Before Environment Canterbury Regional Council

In the matter of	of the Resource Management Act 1991
And	
In the matter of	the Rangitata Diversion Race Consents

Statement of evidence of Martin Bonnett for Central South Island Fish and Game Council

10 April 2018

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Qualifications and experience

1 My name is Martin Lee Bonnett.

2 I am a freshwater ecologist employed by Golder Associates (New Zealand) Ltd.

3 I have been involved with research on the biology and ecology of freshwater fish in New Zealand waters since 1980, and I have had relevant experience with freshwater fish and fisheries in a variety of waters in the South Island.

4 I hold the following qualifications: Bachelor of Science (Zoology) and Diploma in Science (Zoology) from Massey University, and Master of Science (Zoology) from University of Canterbury. I am a member of the Royal Society of New Zealand, and the New Zealand Freshwater Sciences Society.

5 I have published three scientific papers and one report on the fish and fisheries resources of the Rangitata River. I am co-author of the guidelines for fish screening in Canterbury, and have also conducted and reported on tests of effectiveness of fish screens in Canterbury. **Appendix I** to my evidence contains citations for these publications.

6 In preparing this evidence I have reviewed the statements of evidence of other experts giving evidence relevant to my area of expertise, including:

(a) The evidence of Mr Mark Webb; and

(b) The evidence of Dr Gregory Ryder; and

(c) The evidence of Mr Paul Morgan.

7 I have also reviewed:

(a) The section 42A officer's report prepared by Ms Natalia Ford and the additional review of resource consent applications by Dr Adrian Meredith for the Canterbury Regional Council (**CRC**);

(b) The section 42A officer's report prepared by Mr Nick Boyes for the Ashburton District Council (**ADC**); and

(c) The consent conditions recommended by CRC, and the proposed changes to recommended conditions of consent that are attached to the evidence of Mr David Greaves.

8 On 19 March, 2018, I participated in expert conferencing with Dr Gregory Ryder (Ryder Consulting on behalf of RDRML), Mr Mark Webb (Central South Island Fish and Game Council), Dr Adrian Meredith (Environment Canterbury) and Mr Paul Morgan (Riley Consultants on behalf of RDRML). This conferencing

focused on the fish screen proposal, the taking of the additional water, the Klondyke Reservoir water quality and discharges back to the Rangitata River. The Joint Witness Statement from the conferencing is attached to my evidence as **Appendix II**.

9 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

10 I have been asked by Central South Island Fish and Game Council (**CSIFGC**) to prepare evidence in relation to Rangitata Diversion Race (**RDR**) Consents. This concentrates on the suitability and likely effectiveness of a proposed fish screen, and its associated bypass, for excluding fish at the RDR intake on the Rangitata River.

11 I will outline which species of fish are present, their migratory habits, and species at risk near the RDR intake. I will then discuss what features make a fish screen effective, how the proposed screen will meet the criteria for effective screens, how the screen will meet requirements for Rangitata fish, as well as the importance and appropriate requirements of verification trials.

Executive summary

12 Six species of freshwater fish are at risk at the proposed RDR intake screen, as they are likely to be present near the intake, or encounter it during migration in the river. The proposed rotary cylinder fish screen should meet or exceed guideline criteria for fish screening and thereby effectively exclude these fish from entering the RDR, returning them safely and promptly back to the Rangitata River. However, it will need to be demonstrated that the water adjacent to the proposed screens will have a uniform approach velocity that is no greater than 0.12 m sec^{-1}, that there will be high sweep velocity to prevent fish being exposed to the screens for much more than 60 seconds, and that a suitable programme for operation and maintenance of the screening facility and bypass is in place. Meeting or exceeding guideline criteria does not guarantee that the screen will be effective, and verification trials will be necessary. There are several options for verifying the effectiveness of the fish screen, and generally these will be facilitated if the screen design and installation makes provision for access and fish trapping equipment.

Freshwater fish of the Rangitata River

13 From my own research and from information downloaded from the New Zealand Freshwater Fish Database (**NZFFD**), I am aware of at least fifteen native and five introduced species of freshwater fish occurring in the Rangitata River catchment (**Table 1**). 73% of the native species of freshwater fish from the river are endemic, i.e. they are only found in New Zealand and 73% are migratory, having a marine phase during their life cycle. The assemblage of fish species in the river is typical of braided rivers along the east coast of the South Island.

14 In **Table 2**, I have summarised the results of seven electric fishing surveys conducted in four reaches of the Rangitata River between June 1983 and June 1984 (data from Bonnett 1986). The greatest species diversity and abundance of fish occurs near the sea, with numbers decreasing with increasing distance upstream. This is due to migratory species reaching inland penetration and elevation limits. Three migratory species (bluegill bully, common bully and torrentfish) dominate the native fish fauna in the lower river, whereas the river above the gorge is dominated by four non-migratory species (upland bully, alpine galaxias, Canterbury galaxias, and longjawed galaxias). Fishes swimming ability, and the availability of suitable habitat are likely to be the primary features governing inland distribution. The longitudinal distribution of fish within the Rangitata catchment is not typical of braided rivers along the east coast of the South Island, in that there is a marked distinction between native fish communities upstream and downstream of the Rangitata River Gorge. Migratory native species rarely penetrate above the Rangitata Gorge, while most non-migratory native species are rarely encountered below it; only one native (upland bully) and two introduced species (brown trout and Chinook salmon) can be described as having widespread distribution throughout the catchment.

Freshwater fish at risk near the RDR intake

15 Six of the fish species known to occur in the Rangitata River might be regarded as being at risk of entrainment into the RDR because they occur close to, or migrate past, the RDR intake. Migratory fish are of most concern near intakes, as they move up and down the river as a normal part of their life cycle and are therefore more vulnerable to being diverted through the intake. In the following sections (15 to 20) I briefly summarise the risks to each of these species.

16 Longfin eels migrate upstream from the sea as juveniles, and back downstream to the sea as large adults. The longfin eel is acknowledged as a threatened species and there is increasing concern for the protection of its habitat and passage (Parliamentary Commissioner for the Environment 2013). Longfin eels (from about 100mm in length up to more than a metre in length) will occur near the RDR intake, but of most concern at any intake are downstream migrating

adult eels; these are large (often exceeding 1 m in length) and old (may be more than 50 years) that make their way downstream during late autumn and early winter to breed at sea. I would expect downstream migrating eels to be extremely uncommon – if not totally absent – from this location, as there is virtually no population of eels upstream of the Rangitata Gorge.

17 Torrentfish migrate into freshwater as juveniles then continue to gradually move upstream as they grow, so it is unlikely that small juvenile torrentfish would be found near the RDR intake, which is approximately 350 metres above sea level (**masl**) and 55 km inland. Research on torrentfish distribution in the Rangitata River (Bonnett 1986) and Rakaia River (Davis et al. 1983) showed that the proportion of female torrentfish in the populations of both rivers increased with increased distance from the sea, and I would expect torrentfish present near the RDR intake to be mostly female and mostly greater than 50 mm in length.

18 Bluegill bully may occur near the RDR intake, however, this location is at the extremes of this species range, as it has not been recorded in Canterbury Rivers above 360 masl or 68 km inland. These fish also migrate into freshwater as juveniles then continues to gradually move upstream as they grow. I would expect to find few bluegill bully near the RDR intake, and any that were present would be greater than 50 mm in length.

19 Chinook salmon occur throughout the Rangitata River, and the main risk to this species occurs during the downstream migration of juvenile fish (fry) from late winter to early summer. Over this period, the fry are mostly less than 40 mm in length and undergoing an obligatory migration to the sea, so that exposure to any intake that is improperly screened is likely to result in significant losses to the fishery.

20 Brown trout also occur throughout the Rangitata River, and the risk to this species also occurs mostly at the juvenile life stages. Many trout do move downstream as juveniles, however this is not an obligatory migration like that for Chinook salmon, and many trout do not reach the sea.

21 Upland bully will occur near the RDR intake, and may be regarded as being at risk if there is no screen. However, this species is very widespread in Canterbury, and it is likely that significant populations already exist within the RDR system. Although the upland bully is non-migratory, it is widely distributed because the tiny larvae of this species are easily dispersed.

What a fish screen needs to do

22 The criteria and standards for effective fish exclusion at intakes are presented in the NIWA Good Practice Guidelines for Fish Screening in Canterbury (Jamieson

et al. 2007) and Schedule 2 of the Canterbury Land and Water Regional Plan (2016). These are summarised below:

(a) The intake and screen should be installed at, or as close as practical to, the source river.

(b) Screening material should have apertures small enough (3 mm mesh or 2 mm bar width) to prevent fish penetrating the screen.

(c) The approach velocity (i.e. the speed of water as it approaches the screen) should be less than 0.12 m sec^{-1} to enable small fish to swim away and escape.

(d) The sweep velocity (i.e. the speed of water guiding fish past and away from the screen) should be greater than the approach velocity, and should be swift enough to move fish downstream promptly; fish should be exposed to screens for no more than 60 seconds (Bejakovich 2006).

(e) A bypass is required to divert screened fish back to the river of origin.

(f) The bypass should contain sufficient flow to maintain connection with the river of origin, and include features that prevent fish returning up the bypass channel.

(g) The screen and bypass should be operated and maintained so that it excludes fish and returns them to the source river at all times and in all environmental conditions.

Will the proposed rotary cylinder screen meet guideline criteria?

23 The applicant has submitted a proposal for a fish screen on the RDR intake utilising rotary cylinder screens mounted on the side of a concrete structure. Assessing whether the proposed screen will meet guideline criteria is summarised as follows:

24 Installation as close as practical to source. The proposed fish screen will be located approximately 1.4 km downstream of the RDR intake gates on the Rangitata River. Although this is a considerable distance for small fish to travel, their downstream passage will be aided by swift water flow (approximately 0.8 to 1.0 m sec^{-1}) within a large channel. The intake channel also mimics a large natural river channel in most respects, and I would not expect its length to be detrimental for fish.

25 Screening material. It is proposed to use screens composed of metal "wedge wire" bars with a 2 mm gap between bars. This will be a suitable screening material, and will meet the criteria for excluding fish. All of the fish likely to be

present near the RDR intake should be large enough to be successfully screened, with the exception of any upland bully larvae, which, at 5 mm to 10 mm in length, may pass through the screen.

26 Approach velocity. It is proposed to design the screen to achieve an approach velocity of 0.12 m sec^{-1} or less, which would meet guideline criteria. However there is uncertainty regarding whether 0.12 m sec^{-1} will be a maximum or an average value, The proposal for the screen recognises that modelling of water flows at the detailed design stage will be required to ensure that the approach velocities are consistent and less than 0. 12 m sec^{-1} for all for the screen area. This is very important, as there is a need to demonstrate that approach velocity is uniformly low in order to ensure that small fish can escape from being impinged on any part of the screens.

27 Sweep velocity. The proposal specifies a designed sweep velocity of approximately 1.0 m sec^{-1}, which is much greater than approach velocity. This comfortably meets guideline criteria, and should ensure that fish encountering the screening facilities are prevented from returning upstream, and are promptly swept downstream into the bypass. Although the design sweep velocity meets guideline criteria, the proposed screen is approximately 100 m in length, so that even at a water velocity of 1.0 m sec^{-1} fish may be exposed to the screen for much more than 60 seconds. This may result in the fish becoming exhausted and impinged on the screens.

28 Bypass provision. A substantial bypass is proposed, with a design flow of 3.0 m^3 sec^{-1} to 5.0 $m^3 sec^{-1}$, depending on the amount of water being diverted to the RDR. Consideration should be given to operating the bypass at 5.0 m^3 sec^{-1} at all times, irrespective of the amount of water being diverted; this, combined with a relatively short bypass (c. 400m), is more likely to ensure the prompt return of fish to the Rangitata River. The bypass should incorporate features to prevent any fish moving upstream from the Rangitata River into the facility, and prevent bypassed fish returning up the bypass.

29 Bypass connection. A short bypass with substantial flow should ensure very good connection back to the Rangitata River. The bypass is a very important feature of any fish screen, as having a functional screen is pointless if fish do not return promptly to the source river.

30 Operation and maintenance. How a fish screen is operated and maintained is critical to its performance and effectiveness. Of particular importance is checking for damage or changes to the screens themselves, and checking the integrity of any seals or gaskets between the screen and its supporting structure. Even a small gap can create a strong flow that draws fish through. Maintenance of the

bypass channel is also important, as the bypass needs to provide good connection with the source river at all times the screen is operating.

Likely effectiveness of the proposed rotary cylinder screen for Rangitata fish

31 If the proposed fish screen meets the guideline criteria and is operated and maintained accordingly, it should be very effective for excluding those species of fish at risk in the Rangitata River. The effectiveness for each species is summarised as follows (sect 32 to 37):

32 Longfin eels should be very effectively screened at the proposed intake, firstly as they will mostly be of a size that will allow them to escape the approach velocity as well as preclude them from penetrating the screen, and secondly as they are mostly benthic (bottom-dwelling) in nature and unlikely to encounter screens mounted on the side wall of the screen structure. Downstream migrant eels will be extremely uncommon – if not totally absent – near the intake, as there is virtually no population of eels upstream of the gorge. Any migrant eel encountering the intake should easily bypass the fish screen.

33 Torrentfish near the intake will be of a size (> 50 mm long) that should ensure they cannot penetrate the screen, and of a swimming ability that allows them to escape from the approach velocity – juvenile torrentfish will be unable to penetrate this far up the Rangitata River. Torrentfish are also benthic in nature, and very unlikely to encounter screens mounted on the side wall of the screen structure.

34 Bluegill bullies will mostly not penetrate as far upstream as the RDR intake; any that do encounter the fish screen will be of a size (> 50 mm long) that should ensure they cannot penetrate the screen and are effectively bypassed downstream.

35 Chinook salmon are the fish of most concern at the RDR intake, because of their abundance, size, and migratory nature. An average of more than a million juvenile salmon will migrate downstream past the intake each year (Evidence of Mr Mark Webb). These fish will mostly be less than 40 mm in length and travelling at various depths within the water column (i.e. mostly not benthic) as part of an obligatory downstream migration. Juvenile salmon are therefore likely to encounter screens mounted on the side wall of the structure, and would be vulnerable if the fish screen does not meet recommended standards or is inadequately operated or maintained. Risks include, but are not limited to: impingement on the screens, and subsequent death, if approach velocities are greater than recommended; entrainment into the RDR if the screen apertures are too large and/or seals are damaged or poorly maintained, death by desiccation or predation if the bypass channel(s) are improperly maintained.

36 Brown trout will also be of concern at the intake, as juveniles will be present in the river during spring and summer. In most respects, brown trout (and any rainbow trout) that encounter the screen will have the same requirements and vulnerabilities as Chinook salmon.

37 Upland bully will occur near the RDR intake, and adult fish will be mostly of a size and benthic habit that will preclude their being at risk from the fish screen. Upland bullies are not migratory, but have a long breeding season from spring to autumn and produce vast numbers of very small larvae (5mm to 8mm in length) that drift and disperse downstream until they "settle" in suitable habitat. Some upland bully larvae may pass through the proposed screen into the RDR.

38 Overall, the proposed rotary cylinder fish screen should be very effective at excluding all fish species from the RDR and bypassing them back to the Rangitata River, provided that it meets and maintains guideline criteria and standards. If the screen does not meet all guideline criteria there are risks of fish mortality and/or losses into the RDR. However, meeting or exceeding all guideline criteria does not guarantee that the screen is totally effective, and the shape of the rotary cylinders, the depth of the water, and the opacity of the water at the site will prevent useful observations of screen integrity and performance. Effectiveness of the screen can therefore only be satisfactorily verified by testing using live fish.

Testing screen effectiveness

39 I have been involved in, and reported on, various tests of fish screen effectiveness in Canterbury during the last 10 years (**Appendix I**), and in sections 40 to 46 I comment on the various approaches and drawbacks to testing fish screens.

40 The "standard" approach for testing screen effectiveness utilises a release of test fish upstream of the facility and recapturing fish in traps placed in both the bypass and in the "scheme supply" channel downstream of the screen. Effectiveness of the screen can then be calculated as the proportion (percentage) of fish found in the bypass. Ideally – if the fish screen works perfectly – no fish will be found in the scheme supply channel and effectiveness is 100%. The drawback of this approach is that it is difficult to apply at large-scale facilities such as the RDR intake screen, as a flow of more than 40 m^3 sec^{-1} in the scheme supply channel would preclude the use of most traps or nets.

41 An alternative approach is to trap the bypass only and release a known number of fish upstream. The proportion of fish recovered from the bypass traps provides an estimate of effectiveness. If all released fish are recovered in the bypass trap, effectiveness of the screen can be estimated as 100%. This approach has two major drawbacks: Firstly, some allowance must be made for any wild fish that

may be present in the area and whose capture would inflate the estimate of effectiveness; this may be overcome by using a known number of marked fish (e.g. fin-clipped or dye-marked fish). Secondly, fish will not necessarily move downstream into the bypass trap at the same time and some may "hold" near the release point for many weeks, resulting in an underestimate of effectiveness.

42 A simpler monitoring approach is to operate one or more fish traps downstream of the fish screen in subsidiaries of the scheme supply channel that are small enough to be trapped. Capture of fish (e.g. juvenile Chinook salmon) would demonstrate that the fish screen is not excluding 100% of the fish encountering the screen. The total effectiveness of the screen can be estimated from the numbers of salmon caught in particular channels. Capture of other fish species within the RDR is less conclusive with respect to fish screen effectiveness, as stocks of upland bullies or longfinned eels may have become established within the canal system or entered the RDR from another source.

43 Testing fish screen effectiveness is greatly facilitated if provision for testing is included in the design and installation of fish screening facilities; e.g. providing suitable sites to mount traps in bypass and scheme supply channels, and allowing for safe access to these sites when traps are in operation. When trapping bypass channels, it is desirable that the entire channel is trapped; trapping only a portion of the bypass flow and then factoring up may give erroneous results if fish behaviour changes in response to environmental factors such as light, water temperature, turbidity etc.

44 Two separate trials should be undertaken; firstly a monitoring trial in subsidiary channels of the RDR to ascertain if any juvenile salmon have penetrated the screen, and secondly a release of trial fish upstream of the screen, with recapture downstream in the bypass channel as close to the screen as possible.

45 Juvenile salmon have been used for most testing of fish screens in Canterbury, partly because substantial numbers of these fish are available from hatcheries, and partly because of their downstream migratory behaviour which facilitates recapture. Use of hatchery fish limits testing to the period from late winter to early summer, when small hatchery fish are available. It is also important to note any observations of other species encountered during effectiveness or monitoring trials, as knowledge of the screen's effectiveness should not be limited to juvenile salmon.

46 In my opinion, the development of the proposed Fish Screen Verification Management Plan (**FSVMP**) (Ryder 2018) in consultation with CSIFGC and other interested parties (e.g. Te Runanga O Arowhenua, Department of Conservation) will be the most appropriate method to establish a monitoring regime, and

facilitate the collection of data to confirm that the screen is operating to its design specifications.

Consent conditions and proposed changes to consent conditions

47 Proposed changes to conditions of CRC011237 are designed to enable the installation of a Mechanical Rotary Fish Screen at the RDR intake. Essentially the proposed conditions specify that the screen needs to meet the design criteria of the current good practice guidelines, and that the screen is installed and is operating in accordance with the design specifications,

48 In my opinion it would be beneficial for the conditions to include further details on:

(a) Monitoring of screen operation and the integrity of screen components; and

(b) Maintenance when monitoring finds damage; and

(c) Maintenance of the bypass channel to promote the safe passage of fish back to the Rangitata River; and

(d) Verification of fish exclusion, including adoption of a Fish Screen Verification Management Plan.

Conclusion

49 The Rangitata River supports an assemblage of native and introduced fish species that is typical of east coast South Island rivers, however the distribution of native fish in the river is best described as atypical, with mostly migratory fish downstream of the Rangitata Gorge and non-migratory above. Six species of fish are at risk at the proposed RDR intake screen, as they are likely to be present near the intake or encounter it during migration in the river.

50 The proposed rotary cylinder fish screen should be very effective at excluding all fish species from the RDR and bypassing them back to the Rangitata River, provided that it meets and maintains guideline criteria and standards. However, for the proposed rotary cylinder screen to be effective, several aspects of the design and installation need to be considered, as follows.

51 To prevent fish from entering the RDR the screening material and all seals or moving parts need to be kept intact. Improper installation of the screen, or damage to parts of the screen, may allow fish to penetrate the screen into the RDR. As it will not be possible to observe the screens during operation, the integrity of the screening material, joints and seals should be checked as often as practical, to ensure that fish cannot penetrate the screen.

52 To prevent damage and/or mortality to fish which may become impinged against screening material, approach velocities toward all parts of the screen must be no more than 0.12 m sec^{-1}. Average values for approach velocities are not meaningful – if approach velocities are higher than recommended at any point near the screen there is a risk that fish would be unable to escape from being impinged on the screen.

53 A sweep velocity of close to 1.0 m sec^{-1} is required to sweep fish downstream promptly, preferably within 60 seconds. Although many fish may move quickly downstream with the water flow, some fish may behave quite differently in the vicinity of the screen; some may resist moving downstream past the screen, or continue to attempt to locate an exit through the screen, or resist entering the bypass. There is a risk that these fish will eventually become exhausted and impinged on the screen.

54 During pre-hearing conferencing, experts could not agree on the design detail around meeting the approach velocity and sweep velocity requirements, and these issues will need to be considered further.

55 The effectiveness of the fish screen would be best tested by undertaking two trials. Firstly, operating trap(s) in subsidiary channels of the RDR to determine if any juvenile salmon or other fish have penetrated the screen. Secondly, by release of a known number of juvenile Chinook salmon upstream of the screen, with recapture in traps on the bypass channel; this trial will be facilitated if the screen design and installation makes provision for access and fish trapping equipment. These trials should be undertaken as soon as possible after the installation of the fish screen.

Martin Bonnett
10 April 2018

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Appendix I

Relevant research publications.

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Appendix II

Joint Witness Statement from expert conferencing 19 March 2018.

IN THE MATTER OF: The Resource Management Act 1991

AND

IN THE MATTER OF: resource consent applications by Rangitata Diversion Race Management Limited (**RDRML**) to the Canterbury Regional Council and Ashburton District Council for resource consents for the construction, operation and maintenance of the Klondyke Water Storage Facility, its associated water takes from and discharges to the Rangitata River, and all associated activities

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JOINT WITNESS STATEMENT OF GREG RYDER (RDRML)
AND PAUL MORGAN (RDRML)
AND ADRIAN MEREDITH (Canterbury Regional Council)
AND MARTY BONNETT (Central South Island Fish and Game)
AND MARK WEBB (Central South Island Fish and Game)

Water Quality / Aquatic Ecology

Dated: 19 March 2018

INTRODUCTION

1. This Joint Witness Statement is prepared in accordance with section 7 and Appendix 3 of the Environment Court's Practice Note 2014.

2. This Joint Witness Statement relates to expert conferencing on the topic of water quality / aquatic ecology.

3. The conference was held on 19 March 2018.

4. Attendees at the conference were:

   (a) Greg Ryder for RDRML.

   (b) Paul Morgan for RDRML.

   (c) Adrian Meredith for Canterbury Regional Council (ECan).

   (d) Marty Bonnett for Central South Island Fish and Game (Fish & Game).

   (e) Mark Webb for Central South Island Fish and Game (Fish & Game).

AGENDA

5. The parties agreed the following issues should be discussed at caucusing:

   (a) Fish screen
      design concept
      effectiveness
      Rangitata River section between RDR intake and fish screen bypass return flow

   (b) The effects of taking an additional 10 cumecs from the Rangitata River
   (c) Klondyke Reservoir
      Reservoir water quality
   (d) Reservoir sluicing - proposed sluicing regime
      effects on downstream flows and associated river ecology
      monitoring

OUTCOMES

6. Issues that are agreed between the experts:

   (a) All the experts endorsed the proposal in the fish screen design to use 2mm slot spacing for wedge wire as this was appropriate for effective screening of fish.

   (b) It was agreed that there needed to be certainty in seal design and systems to ensure they were well seated and did not leak or fail.

(c) There was agreement that detailed design will be required to confirm how these velocity design criteria will be achieved and how they will be demonstrated and tested.

(d) The experts agreed that the bypass design needs to incorporate features upfront that enable the capture of fish safely in order to check the performance of the bypass at conveying fish back to the river and to confirm that fish are in a healthy condition.

(e) The experts agreed that the bypass design needs to incorporate features at the downstream end to prevent fish in the Rangitata River entering the bypass outlet and features at the upstream end to prevent fish from swimming back upstream towards the screen section of the structure.

(f) The experts discussed monitoring of the bypass and RDR canal for fish following the commissioning of the new screen and agreed that any monitoring for fish should include the full migration season for out-migrating salmon (i.e., 1 August to 31 July) and that this should be reflected in proposed consent conditions.

(g) It was agreed that exclusion of the whole fish community, and in particular indigenous fishes was required, and that any monitoring should be explicitly designed to address indigenous fishes as well as salmonids.

(h) The experts by all agreed that that the period of time that fish are exposed to the screen should be minimised. However full agreement was not reached on how long the minimum exposure time should be (see below).

(i) The experts agreed that a high (5 m^3/s) bypass flow, was preferable to a 3 m^3/s, unless otherwise proven. The experts agreed that a higher bypass flow would provide a greater sweep velocity, lower risk to the screen not working effectively, and provide greater ability to reduce sediment from accumulating in the vicinity of the fish screen. However, if a flow of 3 m^3/s was subsequently found to be effective, then a reduction in the 5 m^3/s flow should be required.

(j) The experts agreed that a higher fish screen bypass flow was likely to have minor or less than minor ecological effects, at worst, in the 1.3km dewatered section of the Rangitata River between the RDR intake at the proposed location of the fish screen bypass return flow.

The primary basis for this view was that the benefits to all fisheries of the Rangitata River by having an effective functioning fish screen and fish bypass were more advantageous than a slightly lower river flow in that section of the river.

7. Issues upon which the experts cannot agree and the reasons for their disagreement:

(a) With respect to the fundamental design concept of the proposed modular rotary fish screen and associated bypass, the experts could not agree on the design detail around meeting the maximum approach velocity of 0.12 m/s and the magnitude of the sweep velocity within channel that conveys water past the rotary drums.

(b) The experts did not agree on conditions to permit the sluicing of reservoir sediment back to the river. Sediments discharged from the proposed fish bypass and existing sand trap have a high sand composition and are appropriate to discharge as they generate beneficial bed surface scouring action. Sediments in the reservoir will be finer silts and muds and are not appropriate to discharge back to the river.

(c) Adrian Meredith, Greg Ryder, Marty Bonnett and Paul Morgan agreed that, if the proposed rotary fish screen and associated bypass was adopted and included the design criteria noted above, and met the NIWA fish screening guidelines (Jamieson *et al*. 2007) then fish screening efficiency performance numbers would not be required as conditions of consent. However, such performance criteria would be required for alternative fish screen designs.

Mark Webb's position was that Fish & Game would agree to removing the 80% and 90% performance targets but these needed to be replaced with the WCO wording to the effect of "*The fish exclusion or fish bypass system must prevent fish from being lost from the Rangitata River*". Mark noted that meeting this criteria needs to be verified and verification should occur at critical periods that could be more frequent during first 5 years of operation and then at periodic intervals relative to maintenance/replacement of screens and seals. As proof of screen success is confirmed, verification frequency could be diminished.

(d) The experts did not agree on how long the minimum exposure time should be for fish passing the screen. Mark Webb, Marty Bonnett, and Adrian Meredith agreed that the period of exposure time should ideally not exceed 60 seconds. Paul Morgan noted that the sweep velocity and the maximum length of screen to be traversed determine exposure time. For example, with an estimated screen length of 100m and a sweep velocity of 1 m/s, exposure time would be calculated at 100 seconds. Greg Ryder did not state a position on preferred exposure time.

(e) With respect to reservoir sluicing, Adrian Meredith and Mark Webb agreed that, from a water quality and ecological perspective, it was not appropriate to discharge the fine (mud, silt and clay) sediment back to the river irrespective of the flow regime on discharge. Adrian stated that it was probable that the sediment would be finer than the typical fine sediment entrained from the river (predominantly silts, muds and clays), may become consolidated, nutrient enriched from organic slimes, and potentially anoxic, and so changed in character from the sediment that entered the reservoir. The discharge of such material to the river has no benefit to the river, and a number of potential detriments.

Greg Ryder's position was that the proposed reservoir and sluicing monitoring plan contained assessments of nutrients and anoxia in reservoir sediment. This would enable sediments on the reservoir bed to be assessed prior to any potential discharge and so adverse effects on water quality could be avoided. He also noted that the sluice discharge and receiving water would be monitored also to assess the effect of the discharge on water quality. He further noted that proposed conditions provided for the first discharge to occur at a higher river flow than initially proposed (i.e, 300 m^3/s at Klondyke recorder vs 140 m^3/s).

Marty Bonnett had no comment on this issue noting he was in attendence primarily to fish screening. Paul Morgan made no comment on this issue.

(f) Mark Webb and Adrian Meredith considered that the threshold for sluicing the existing sand trap was set when the RDR was the only abstraction from the Rangitata River and the residual flow in the river into which the discharge occurred was 110 m^3/s.

(g) The experts did not agree on conditions to take an additional 10 m^3/s.

Adrian Meredith and Mark Webb expressed concern that cumulative effects on the Rangitata River (e.g., effects on water temperature, sedimentation, bed flushing and riverbed growths) had not been adequately assessed. Adrian commented that the Rangitata was a resilient river, but at what point does that resilience get broken.

Greg Ryder considered there was no evidence to indicate that changes in water clarity, flow variabiity and habitat would occur as a result of the proposed additional 10 m^3/s abstraction.

Marty Bonnett had no mandate to comment on this issue.

CODE OF CONDUCT

8. We confirm that in producing this Joint Witness Statement, we have all complied with the Code of Conduct for Expert Witnesses.

………………………………………….
Greg Ryder

………………………………………….
Paul Morgan

Adrian Meredith

Marty Bonnett

Mark Webb

Tables

Table 1. Common name, scientific name, status, and conservation status with qualifiers of freshwater fish that are known to occur in the Rangitata River catchment.

Common name	Scientific name	Status	Conservation status #	Qualifiers #
Native				
Longfinned eel	*Anguilla dieffenbachii*	endemic, migratory	At Risk - declining.	Conservation Dependent
Shortfinned eel	*Anguilla australis*	migratory	Not Threatened	Increasing
Canterbury galaxias	*Galaxias vulgaris*	endemic, non-migratory	At Risk - declining.	Data poor
Alpine galaxias	*Galaxias paucispondylus*	endemic, non-migratory	At Risk - naturally uncommon	Range Restricted
Longjawed galaxias	*Galaxias prognathus*	endemic, non-migratory	Nationally Vulnerable - declining	Data poor
Koaro	*Galaxias brevipinnis*	migratory (whitebait)	At Risk - declining.	Partial Decline
Inanga	*Galaxias maculatus*	migratory (whitebait)	At Risk - declining.	Conservation dependent; Secure Overseas
Torrentfish	*Cheimarrichthys fosteri*	endemic, migratory	At Risk - declining.	
Upland bully	*Gobiomorphus breviceps*	endemic, non-migratory	Not Threatened	
Bluegilled bully	*Gobiomorphus hubbsi*	endemic, migratory	At Risk - declining.	Data poor
Common bully	*Gobiomorphus cotidianus*	endemic, migratory	Not Threatened	
Giant bully	*Gobiomorphus gobiomorphus*	endemic, migratory	Not Threatened	Data poor
Lamprey	*Geotria australis*	migratory	Nationally Vulnerable - declining	Overseas security uncertain

Stokell's smelt	*Stokellia anisodon*	endemic, migratory	At Risk - naturally uncommon	Range Restricted
Black flounder	*Rhombosolea retiaria*	endemic, migratory	Not Threatened	Data poor
Introduced				
Brown trout	*Salmo trutta*	spawning migration	Introduced and Naturalised	
Rainbow trout	*Oncorhynchus mykiss*	spawning migration	Introduced and Naturalised	
Chinook salmon	*Oncorhynchus tshawytscha*	migratory	Introduced and Naturalised	
Brook char	*Salvelinus fontinalis*		Introduced and Naturalised	
Perch	*Perca fluviatilis*		Introduced and Naturalised	
# from Goodman et al. 2014.				

Table 2. Total numbers of fish sampled by electric fishing in 4 areas of the Rangitata River during 7 surveys between June 1983 and June 1984 (data from Bonnett 1986).

General location	Near mouth	Near SH1	Near SH72	Above gorge
Approximate elevation (m)	0-30	100	180	430
Approximate distance from sea (km)	0-5	18	30	80
"Estuarine" fish				
Inanga	139			
Black flounder	47			
Common smelt	46			
Stokell's smelt	4			
Giant bully	4			
Shortfinned eel	1			
"Lower river" fish				
Bluegilled bully	555	355	138	
Torrentfish	308	307	206	
Common bully	569	62		
Lamprey		2		
"Upper river" fish				
Upland bully		18		434
Alpine galaxias				101
Longjawed galaxias				81
Canterbury galaxias				44
Rainbow trout	1			42
"All areas" fish				
Chinook salmon	4	88	53	181
Longfinned eel	102	40	57	1
Brown trout	27	55	45	59