced scheme will result in slightly higher flows in the Kaniere River from the lake outlet to McKays weir, reduced flows in the reach from McKays weir to the McKays Station discharge, and increased flows downstream of the McKays Station discharge. In the lower river (downstream of McKays weir) flow variation will be increased between reaches relative to the existing situation. Major flow variations between reaches are due to water intakes and water discharges above and below the power stations. Aside from upstream migrating fish potentially being attracted to the power station tailraces during generation, reductions in flow may also affect connectivity within the mainstem and access to tributaries. In order to allow identification of areas in the river where this may occur, Dr Goldsmith and I inspected the upper river at low flows in May 2010. At the time of the survey the flow at the lake outlet was 0.2 cumecs, increasing to 0.65 cumecs at Ward Road (due to surface water inflows). These inspections did not identify any connectivity issues for fish. Low flow inspections below McKays weir were unsuitable in May due to higher flows, therefore a similar flow reduction trial was undertaken in the lower river in August 2010, where the entire river reach from McKays weir downstream to the McKays power station tailrace discharge (approximately 3.8km long) was

inspected under low flow conditions. At the time of survey the flow at McKays weir was 0.22 cumec, increasing to 0.8 cumecs at McKays Ford. These inspections revealed that native fish passage is unlikely to be affected by shallow water depths observed at some sites; however, passage for larger salmonids may be.

(ii) *Blue Bottle Creek*

61. The existing take from Blue Bottle Creek to the McKays race is up to 1 cumec and this will not change under the enhanced scheme. No minimum residual flow is currently provided below the intake in Blue Bottle Creek and the median residual flow is 0.06 cumecs (Palmer 2010). Further downstream, surface and groundwater inflows contribute water so there is surface flow, although connectivity is limited under these conditions. Despite this existing situation, fish distribution records indicate that fish can and do move freely throughout the creek at higher flows, although fish densities indicate instream structures may limit this movement somewhat.

Effects of the scheme's flow regime on the instream habitat of river biota

62. Dr Goldsmith and I assessed the relationship between instream habitat and flow for key aquatic species in the Kaniere River using a technique known as instream flow incremental methodology (IFIM). This approach enables an assessment to be made of the effects of flow alterations on physical habitat for fish, invertebrates and periphyton. The IFIM technique is used widely throughout New Zealand and the world, and is frequently used by regional councils in setting minimum flows.
63. The physical characteristics of two reaches of the river were surveyed to provide data for the IFIM model: an upper reach (Ward Road) representing the narrower, steeper gradient section of the river from the lake outlet to upstream of McKays weir, and a lower reach (McKays Ford) representing the wider and less steep section downstream of McKays weir.
64. The two primary components of an IFIM analysis are the hydraulic simulations of a stream reach and habitat suitability criteria for the biological group of interest (e.g. fish, macroinvertebrates or periphyton). Hydraulic simulation is used to describe the area of a stream having various combinations of depth, velocity and substrate type as a function of flow. This information is used to calculate the 'Weighted Useable Area' (WUA) of the stream segment from suitability information based on knowledge of the preferred habitat of various aquatic species. Habitat suitability criteria are a way of describing what is considered to be 'good' habitat (Jowett 1996). Once habitat suitability criteria are defined they can be applied to habitat survey data and the amount of suitable habitat with varying flow calculated.
65. Habitat suitability was modelled against flow using RHYHABSIM software (Jowett 1996). Nine fish species and five macroinvertebrate taxa were included in the model. Food

producing habitat, which brown trout abundance is related to (Jowett 1992), was also modelled. Three periphyton groups: diatoms, and short and long filamentous algae, were included to evaluate the potential for nuisance algae growths.

66. Using the IFIM modelling approach, I calculated the amount of available instream habitat for aquatic species under the existing situation and enhanced scheme for each of the five locations in the river. The approximate length of river relating to each location is as follows:
- a. Lake outlet – 3.1km;
 - b. Ward Road – 4.1km;
 - c. Downstream of McKays weir – 1.8km;
 - d. Downstream of Kaniere Forks Station – 2.0km; and
 - e. Downstream of McKays Creek Station – 5.6km.
67. The amount of habitat available for a species depends on its habitat requirements. For some species the amount of habitat increases as flows increase (e.g., koaro and torrentfish) and for other species it decreases (e.g., common bully and redfin bully). Determining the appropriate amount of habitat for various species in a managed flow environment depends on the management objectives of the river. It is fair to say that to date the Kaniere River has been managed primarily for hydro generation. However, the river also provides habitat for native fish species and consideration is required to provide sufficient flow to sustain their populations within the wider catchment, as well as considering the need to provide some habitat for other aquatic taxa (e.g., brown trout and benthic invertebrates) and minimising nuisance algae growths.
68. Relative to the existing situation upstream of McKays weir (reach length approximately 7.2km), minimum flows under the enhanced scheme are predicted to decrease habitat for native fish, brown trout, food producing habitat and invertebrates. Increased median flows upstream of McKays weir would also decrease habitat.
69. In the reach downstream of McKays weir (length approximately 1.8km), the minimum flow under the enhanced scheme is expected to be slightly higher than the existing situation resulting in similar or slightly increased habitat. However, the proposed decreased median flow is predicted to decrease habitat for most species.
70. I describe these habitat changes in more detail in the section on 'Instream Habitat' (paragraphs 96-111).
71. In the reach downstream of Kaniere Forks station (length approximately 2km), minimum flows under the enhanced scheme are predicted to slightly increase habitat for native fish, trout, food producing habitat and invertebrates relative to the existing situation.

Decreased median flows are predicted to increase habitat for native fish species with lower velocity preferences, slightly decrease brown trout habitat, and decrease food producing and some invertebrate habitat.

72. In the reach downstream of McKays Creek station (length approximately 5.6km), decreased minimum and increased median flows under the enhanced scheme are predicted to decrease habitat for native fish species, brown trout and most invertebrate taxa relative to the existing situation.
73. In most reaches habitat for nuisance long filamentous algae growths are predicted to be similar or increased under the enhanced scheme relative to the existing situation.
74. I discuss the issue of flow mitigation in more detail below under the section on monitoring and mitigation.

Fluctuating water levels in Lake Kaniere

75. Under the enhanced scheme, there will be no change to the consented operating range of Lake Kaniere, which is -0.2m to 1m; however, the amount of time that the lake is at levels within this range will change, and this will vary on a seasonal basis. In summer months (November to March), median and mean lake levels will decrease by 0.34m and 0.27m, respectively, relative to the existing situation. In winter months (April to October), median and mean lake levels will decrease by 0.55m and 0.41m, respectively, relative to the existing situation. Relative to the existing situation, with the percent of time that the lake is spilling decreasing from 38 to 10% (evidence of Mr Lennie Palmer).
76. Such changes may potentially adversely impact aquatic plant communities in the littoral zone of the lake (the bed of the lake that receives sunlight and so supports plant growth). In my experience, such effects are likely to be no more than minor as most plant species are present at a range of depths, the changes are within the existing operating range, and variations in lake level will take place over periods of weeks rather than daily fluctuations.
77. A reduction in the proportion of time that the lake is spilling may affect fish passage, but given that mean flows at the lake outlet have been estimated to exceed 5 cumecs in every month except August (where it dips just under 5 cumecs), I consider there will be sufficient and regular opportunity for all fish species to migrate in and out of the lake from the upper Kaniere River. Information on mean monthly flows is presented in Figure 13 of Mr Palmer's evidence. Further downstream, below the McKays weir, if proposed monitoring determines that fish recruitment upstream of the weir is not occurring, there is an ability to recommend release flows, within the limits of the control gate operation, timed to coincide with peak migration periods for key species (e.g., eels). The relevant monitoring conditions are found in Consent RC10001/19 (conditions 11-16).

78. Daily fluctuations in the level of Lake Kaniere as a result of scheme operation are minor, with daily fluctuations greater than 2cm occurring less than 50% of the time. I understand from the evidence of Mr Lennie Palmer that the maximum daily change in lake level that can be achieved as a result of scheme operation would be less than 5cm, under conditions where there is no inflow to the lake and the maximum outflow of 8 cumecs is maintained. In my opinion, such a small variation would have a less than minor effect on the lake's littoral communities including plant communities. The largest changes in lake level observed (10cm and greater) are due to natural increases associated with rainfall events. Most of the lake's shoreline is also subjected to much larger, sharp changes in water level associated with wave action (wave height of 30cm, Single 2011).

Effects of the scheme's flow regimes on water quality

79. As I have already stated, water quality in the Kaniere River is good due to the limited development in the catchment and the large amount of native riparian vegetation that remains as a consequence of this. There are no major discharges to the river so reduced flows in the river under the enhanced scheme will have no effect on potential contaminant dilutions; however, water temperatures may be affected.
80. A maximum water temperature of 23°C was recorded in the Kaniere River during monitoring from November 2009 to April 2010. Sustained periods of reduced flow under the enhanced scheme could cause temperature variation in the river, particularly during summer months. Substantial increases in water temperature coupled with an absence of safe retreats can result in fish and invertebrate stress and potential mortality. While flow does not have a large effect on daily mean temperatures, a reduction in flow may increase the daily variation by increasing temperatures in the afternoon and decreasing them in early morning.
81. In general, the tolerances for native fish species are much higher than for trout, and lethal temperatures are unlikely to ever be achieved in flowing sections of most rivers. Trout, therefore, remain the species that, if protected against, any meaningful temperature increase will result in protection of other river fish species.
82. Surface water temperature is driven by climatic and geographic conditions including air temperature, radiation and shade. The high water temperatures in Kaniere River in late summer are driven by the lake outlet water temperature as lakes act as heat stores, as shown in Appendix 1, Figures 3, 4 and 5. The Arnold River, which flows out of Lake Brunner, is another good example of this on the West Coast (Ryder 2010). However, when the flow of a river reduces it becomes more sensitive to radiation because it is shallower and flows more slowly. Such an effect can be induced by hydro-electric power schemes through the diversion of water away from the river.

83. I have recommended to TrustPower that river temperature is monitored continuously at two key sites in order to determine the relationship between flow and temperature under the enhanced scheme's flow regime.⁵ I have also recommended that a temperature trigger be incorporated into a consent condition to provide a mechanism for addressing any situation where temperatures reach a situation of concern thus requiring investigation and a response from the consent holder.⁶ In my opinion this approach is appropriate to address the potential effects of temperature increase on aquatic communities.

EFFECTS OF SCHEME CONSTRUCTION

84. Construction works associated with the re consenting of the Kaniere Forks scheme and the enhanced McKays scheme include dredging at the lake outlet, amendments to the race intakes and lake outlets and the modification of the McKays water race. The potential effects of these works on aquatic communities within the race and in the Kaniere River include direct habitat disturbance and also indirect effects due to elevated levels of sediment or other contaminants, or the introduction of aquatic weeds or algae. These potential effects are quite predictable and in my experience can be managed to ensure they remain short-term and reversible once construction is completed.

Water race modification

85. Construction work will be required under the enhanced scheme to increase the capacity of McKays water race. To undertake the works, the race will be dewatered and excavation of the race channel will be undertaken to widen and/or deepen it. Dewatering of the race is currently undertaken regularly to enable routine maintenance. It is likely that fish living within the race are able to survive these periods of temporary dewatering by moving to areas within the race where deeper water remains. However, the length and the extent of the works under the enhanced scheme will be greater and it is unlikely that fish will be able to move to avoid the works. Elevated suspended sediment levels in the race as a consequence of excavation will also be potentially unfavourable for macroinvertebrates and fish.
86. Other construction works associated with the enhanced scheme could result in the release of sediment or other contaminants to the river. Excavation or disturbance of an area of the river bed is likely to be required at the lake outlet and also during amendments to the McKays Weir. Adverse effects on aquatic communities in the

⁵ See: West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Water Permit RC10001/22 condition 3; and West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Water Permit RC10001/5 condition 3.

⁶ See: West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Water Permit RC10001/22, conditions 4 and 5; and West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Water Permit RC10001/5, conditions 4 and 5.

immediate area and downstream are possible if appropriate guidelines to prevent contaminants entering the river are not followed.

87. In my experience, post-construction, macroinvertebrates and fish will re-colonise the races and other disturbed areas if similar habitat to that present pre-construction (i.e., gravel/cobble dominated substrate) remains. Macroinvertebrates will colonise almost immediately mainly through drifting downstream from upstream habitats. This process is natural and occurs continually in rivers. Fish will also colonise by this method, although their re-colonisation will be more dependent on migration cycles as well as general movement about their wider environment. I would expect most local fish species to re-colonise areas affected by construction within 3-12 months depending on individual species.
88. Materials and machinery may be brought in from outside locations for the construction works and with this comes the potential for the introduction and spread of aquatic weeds and nuisance algae (e.g., *Didymosphenia geminata*). As with most construction activities near waterways, there is also the potential for materials and machinery to spill contaminants to waterways (e.g., diesel or concrete). The risk of such potential effects occurring can be minimised through the adoption of best management practices, which are typically specified within a construction management plan which is proposed in the conditions as proffered.

MONITORING AND MITIGATION

Fish screening

89. As I stated in paragraph 45 above, currently there is no effective fish screening of intakes to the Kaniere Forks and McKays water races with the consequence that fish are entrained to the schemes. Consequently, I have recommended to TrustPower that the existing water races are screened at some point prior to the power station penstocks and that safe fish passage is provided back to the Kaniere River. I have recommended that emphasis should be on excluding adult eels and migratory adult galaxiids and therefore a 20mm maximum gap size for screens is appropriate. This recommendation has been adopted by TrustPower and forms a part of draft consent conditions.⁷
90. I have also recommended screening of the Blue Bottle Creek intake to prevent adult eels and galaxiids entering the intake.⁸

⁷ See: West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Land Use Consent RC10001/2, condition 1; and West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Land Use Consent RC10001/19, condition 8.

⁸ This is provided for in West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Land Use Consent RC10001/11, condition 8.

Barriers to fish migration

91. Modifications to the instream structures at the Lake Kaniere outlet and McKays weir are, in my opinion, required to provide unhindered native fish passage. Due to the low height of the structures, only minor modifications should be necessary to achieve this and, in my opinion, this existing adverse effect can be rectified relatively easily.

Connectivity

92. The instream analysis I have undertaken indicates that mean water depths will be sufficient to allow native fish passage; however, there may be the occasional 'pinch' point where sufficient depth is not provided under low flow conditions. If such situations are present in the river after the enhanced scheme has commenced operation, it would be possible to modify the channel to maintain passage at the appropriate location(s) through the use of machinery.⁹
93. There is currently no residual flow provision in respect of Blue Bottle Creek, which results in a loss of connectivity in the lower reaches of the creek during low flow periods. This may be affecting fish distribution, although only one species found downstream of the intake has not also been found upstream. Recommending a residual flow is not possible at this stage because I am uncertain of what flow is sufficient to maintain connectivity, and this is likely to vary at different times of year due to variation in ground and surface water inflows downstream. I have therefore recommended a trial of residual flow options and this is provided for in TrustPower's draft consent conditions.¹⁰

Water quality

94. The existing water quality of the Kaniere River catchment is good and this is not anticipated to change under the enhanced scheme. The potential effect of further flow reductions on elevating water temperatures in the river is relevant because existing water temperatures have reached levels (23°C) that are unfavourable for some aquatic species, particularly if they are sustained over long periods. Water temperatures in the river appear to be driven by those at the lake outlet (see Appendix 2, Figure 3) and although daily fluctuations in water temperature are expected to increase slightly as a result of the enhanced scheme, daily mean temperatures should not be altered greatly. As already noted above, I have recommended temperature monitoring in respect of both schemes. In respect of the McKays scheme, monitoring is to occur immediately downstream of the McKays weir intake and at McKays Ford (3km downstream of the

⁹ See: West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, General Condition Section 1.11 and Water Permit RC1001/2, condition 6; and West Coast Regional Council Proposed Consent Conditions – McKays HEPS Water Permit RC10001/9, condition 16.

¹⁰ See: West Coast Regional Council Proposed Consent Conditions – McKays HEPS Land Use Consent RC10001/19, conditions 14 and 15.

weir). Monitoring for the Kaniere scheme is to occur immediately downstream of the Lake Kaniere outlet and immediately upstream of the McKays weir intake.

95. This monitoring programme has been incorporated into draft consent conditions and is linked to a temperature trigger condition whereby the minimum flow downstream of the McKays weir intake is to increase by 300L/s (0.3 cumecs) when the measured water temperature at downstream of the McKays weir intake exceeds 20°C, and water temperature at McKays Ford exceeds that at the first monitoring site by 3°C or more over a specified time interval.¹¹ An equivalent condition is proposed in respect of the Kaniere scheme.¹²

Instream habitat

96. Native fish are present throughout the Kaniere River system, with the most obvious effect of the existing scheme due to passage restrictions created by the McKays weir.
97. I regard the maintenance of safe fish passage for native species up and down the Kaniere River system as an important management objective primarily for sustaining the eel population supported in the catchment, but also other native fish species where access to and from coastal waters is essential.
98. Maintaining optimal physical habitat in the river itself, is in my opinion, less critical given the river has been modified for many years now as a result of the existing scheme, yet populations of native fish species still reside in the river, lake and tributaries.
99. A minimum flow range of 0.2-0.23 cumecs in the river upstream of the McKays Creek discharge was initially proposed by TrustPower for the enhanced scheme, which was lower than the existing minimum flow range. In order to identify an appropriate minimum flow regime, I examined physical habitat and flow relationships developed from the IFIM models. The critical 'break point' in the flow versus water width/depth relationship for the river appears to be around the 0.2 - 0.3 cumecs range (Figures 6). As depth does not change substantially with flow, in my opinion species requiring deeper water are unlikely to benefit substantially from major increases in flow. Changes in velocity with flow are more marked and fish with high velocity requirements, but not needing significant water depth, consequently benefit substantially from a major increase in flow in this river (up to a point), in particular bluegill bully, koaro and torrentfish (Figure 7). Similarly, invertebrate taxa such as the filter-feeding caddisfly *Aoteapsyche* and the common mayfly *Deleatidium* (but to a lesser extent) benefit from higher flows through greater velocities despite little change in water depth (Figure 8).

¹¹ The measured water temperature is an average taken over 24 hours commencing at midnight. See West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Water Permit RC10001/22 conditions 4 and 5.

¹² See West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Water Permit RC10001/5 conditions 4 and 5.

100. Tables 1 and 2 (Appendix 1) present a simple 'ranking' I prepared of the benefits to various fish and invertebrate species (in terms of providing physical habitat) from changing the flow from 0.2 to 5 cumecs. I included long filamentous algae also in this analysis as its prevalence can increase with reduced flow (due to lower velocities at low flow) and this can have ramifications for benthic invertebrate communities and aesthetics.
101. My ranking assessment indicates that several fish species have almost no habitat at flows between 0.2 and 0.5 cumecs, namely bluegill bully, koaro, torrentfish and adult brown trout. Further, food producing habitat (which is related to suitable habitat for a range of aquatic macroinvertebrate species that provide food for larger fish) is minimal in this flow range. Torrentfish require flows well in excess of 1 cumec to provide much in the way of habitat. However, I have observed reasonable numbers of torrentfish in one regulated river that is subject to both low and high daily flows (lower Waipori River, Otago, daily flow range 0.6 – 19 cumecs, Goldsmith *et al.* 2004) indicating that they are capable of tolerating low flow habitat provided regular high flows are also provided.
102. There is little habitat for small brown trout (<100mm in length) at 0.2 cumecs, but this increases considerably at 0.4 cumecs at both Ward Road and McKays Ford (Figure 9). There is considerable habitat for several fish species at flows of between 0.2 and 0.4 cumecs (common bully, redfin bully, small shortfin eel and shortjaw kokopu).
103. In general, 0.2 cumecs at both Wards Road and McKays Ford probably provides marginal habitat for many fish species and their food supply, and only small native fish are likely to take advantage of such a low flow if it is prolonged. A flow of 0.4-0.5 cumecs provides additional habitat for bluegill bully, koaro, longfin eel, small brown trout and adult brown trout (the latter only at McKays Ford).
104. In my opinion, maintaining a higher minimum flow of 0.4 cumecs at Ward Road should therefore provide suitable physical habitat for a range of native fish species, and some habitat for small brown trout. This is the minimum flow I recommended to TrustPower, which has been incorporated in draft consent conditions.¹³
105. As detailed in the evidence of Mr Palmer, a median flow of around 0.08 cumecs and a mean flow of 0.30 cumecs is contributed to the river from tributary inflows in the reach from the lake outlet to Ward Road. However as Lake releases for the enhanced McKays station operation were modelled to occur for 90% of the time, that simulated minimum flow of 0.40 cumecs at Ward Road occurred for 8% of the time. Put simply, flows greater than the proposed minimum flow will occur most of the time (i.e., approximately 90% of the time the flow will be greater than the minimum flow).

¹³ See West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Water Permit RC10001/5, condition 2.

106. The lower river below McKays weir is generally less constrained and therefore wider than upstream, and more water is required to achieve the same extent of instream habitat as upstream. I have recommended a minimum flow of 0.5 cumecs downstream of Kaniere Forks Station at the McKays Ford. Hydrological modelling indicates that this can be achieved with tributary inflows by maintaining a minimum flow of 0.3 cumecs at McKays weir.¹⁴ The minimum flow of 0.3 cumecs in the reach from McKays weir downstream to the Kaniere Forks discharge would occur approximately 80% of the time. This minimum flow does not apply to the whole reach as there are additional flow contributions from Coal Creek and Bottle Creek downstream of the weir. In the reach downstream of the Kaniere Forks discharge to the McKays discharge the minimum flow of 0.5 cumecs would occur less than 3% of the time.
107. I have recommended to TrustPower that native fish communities are monitored at several locations to determine the effectiveness of the fish pass systems associated with the enhanced scheme, and this recommendation has been incorporated into draft consent conditions.¹⁵ In the event that monitoring shows that there is not a comparable fish community diversity upstream and downstream of the fish pass system, the consent holder is to commission an independent audit and associated recommendations to be undertaken to establish why the fish pass system is not effective, and to provide recommendations to the Consent Authority for modifications needed to the relevant fish pass and systems.¹⁶
108. Nuisance filamentous algae growths have the potential to develop under the enhanced scheme, although these can develop naturally in lake outlet rivers due to stable flows and high water clarity, a phenomena that we have previously observed in the Kaniere River on occasions. In some situations where storage is available, nuisance filamentous algae growths can be managed by (in this case) shutting out water from the scheme for a period of time (e.g., 12 hours) hours to create a 'flushing flow' effect down the river through the movement of higher velocity water.
109. Typically, the magnitude of flushing flows needs to be in the order of 4-6 times the preceding flow in order for the periphyton to be dislodged from the bed. However, they may need to be even higher in a lake outlet river where the bed is usually more stable than rain fed rivers and consists of large, relatively immobile cobbles. Such an approach to managing periphyton nuisance periphyton growths is river specific and would need to

¹⁴ See West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Water Permit RC10001/22, condition 2.

¹⁵ See: West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Land Use Consent RC10001/19 conditions 11-13; and See West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Land Use Consent RC10001/2 conditions 3-5.

¹⁶ See: West Coast Regional Council Proposed Consent Conditions – McKays HEPS, Land Use Consent RC10001/19, condition 16; and See West Coast Regional Council Proposed Consent Conditions – Kaniere HEPS, Land Use Consent RC10001/2, condition 6.

be monitored and adjusted to determine the most appropriate and efficient flushing regime. In my opinion, the risk is greatest in the reach between McKays weir and the McKays Creek power station, as this reach will carry lower flows more frequently than elsewhere. I have recommend to TrustPower that periphyton be monitored over the warmer months of the year (November–April, in line with MfE guidelines) to check that periphyton guideline levels are not being exceeded due to the operation of the scheme. If nuisance growths (as defined within the guidelines) are a natural phenomena associated with the Kaniere River, then in my opinion TrustPower should be able to curtail this aspect of the monitoring programme.

110. These recommendations have been incorporated into draft consent conditions so that if monitoring indicates that periphyton guidelines have been exceeded the consent holder must initiate a flushing flow downstream of McKays weir intake to generate a flow of at least 6 times the preceding base flow (post enhancements) for no less than 12 hours.

Scheme construction

111. In my opinion, the effects of construction associated with the enhanced scheme will be short-term in nature and relatively minor. Effects on aquatic biota and water quality can be controlled by specifying appropriate strategies to minimise disturbance via management plans. TrustPower has proffered a consent condition requiring an Environmental Management Plan. The plan is to provide details as to the construction programme, and methods for the management of environment effects arising as a consequence of construction activities.
112. TrustPower also has draft consent conditions to provide for a Contingency and Response Management Plan, which will specify the procedures to be followed by the consent holder in the event of any unauthorised accidental discharge of contaminants. An Earthworks and Sediment Control Plan is also proposed that will specify the procedures to be followed during the construction of the enhanced scheme to ensure compliance with the conditions relating to stormwater discharges and earthworks consents.

SUBMISSIONS

113. The Department of Conservation (*DOC*), West Coast Tai Poutini Conservation Board, and Mr Athol Olsen raised aquatic ecology matters in their submissions. While most of the matters raised have been covered in my evidence above, I will briefly comment on each submission.

Department of Conservation

114. DOC's key issue is the proposed minimum residual flow for the Lake Kaniere outlet and immediately downstream of the McKays intake. DOC highlights issues associated with the mean flow of the Lake Kaniere outlet and the proposed take resulting in flow rate

from the proposal as having significant effects on the nature of the river and instream values.

115. I have discussed the potential adverse effects of flow reductions in the Kaniere River on communities in paragraphs 98 to 111 above. As I noted in paragraph 67 the amount of habitat available for a species depends on its habitat requirements, for some species the amount of habitat increases as flows increase (e.g., koaro and torrentfish) and for other species it decreases (e.g., common bully and redfin bully). The determination of an appropriate instream flow regime requires balancing the habitat requirements of different species in order to select a flow that retains some habitat for all species. I have identified that minimum flows below 0.5 cumecs under the enhanced scheme are predicted to decrease habitat for native fish with high velocity preferences, but increase habitat for native fish species with low velocity preferences. For some native fish species reduced flows associated with the enhanced scheme will therefore actually increase the amount of habitat relative to the existing situation. Minimum and median flows will differ among reaches, providing some habitat for native fish species with varying velocity preferences along the river.
116. DOC correctly notes that the minimum flow at the Lake Kaniere outlet would be 0.3 cumecs under the enhanced scheme, however I note that there is a related requirement to maintain a minimum flow of 0.4 cumecs downstream at Ward Road. Surface water inflows are expected to contribute the additional 0.1 cumecs along the 3.1km reach between these two sites, however if they do not TrustPower will be required to release additional water at the lake water to achieve the 0.4 cumec minimum flow at Wards Road. I note that during the low flow trial I discussed in paragraph 60 although a flow of 0.2 cumecs was maintained at the lake outlet, the flow at Ward Road had increased to 0.65 cumecs due to surface water inflows. Therefore although a minimum flow of 0.3 cumecs will be maintained at the lake outlet I expect that flows will be above this for the majority of the river length from the lake outlet downstream to Ward Roads. Similarly, downstream of McKays weir the minimum flow of 0.3 cumecs will increase to 0.5 cumecs within the 2.9km reach downstream to McKays Ford. I note further that the proposed minimum flow regime for the reach between the Lake outlet and McKays Weir is predicted to occur only about 10% of the time and often the flows will be much higher than this.
117. An adaptive management process has been proposed, which will include monitoring of native fish communities, with increased flows required if adverse effects on native fish communities as a result of flow reductions are identified.

West Coast Tai Poutini Conservation Board

118. The West Coast Tai Poutini Conservation Board is concerned that the anticipated residual flows for the uppermost reaches of the Kaniere River as a result of the proposed increase take will result in adverse effects on the aquatic ecology of those reaches.
119. The Board seeks that consent conditions be imposed to increase the residual flow in the uppermost section of the Kaniere River to a degree that supports aquatic ecosystems and maintains natural character and amenity values.
120. As discussed above at paragraphs 98 to 111 and in my response to the DOC submission above, I consider the residual flows proposed in the conditions of consent are suitable based on the physical habitat and flow relationship developed from the IFIM models. As already noted, an adaptive management process will be applied to the residual flow to monitor and mitigate any effects of reduced flows on native fish communities.

Mr Athol Olsen

121. Mr Olsen's submission related to:
- a. degradation of waterways;
 - b. loss of fish breeding ground; and
 - c. water temperature effects.
122. I consider that these concerns relating to waterway degradation and water temperature effects are adequately addressed in paragraphs 79-83 above, respectively. In terms of fish spawning, there will be no effect on fish that may spawn in Lake Kaniere (i.e., bullies, giant kokopu, perch) as the changes in the lake level are subtle and not of the kind that would suddenly expose fish eggs. In terms of the Kaniere River, the only species that might want to use the river for spawning are common, bluegill and redfin bullies. These species lay their eggs under rocks and plenty of suitable habitat will therefore remain in the river. Most fish species in the Kaniere River system are likely to spawn in tributaries (e.g., banded kokopu, koaro) or in tidal habitats downstream (e.g., giant kokopu, inanga).

Mr Nelson Bradley and Ms Jackie Gurden

123. These two submissions relate to the effects of changes to the lake level on fish in the lake. Mr Bradley's submission raises concern that decreased lake levels could affect fish spawning and suggests that lake levels be increased to extend the stream (Sunny Creek) at Sunny Bight to maintain fish spawning. It is not clear what fish species spawning Mr Bradley is referring to and how increasing lake levels would extend the stream at Sunny Bight, if anything increasing lake levels will decrease the length of Sunny Creek as the lake would encroach further upstream at higher levels. Ms Jackie

Gurden is concerned about the impact of lake level fluctuations on fish. As noted in the response to Mr Olsen's submission above, lake level fluctuations will not occur suddenly and therefore will not affect fish.

Fish and Game NZ – West Coast Region

124. The Fish and Game submission identifies that the Lake Kaniere trout fishery is reliant upon upstream trout migration through the Kaniere River, and that the existing instream structures present a significant barrier to migrant fish. The Fish and Game submission states that they currently augment the Lake Kaniere trout and salmon population, however they anticipate that they will have to cease migrant salmon releases under the enhanced scheme as reductions in flow in the Lake outlet to Ward Road section of the river will make this section difficult for migrant salmon to negotiate.
125. The Fish and Game submission does not elaborate on the timing of their restocking programme, but it appears that stocking of trout and salmon to Lake Kaniere has only begun within the last two years. I note media reports¹⁷ in May 2011 that 15,000 yearling rainbow trout fingerlings had been released in Lake Kaniere and 8,000 salmon smolt were released to Geologists Creek, a Lake Kaniere tributary, during the summer of 2009/2010¹⁸. When I reviewed the existing Kaniere River catchment fishery in November 2010 for the preparation of my aquatic assessment of effects, I found only one record for rainbow trout and two records of Chinook salmon in the catchment (NZFWFDB). In comparison there were 29 records for brown trout. Given the lack of salmon records in the catchment I did not consider the requirement to provide upstream passage for salmon necessary at the time my assessment was made. The stocking of rainbow trout and salmon to the lake to establish a fishery of these species in the catchment is a recent initiative by Fish and Game. A recent item on the Fish and Game website suggests the stocking has been successful¹⁹.
126. The salmonid fishery is dominated by brown trout, which undertake their upstream spawning migration during autumn and winter. Upstream migration adult trout and salmon face a barrier at the McKays weir. This is not a total barrier as large salmonids are well capable of negotiating the height of this weir, particularly when the weir is spilling. In relation to the residual flow in the reach upstream of Ward Road being insufficient to allow migrant sports fish passage, a conservative approach suggests that large trout require a minimum water depth of 25cm for upstream passage (Hudson and Harkness 2010), although depths of great than 18cm have also been suggested as sufficient (Thompson 1972 in Young 2007). Smaller trout conservatively require a depth of 20cm (Hudson and Harkness 2010). Under the enhanced scheme the average water

¹⁷<http://www.stuff.co.nz/sport/fishing/area-reports/south-island/4965053/West-Coast-May-2011>

¹⁸<http://www.fishandgame.org.nz/Site/Regions/WestCoast/fishingNews/Feb2010.aspx>

¹⁹<http://westcoast.fishandgame.org.nz/newsitem/west-coast-reel-life-apr-2012>

depth in the reach from the lake outlet to Ward Road at minimum flows of 0.3 and 0.4 cumecs (occurring less than 7% of the time) is predicted to be 19-21cm and 53cm at median flows. Therefore, the largest trout may have to wait for increased flows to pass through some sections of the upper river (estimated flow spilling at the lake outlet under the enhanced scheme is 10% of the time), however, it is likely that smaller trout would be able to move upstream at even the minimum flow.

127. Further, I understand that TrustPower and Fish & Game have agreed on a Fishery Enhancement Programme for Lake Kaniere which addresses Fish & Game's concerns relating to the salmonid fisheries including fish passage.

WEST COAST REGIONAL COUNCIL STAFF RECOMMENDING REPORT

128. I have read the WCRC Staff Recommending Report (section 42A) and have no major concerns regarding issues raised in relation to water quality and aquatic ecology. There appears to be some misunderstanding associated with enhanced fish passes associated with the schemes. These improvements are aimed to enhance native fish passage, which is currently restricted at McKays weir in particular. As I have noted above in paragraphs 125-128, enhanced fish passage for salmonids is not considered necessary.
129. I also note on page 19 of the Officer's report (under section 5.2 Benefits/Positive Effects) that the author's refer to benefits to fish and eels by installing 'mesh fish screens'. This isn't exactly correct as the screens are more likely to be profile bars which form parallel slots similar to those on the existing trash racks but with narrower gaps between the bars to exclude fish.
130. The report refers to some works at the McKays weir intake and at the McKays power station tailrace involving the installation of a pipe to enable fish to return to the river. The pipe at the McKays intake would be positioned immediately upstream of the fish screen to provide an obvious pathway for fish back to the river below the weir. At this stage I am unsure whether a return flow back to the river for fish is necessary at the tailrace. The reason for this is that while it is not uncommon for fish (particularly upstream migrating native fish) to be attracted into power station tailraces, there is no evidence that this has been a problem at the Kaniere/McKays stations. Consequently, I have recommended to TrustPower that the tailrace area is included with the other river fish monitoring required under draft consent conditions, and if there are significant accumulations of fish found in the tailrace, then a return channel would need to be constructed or some other form of transfer system established. This recommendation is reflected in proposed condition 9 of Land Use Consent RC10001/19 (Structures and bed disturbance).
131. The WDC have expressed concern about the effect of lower lake levels on water quality and their town supply. The concern is that with the lake being lower for longer and more

often near the minimum lake level, there would be less of a buffer should any oil spill or hydrocarbon contamination occur.

132. In my opinion, this concern is unfounded. As I have already noted, there will be no change to the lake's water quality.

CONCLUSION

133. In my opinion, proposed consent conditions for the Kaniere/McKays power schemes will ensure that lake and river water quality is maintained in its current good state and that existing fisheries of the Kaniere catchment are maintained and enhanced.

DATED this 29 day of May 2012

Gregory Ian Ryder

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APPENDIX 1

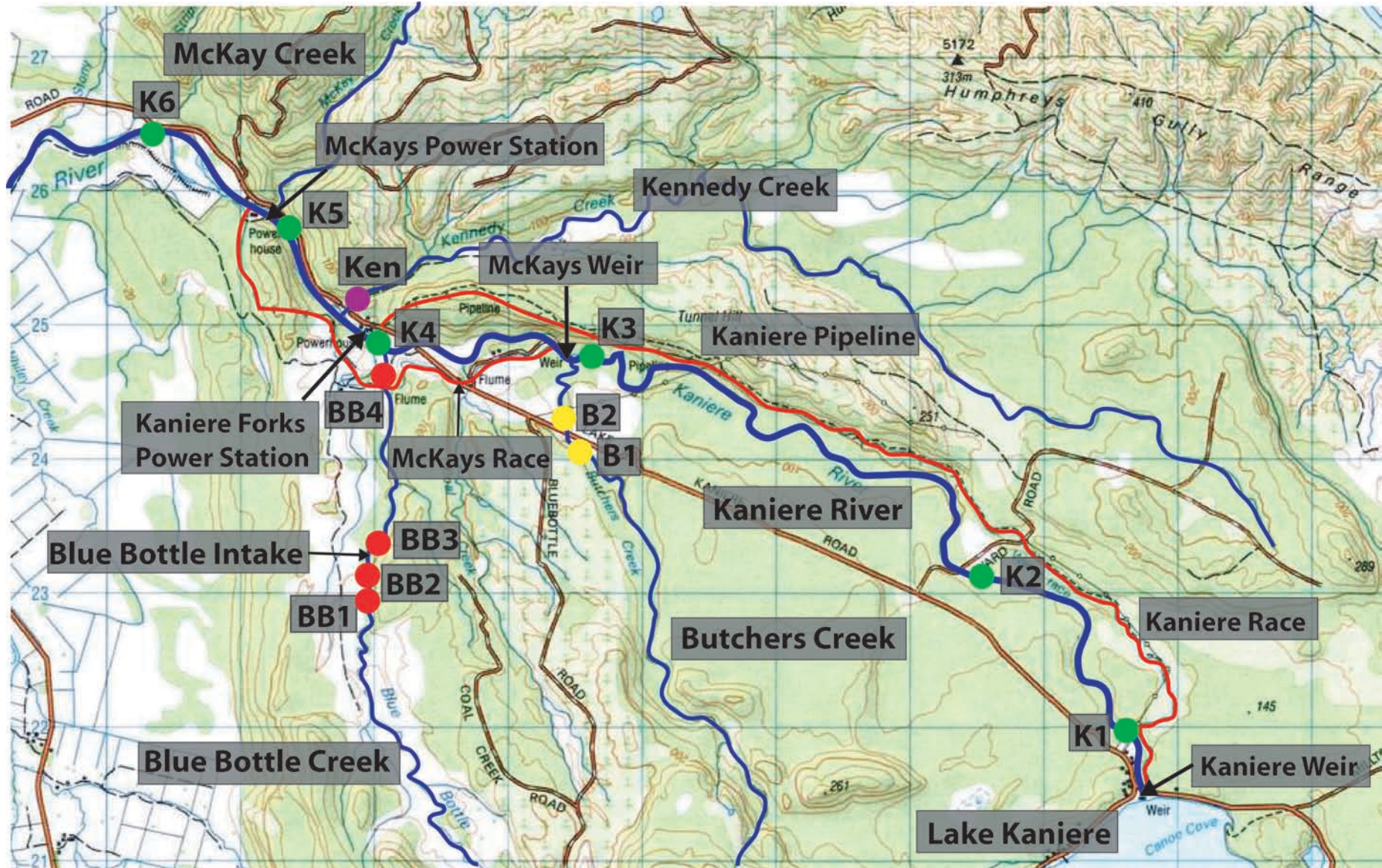


Figure 1 Location of monitoring sites in the Kaniere River catchment.

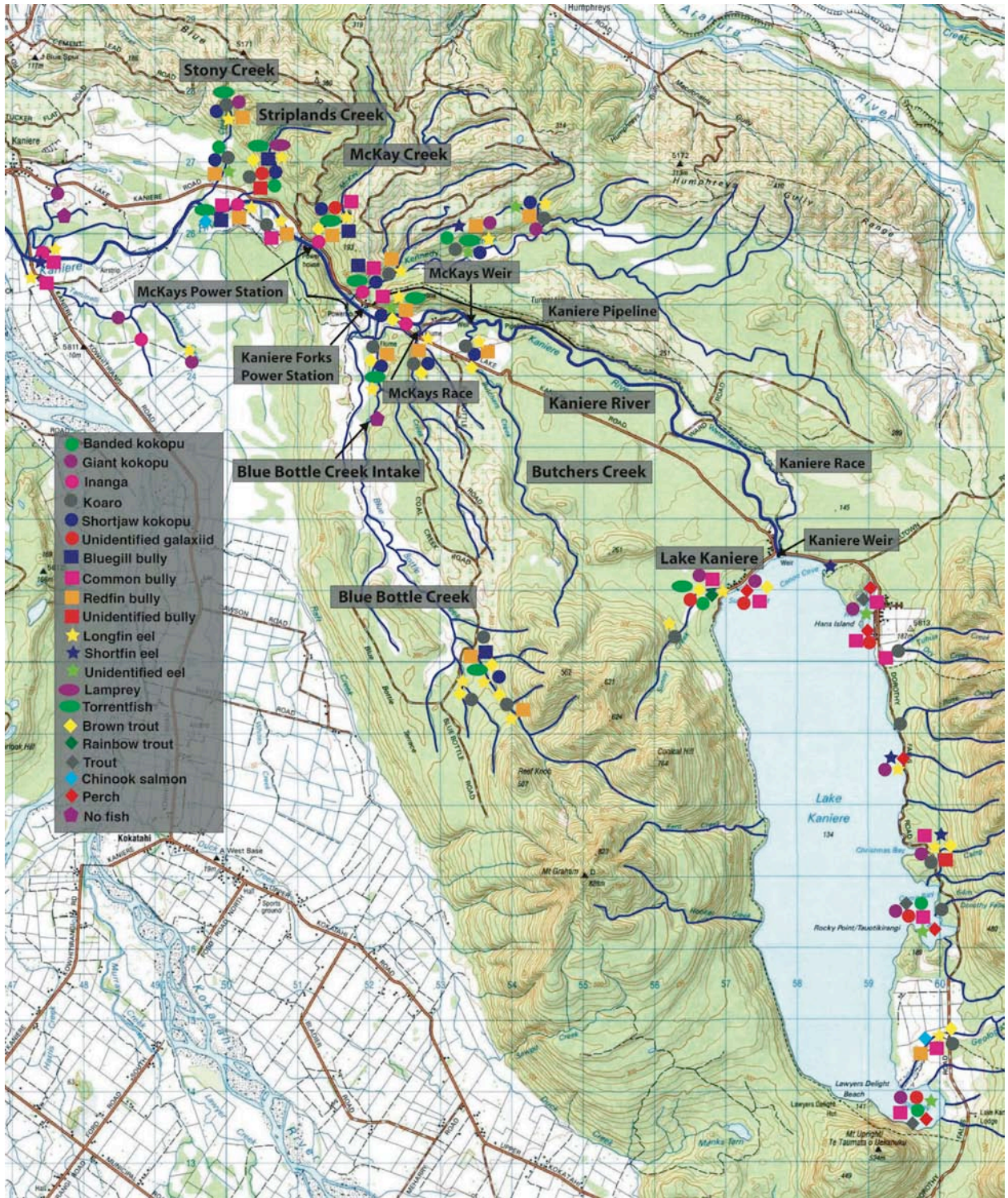


Figure 2 Location of fish records for the Kaniere River catchment.

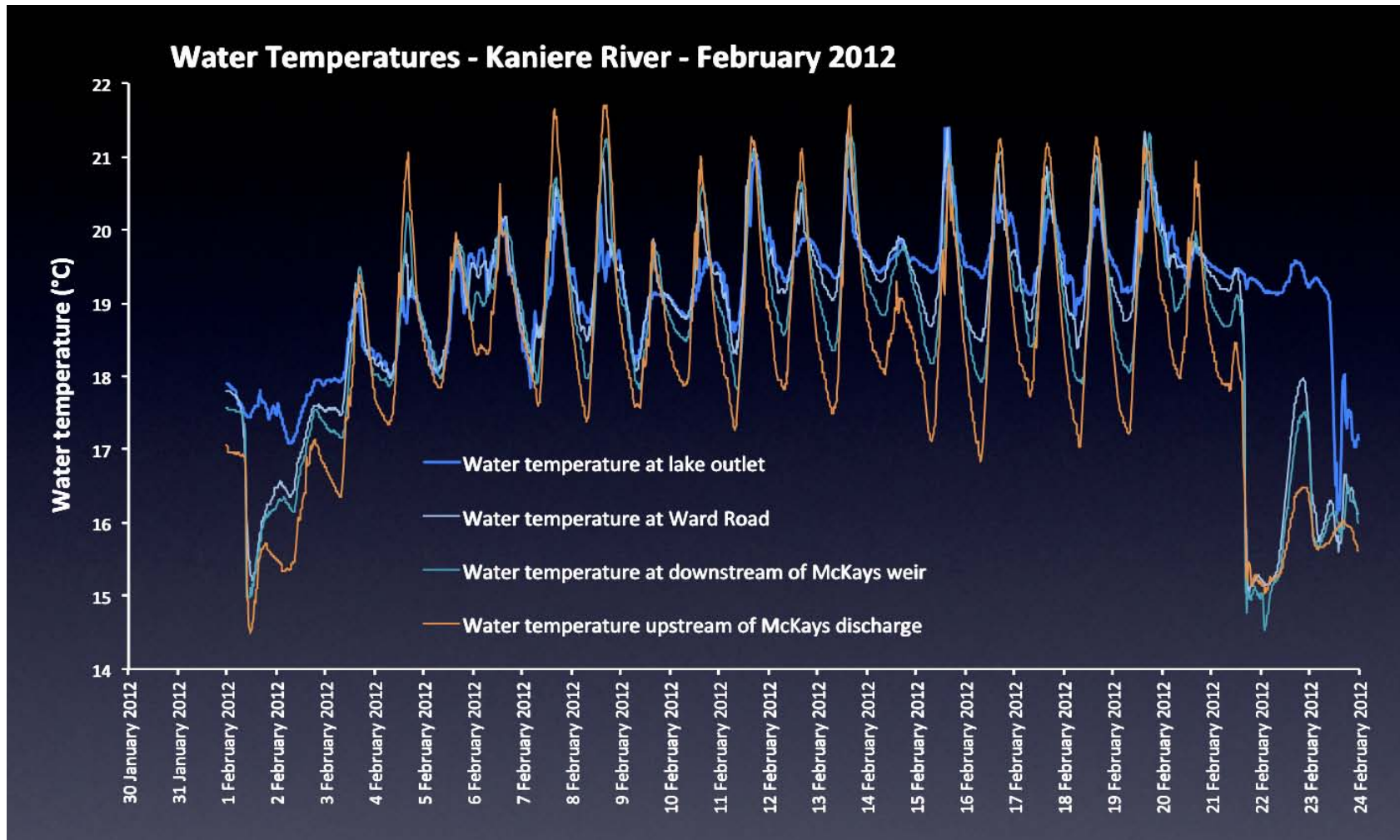


Figure 3 Water temperature profile, Kaniere River, February 2012.

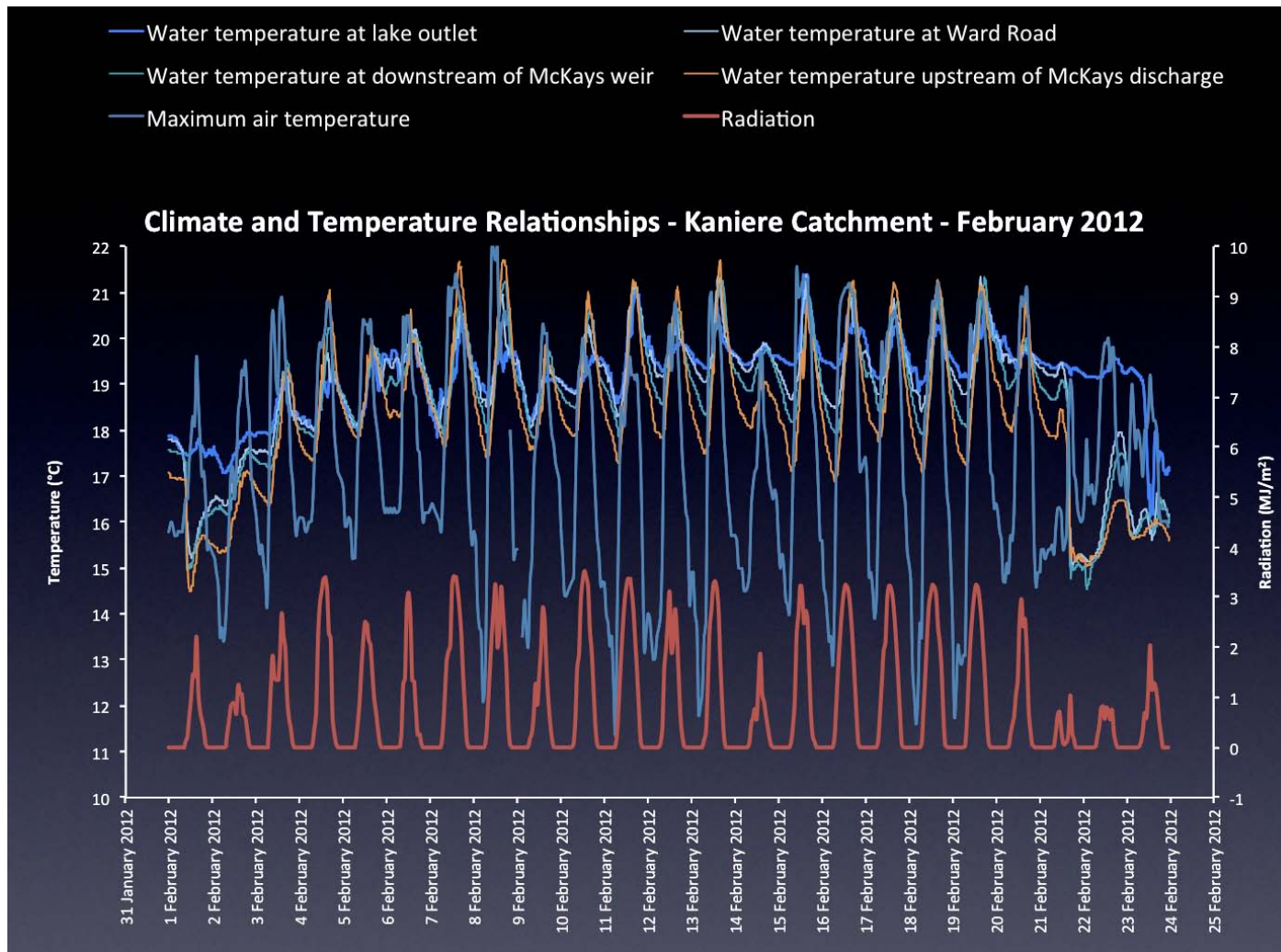


Figure 4 Climate and temperature relationships, Kaniere River, February 2012.

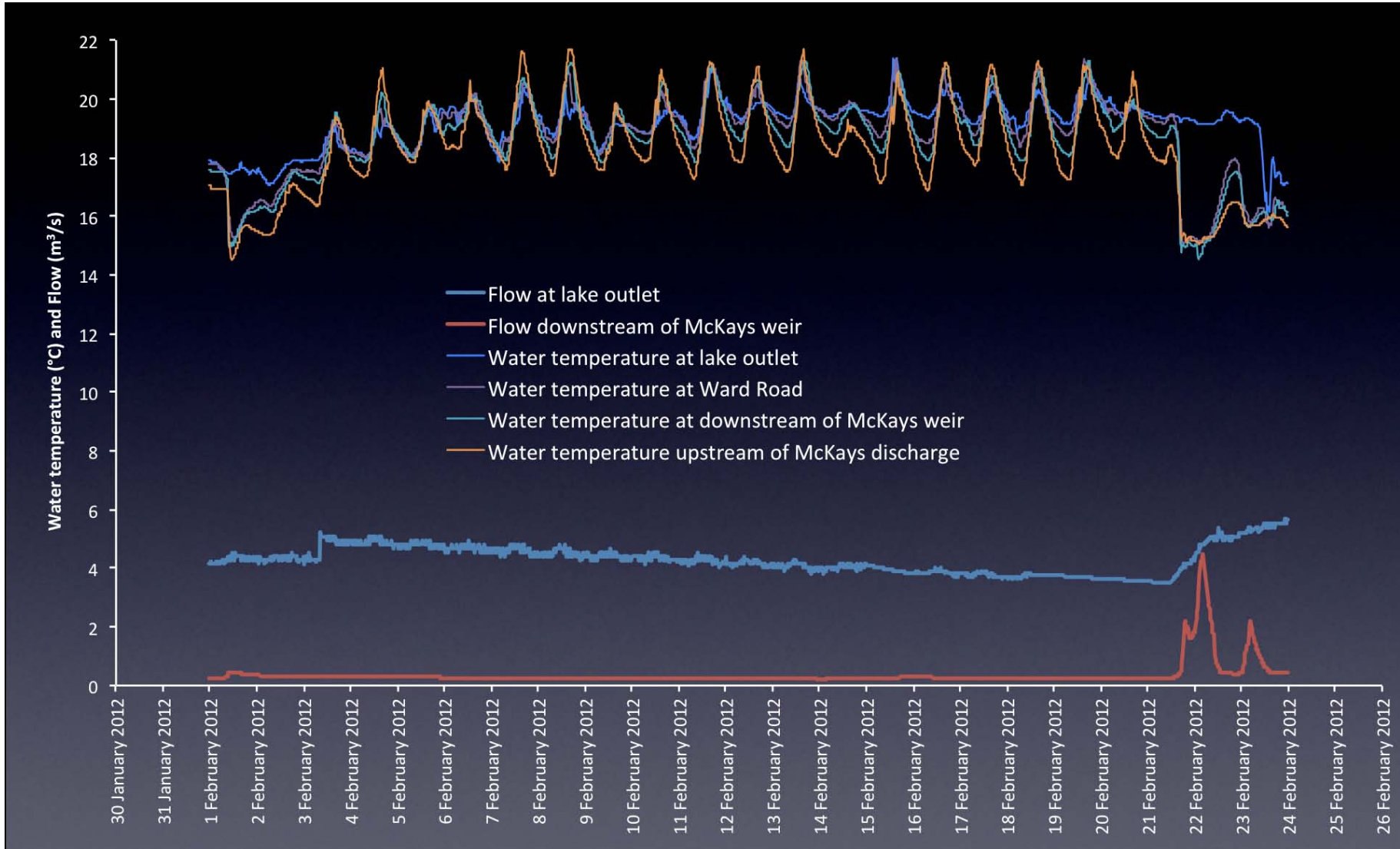


Figure 5 Climate and temperature relationships, Kaniere River, February 2012.

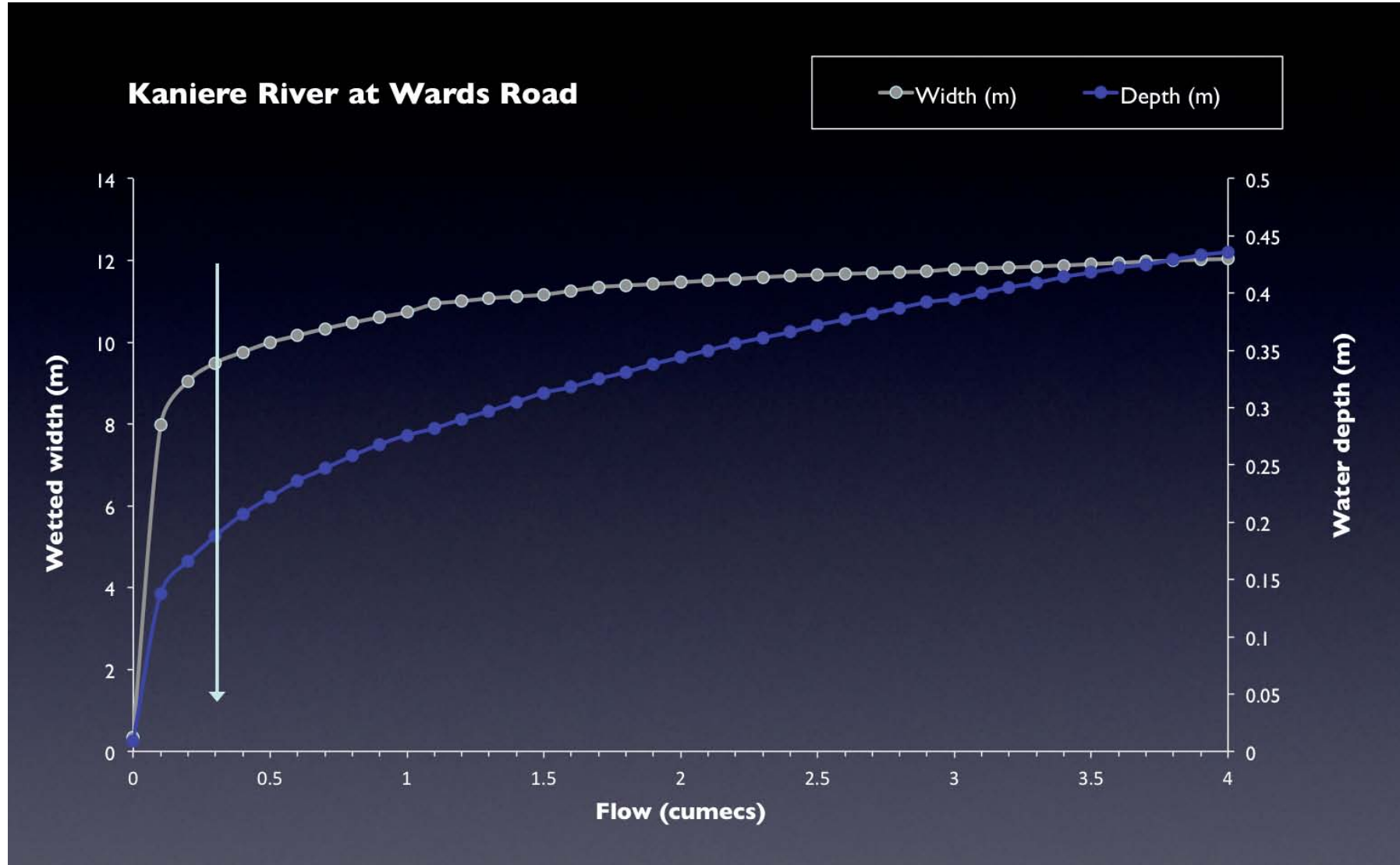


Figure 6 Relationship between water depth and wetted width, Kaniere River @ Ward Road.

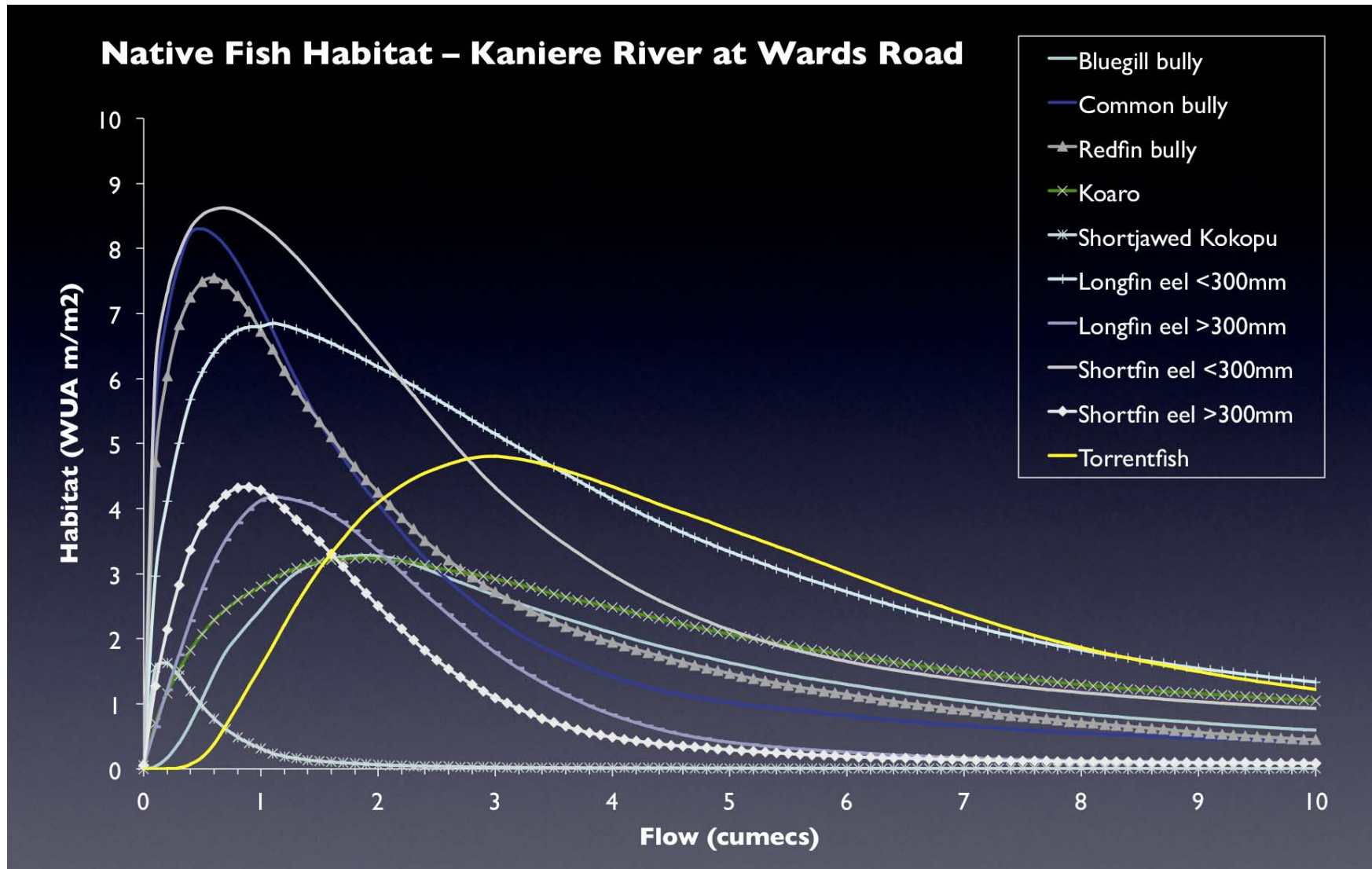


Figure 7 Relationship between flow and potential physical habitat for native fish, Kaniere River @ Ward Road.

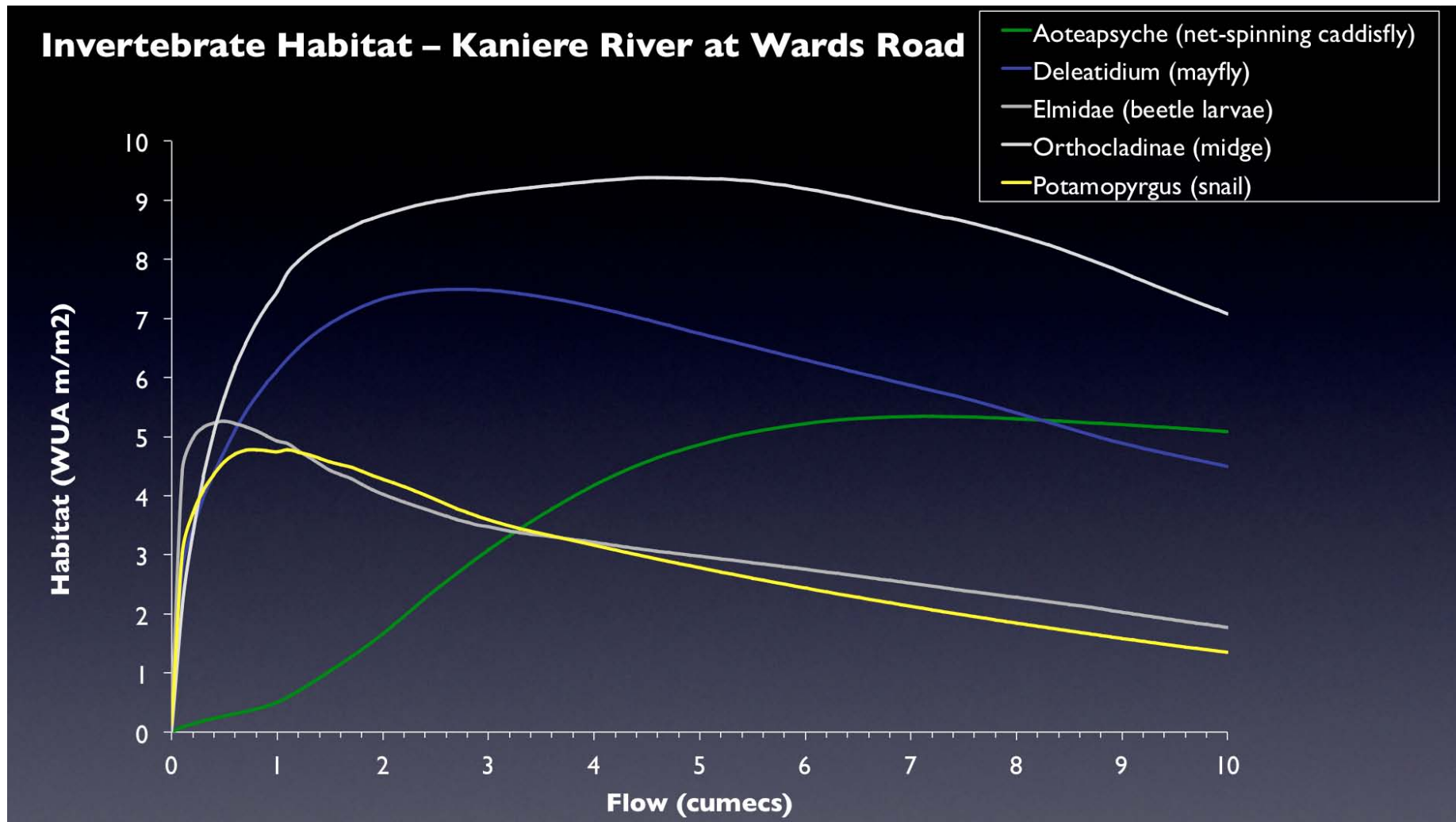


Figure 8 Relationship between flow and potential physical habitat for benthic invertebrates, Kaniere River @ Ward Road.

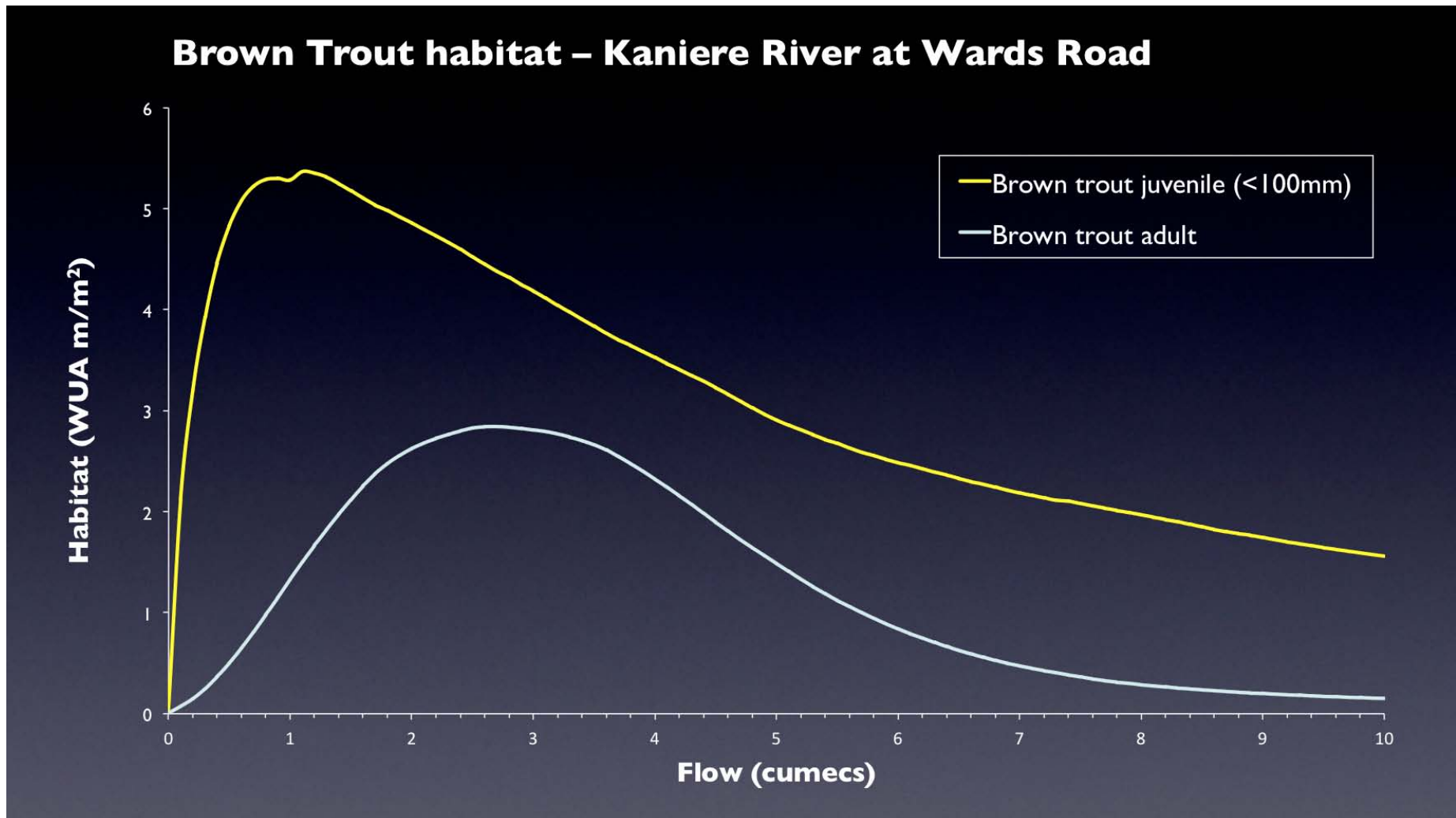


Figure 9 Relationship between flow and potential physical habitat for brown trout, Kaniere River @ Ward Road.

Table 1 *Habitat ranking for a range of species in the Kaniere River at flows ranging from 0.2 to 5 cumecs. Predicted using the Wards Road IFIM model and therefore relevant to the constrained, upper reaches of the river.*

Flow (m ³ /s)	Bluegill bully	Common bully	Redfin bully	Koaro	Shortjawed Kokopu	Longfin eel <300mm	Longfin eel >300mm	Shortfin eel <300mm	Shortfin eel >300mm	Torrentfish	Brown trout <100mm	Brown trout adult	Food producing	Long filamentous
0.2	0	√√√	√√	0	√√√	√	√	√√√	√	0	√	0	0	√√
0.4	√	√√√	√√	√	√	√√√	√	√√√	√	0	√	0	√	√√
0.5	√	√√√	√√	√	√	√√√	√	√√√	√	0	√	0	√	√√
1	√√√	√√√	√√	√	0	√√√	√√√	√√√	√√√	√	√√√	√	√	√√
5	√√√	√	√	√	0	√	√	√	0	√	√	√	√√√	0

Table 2 *Habitat ranking for a range of species in the Kaniere River at flows ranging from 0.2 to 5 cumecs. Predicted using the McKays Ford IFIM model and therefore relevant to the less constrained, lower reaches of the river.*

Flow (m ³ /s)	Bluegill bully	Common bully	Redfin bully	Koaro	Shortjawed Kokopu	Shortfin eel <300mm	Shortfin eel >300mm	Longfin eel <300mm	Longfin eel >300mm	Torrentfish	Brown trout <100mm	Brown trout adult	Food producing	Long filamentous
0.2	0	√√√	√	0	√	√	√	√	√	0	√	0	0	√
0.4	0	√√√	√√	√	√	√√√	√√√	√	√	0	√	√	0	√√
0.5	√	√√√	√√	√	√	√√√	√√√	√√√	√√√	0	√	√	0	√√
1	√	√√√	√√	√	√	√√√	√√√	√√√	√√√	√	√√√	√	√	√√
5	√√√	√	√	√	√	√	√	√	√	√√√	√√√	√	√√√	√

KEY	INTERPRETATION
0	Almost no habitat
√	Some habitat
√√	Good habitat
√√√	Very good or near optimum habitat