

**IN THE MATTER OF** the Resource Management Act 1991

**A N D**

**IN THE MATTER OF** an application for a Water Conservation Order pursuant to section 201 of the Act

**BY** **NEW ZEALAND AND NORTH CANTERBURY FISH AND GAME COUNCILS AND NEW ZEALAND RECREATIONAL CANOE ASSOCIATION**

**Applicants**

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**STATEMENT OF EVIDENCE OF TERENCE DAVID HEILER  
FOR AMURI IRRIGATION COMPANY LIMITED  
DATED 23 MARCH 2009**

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**TERENCE DAVID HEILER** states:

**Qualifications and Experience**

- 1 My name is Terence David Heiler. I am currently employed as Chief Executive of Irrigation New Zealand Incorporated, an association representing the interests of some 3,500 members, comprising irrigators, consultants, commercial companies, and some regional councils.
- 2 I hold a Bachelor of Engineering (Civil, Hons 1) from the University of New South Wales and a PhD (Agricultural Engineering, Water Resources) from the University of Canterbury. I am a Fellow of Institute of Professional Engineers of New Zealand (IPENZ) and a Member of the New Zealand Hydrological Society.
- 3 My whole career (40 years) has been related to the development of water resources, including water storage, flood control, irrigation, water supply and distribution.
- 4 I have had 25 years experience in soil and water research as Director of the Agricultural Engineering Institute at Lincoln College.
- 5 I have been involved with the design and operation of large irrigation schemes and have been employed as a peer reviewer of scheme design, construction and operation and maintenance aspects.
- 6 My international career has included 40 projects in 25 countries working for international agencies on large scale water resources and irrigation projects.
- 7 I have no direct expertise in the science of freshwater fisheries. I have reviewed the international literature on fish exclusion structures as part of my contribution to the Fish Screen Working Party, much of which includes aspects of hydraulic engineering, an area with which I am familiar and professionally qualified.
- 8 I have read the Environment Court's Code of Conduct for Expert Witnesses as set out in the Environment Court Consolidated Practice Note 2006, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

**Scope of Evidence**

- 9 In my evidence I will consider the proposed design standard for fish screens on all intakes in the lower Hurunui River as sought by the Applicants (the New Zealand and North Canterbury Fish and Game Councils together with the New Zealand Recreational Canoeing Association) for the Water Conservation Order

(WCO), and compare it with the fish screen system currently in operation at AIC's Balmoral intake on the lower Hurunui River. More particularly, my evidence will address the following:

- (a) A description of the background to the fish screen design standard sought by the Applicants;
- (b) A description of the appropriateness of the fish screen design standard sought by the Applicants, including the specific aspects of the screen aperture dimensions, approach velocity and sweep velocity.
- (c) A description and assessment of the operational features of the intake arrangements of the Balmoral Irrigation Scheme in the lower Hurunui River.

10 In preparing this evidence I have relied on my knowledge of fish screen design obtained through my involvement in the Fish Screen Working Party (FSWP) which issued the report entitled '*Fish screening: good practice guidelines for Canterbury*'; my own review of international literature on fish screening criteria; my experience in operating irrigation intakes in New Zealand and internationally, and my own engineering assessment of the existing Balmoral Intake on the Hurunui River.

### **Summary of conclusions**

11 In this evidence I reach the following conclusions:

- (a) The fish screen design standard proposed by the Applicants for inclusion in the WCO is inappropriate and unnecessary;
- (b) The existing fish exclusion features at the intake of the Balmoral Irrigation are satisfactory, given current the state of knowledge of New Zealand fish screening requirements; and
- (c) That it is my view that the fish screen design standards sought by the Applicants will restrict innovation and investigation of new technologies which are appropriate to New Zealand conditions.

### **Background to the Applicants Proposals regarding Fish Screens**

12 The Applicant has requested specifically that all fish screens<sup>1</sup> installed or proposed within the Hurunui catchment have the following characteristics:

<sup>1</sup> In general, these suggestions apply to conventional vertical flat screens, and to rotary screens such as that at AIC's Balmoral intake.

- (a) the aperture size of a screen shall not be greater than 3mm in diameter;
  - (b) the approach velocity shall not exceed 0.12m/s;
  - (c) the sweep velocity shall exceed approach velocity at all times; and
  - (d) a safe return of screened fish to an active flowing channel in the river.
- 13 The characteristics of fish screens as proposed by the Applicants (as noted above) have their origin in a document entitled *Fish screening: good practice guidelines for Canterbury*<sup>2</sup> (issued by the Fish Screen Working Party<sup>3</sup> (FSWP) in October 2007).
- 14 The FSWP was put together by ECan in June 2004 to consider the design of fish screens appropriate for New Zealand conditions. Historically, differing views had arisen between applicants for resource consents to take or divert surface water on the one hand, and parties seeking more restrictive fish screening standards. An additional issue was the large number of unscreened intakes, which was viewed by some parties to be damaging to the sports fishery.
- 15 The initial members of the FSWP were ECan (chair), Fish and Game New Zealand, the National Institute of Water and Atmospheric Research (NIWA) and Irrigation New Zealand Incorporated (INZ). The Department of Conservation (DoC) also became involved in the early stages (mid 2005). The FSWP met approximately quarterly over the period from early 2005 through to 2007.
- 16 The objectives of the FSWP were as follows:
- (a) Summarise structural design options currently available;
  - (b) Identify and list of good design features for screening success that, **when appropriately incorporated into a design** [my emphasis], represent best practice;
  - (c) Identify and summarise the movements of the New Zealand fish species that will be susceptible to water diversions and that will need screening protection;
  - (d) Identify screening characteristics (e.g. mesh sizes) most appropriate to the various fish species;

<sup>2</sup> NIWA Client Report: CHC2007-092, NIWA Project: INZ06501, Fish screening: good practice guidelines for Canterbury, October 2007.

<sup>3</sup> The FSWP comprised representatives for ECan (chair), Irrigation NZ, Fish and Game, Department of Conservation, NIWA.

- (e) Provide information that would encourage technical innovation by all parties involved with intake design;
  - (f) Identify further work to clarify issues around fish biology, fish behaviour at intakes and information on how intakes perform in practice (including how to deal with a new invasive alga species – didymo (*Didymosphenia geminata*));
  - (g) Provide good working examples of fish screens currently operational in contrasting situations in Canterbury.
- 17 The FSWP sought and obtained support from the Sustainable Farming Fund (application made January 2005, approved for the 2006 financial year). The main two expenditure items in the project were for engineering advice and for NIWA review.
- 18 It became clear early on that the information available in New Zealand was insufficient to address the all of the initial objectives, primarily the dearth of quantitative information on the performance of installed fish screens in New Zealand.
- 19 As a consequence, reliance was placed on international criteria with emphasis on screening criteria from the United States (US).
- 20 To assist the FSWP, Fish and Game carried out a literature review focused on criteria used in various jurisdictions in the US and Europe; NIWA summarised NZ knowledge on sport fish location and behaviour in NZ rivers; and DoC reviewed similar information on New Zealand native fish. The engineering consultant, David Attewell, reviewed the engineering aspects of fish screen structure options, with an emphasis on international examples.
- 21 My involvement with the work of the FSWP commenced during 2006, and by that time the essential literature investigations were complete. I was asked to become involved by the INZ Board because one of the INZ representatives on the FSWP had resigned, and the preliminary recommendations of the FSWP conveyed to the board were considered to be too rigid, too focused on US practice, and did not reflect the inadequacy of knowledge and experience of fish exclusion under New Zealand conditions.
- 22 My task was to become familiar with the literature and to discuss the INZ concerns with the FSWP. During these discussions it was agreed that more work needed to be done to increase knowledge of local fish exclusion techniques – gravel weirs, galleries, behavioural devices – and to see if some promising new

developments being developed overseas had merit for application in the New Zealand situation.

23. Given that more work was planned, it was agreed by the FWSP to issue a report as a "guideline" to assist designers adopt best practice and to make the valuable data on local fish behaviour obtained.
24. The FSWP subsequently issued its report entitled *Fish screening: good practice guidelines for Canterbury* in October 2007 ('the Report') (Attached as **Attachment 1**). The Report concluded that there is a need for a "whole of intake design" if fish are to be efficiently and effectively diverted without damage from intakes. It concluded that a fish screen will only be effective when all the following features are **sufficiently** [my emphasis] implemented:
- (a) The site is located to minimize exposure of fish to fish screen structure, and minimizes the length of stream channel affected while providing the best possible conditions for factors (b) – (f) below:
  - (b) Water velocity ("speed") through the screen ("approach velocity") is slow enough to allow fish to escape entrainment (being sucked through or washed over the screen) or impingement (being squashed or rubbed against the screen);
  - (c) Water velocity across (or past) the screen ("sweep velocity") is sufficient to sweep the fish past the intake promptly;
  - (d) A suitable fish bypass is provided so that fish are taken away from the intake and back into the source channel;
  - (e) There needs to be "connectivity" between the fish bypass and somewhere safe, usually an actively flowing (i.e. not still) main stem of the waterway;
  - (f) Screening material (mesh, profile bars or other) on the screen needs to have openings small enough to exclude fish, and a surface smooth enough to prevent any damage to fish; and
  - (g) The intake needs be kept operating to a consistent, appropriate standard with appropriate operation and maintenance. This should be checked or monitored.
25. It was recognised by the FSWP that these factors collectively and interactively influence fish exclusion at any specific site and that a holistic and site specific assessment of all factors is necessary in developing suitable fish exclusion

arrangements. It was also decided that further local information on exclusion performance was required before any recommendations as to design "standards" could be made and that another separate project was needed to do this.

- 26 Subsequently, a new project has been formulated by the FSWP and submitted to the Sustainable Farming Fund for the 2009 funding round, to carry out studies of actual performance in order to understand the peculiarities of fish exclusion in New Zealand.
- 27 The project as submitted includes field measurement of the exclusion performance of existing NZ screening installations; the influence of associated engineering parameters like aperture size, approach and sweep velocity, and fish return facility performance. In addition, the project proposal includes the installation and testing of new exclusion techniques identified in the literature review.
- 28 Given this background, I now wish to focus on the three requirements contained in the WCO proposal.

#### **Screen Aperture Proposals**

- 29 The FSWP reviewed international literature (based on the initial Fish and Game review).
- 30 The information collected identified screen aperture sizes that would effectively exclude close to 100 percent of juvenile native and introduced fish species, based on international and local measurements of the physical dimensions of (deceased) juvenile fish samples. This information was not based on actual screen performance, just on the measurements of the width of the head of juvenile fish of various lengths (a surrogate for age).
- 31 The objective of most international fish exclusion criteria has been to protect endangered fish species by ensuring complete exclusion of fish using screen aperture sizes that physically excluded all fish.
- 32 The question in the New Zealand context is "what percentage exclusion is appropriate in each situation to sustain the fishing resource?" The FSWP was unable to answer this question, and the position of Fish and Game was that given the uncertainty, a cautionary approach should be taken that screen aperture sizes should be used that would ensure 100% exclusion in all situations.
- 33 This position was not supported by INZ because it believed that the objective overall should be to design fish exclusion systems that would sustain the

resource. Further, it was not convinced that 100% exclusion was justified by any of the available information.

- 34 There are also practical consequences with small aperture screens in the NZ situation. Smaller screen apertures increase the risk of blockage in situations where debris and dirty water has to be handled, a common situation in New Zealand rivers. The strength of screens with small apertures is less than for screens with larger apertures, and hence damage from flood debris is more likely. If the Fish and Game proposals were to be adopted, it was anticipated that the operation of some existing intakes would be compromised.
- 35 The Applicants' request that aperture size of fish screens on the lower Hurunui River be not more than 3 mm in diameter is based on an assessment that this screen aperture is necessary to ensure the screen function on its own would need to exclude 100% of juvenile salmon and trout.
- 36 As already explained however, the FSWP recognised that other factors are likely to influence the exclusion performance of screens in the New Zealand environments, primarily the prospect of high sweep velocities and approach conditions. It was clear from the information considered by the FSWP that water velocities in many New Zealand rivers are in general higher than the velocity environments used in the international studies. This was one reason for identifying the need for further NZ investigations.
- 37 However, as the data on screen aperture needed to ensure 100% exclusion in New Zealand conditions was available (whereas information as to appropriate sweep and approach velocity was not), the FSWP decided to issue the information on screen aperture sizes that would result in total exclusion in isolation from other factors – without answering the question as the exclusion percentage needed to sustain the resource – and also recognising that other factors were influential in exclusion performance.
- 38 As already noted, this situation led to the decision to issue "guidelines" rather than "standards" that contained information of relevance to designers, recognising that a specific installation needed to take all of the influential factors (described earlier in this evidence) into account.
- 39 It is my view that the inclusion of a fixed and conservative fish screen aperture standard into the WCO Order is not justified. Given that such an inclusion would inevitably flow on to the Regional Plan and affect all of Canterbury, this would preclude the on-going efforts of the FSWP to better understand the issues and look for innovative solutions appropriate to New Zealand conditions

### **Approach Velocity**

- 40 The Applicant's seek that the WCO restrict approach velocity to maximum of 0.12m/s. This is based on the estimate of a sustainable swimming ability of a 30mm long juvenile fish. This approach velocity would therefore help to achieve 100% exclusion of juvenile trout and salmon.
- 41 The literature defines this approach velocity as the velocity measured 75mm from the screen surface when operating at maximum design diversion flows, and calculated on the basis of the net area – not open area – of the screen. Using these assumptions I have calculated approach velocity to the existing fish screen arrangement at the Balmoral intake (refer paragraph 64 of this evidence), and determined that the approach velocity currently ranges from 0.125 to 0.25 m/s, depending on flow rate. The approach velocity sought by the Applicants is therefore currently not achieved at the Balmoral intake.
- 42 The evidence of Richard Allibone addresses the likely influence of the Balmoral intake approach velocities in terms of impacts juvenile and native fish species in the Hurunui.

### **Sweep Velocity**

- 43 The Applicant proposes that the sweep velocity along the length of the screen structure be not less than the approach velocity (0.12m/s). The reason for the requirement is to allow fish that come in close to the screen to be moved away promptly from the intake area.
- 44 In my view, the rationale for this (US) requirement is for situations where intakes are located in "dead water" that has no intrinsic current and to avoid siting screens where fish have few options to escape the intake area. This requirement will be or could be met in almost all NZ intake situations, especially where screens are adjacent to rivers. I comment on this situation in regard to the Balmoral intake at paragraphs 68-71.
- 45 In the case of the Balmoral Intake, adoption of the proposed limit would require a doubling of the capacity of the existing intake (refer paragraph 75 of my evidence).
- 46 In my view, this is not justified given the current state of knowledge, in respect to which it has been recognised by the FSWP is lacking, and further research is required before specific recommendations as to approach and sweep velocity standards can be made.

**Balmoral Intake**

- 47 The main irrigation intake on the Hurunui River is operated by AIC resource consent CRC951327, renewed for 35 years in 1997.
- 48 I have visited the Balmoral Intake on several occasions and made a special visit there on 24th February 2009 in regard to this evidence.
- 49 AIC's consent is to take a maximum of 5 m<sup>3</sup>/s, to irrigate 5200 ha of agricultural land. In order to access the authorised take for irrigation, and operate the intake system, approx. 7 m<sup>3</sup>/s is taken at the gated river intake on the true left bank of the river located at or near map reference NZMS 260M33: 742-234, and 2 m<sup>3</sup>/s returned directly to the river from the stilling pond, as described below.
- 50 The overall layout of the Balmoral intake is shown as an aerial photo in **Attachment 2**. I will describe the components and operation features hereunder.
- 51 The way the system operates can be described as follows. A gravel diversion weir is constructed by machinery in the river bed to send water to the intake structure. This structure is fitted with a gate to control flows into an intake channel. At most time the flow into the intake channel is about 7 m<sup>3</sup>/s. There is no screening on this intake.
- 52 The water flows by gravity along 1.2 km of intake channel and enters a stilling pond of about 3 ha in surface area. This stilling pond is immediately adjacent to the river and has a confining embankment to contain the pond water, and the pond water level is some meters above the river.
- 53 Just downstream of where the intake channel enters the pond, there is a gated silt flushing structure constructed into the confining embankment. The purpose of this structure is to flush accumulated sediment in the intake channel back to the adjacent river. The structure has approval to operated at a maximum of once per week, but is used as needed depending on whether there has been silt build up. Over an average season, the gates would be opened about 9 times.
- 54 The stilling pond is about 150 metres away from the river. A second structure is sited in the confining embankment some 300 meters downstream of the aforementioned silt flushing structure. This a 40m long ungated gravel weir with a level overflow sill. This weir operates automatically to return excess water (2 m<sup>3</sup>/s approx) back to the main river keeping the water level in the pond area approximately the same regardless of the quantum of diverted flow from the river. Its discharge will vary depending on diverted flow and the flow being taken for irrigation at the time. Some of the fish entering the pond can leave the pond via the weir into a natural active channel connected to the main river.

### **Irrigation Intake and Fish screens Balmoral intake**

- 55 Irrigation water is taken into the scheme through a screened intake structure located at the most downstream end of the pond. A photograph of this structure is included as **Attachment 3**. This structure is some 1.5 km in total from the river intake.
- 56 The intake structure is fitted with two electrically driven rotating drum fish screens, each 5m long and 2m in diameter. The drum surface is currently encased with a woven wire stainless steel mesh, with a square aperture of 5mm and wire diameter of 1.2mm. The total open area (i.e. the open areas between the wire mesh) is about 50% of the net area of the wire mesh.
- 57 Below each drum screen there is a fixed vertical flat screen. Each drum screen sits above this 500mm high screen that runs between the concrete abutments that are the horizontal limits of each drum screen assembly. There are 120mm long brushes fitted to the top of the fixed screen and the drum screen runs across the brushes. The purpose of the brushes is to prevent any fish passing under each drum screen. Hence the total water way area of the intake through the screens is the depth of the fixed screen above the concrete bottom of the structure plus the depth of water above the brush screens to the water level in the pond. Given that the pond level is relatively constant, this depth is always about 2 m regardless of the flow being taken for irrigation purposes.
- 58 There are two fish bypass channels at the entrance to each assembly to trap fish and return them safely to the river. These are shown on Attachment 2 for location and in Attachment 3 for detail. Essentially, fish that reach the screen are introduced to a sweep velocity that takes them into a small channel and then into pathway back to the main river.
- 59 During the operation of the intake, the water level in the pond stays relatively constant regardless of the irrigation flow. The flow into the irrigation main race is controlled by gates downstream of the screen assembly.

### **Mesh on fish screens**

- 60 I understand from discussions with Norm Williamson of AIC and the engineer who modified the screens – Mark Eastman – that when initially installed, the 5mm mesh was vulnerable to damage from floating debris, causing indentations in the mesh surface and loss of contact with the fish exclusion brushes. Strengthening of mesh supports when the mesh was replaced has removed this problem.

- 61 The Balmoral intake is subject to flood flows in the river, and the associated problem of debris – logs etc. Given the risk of damage to the screen mesh by floating debris, a change to 3mm mesh would, in my view, increase the incidence of mesh damage and could result in malfunctions of the operation of the brush exclusion arrangements under the drum screens, and increase the risk of fish passing under the screen.

#### **Condition of current fish screen structures at Balmoral intake**

- 62 The Balmoral intake arrangements have been in place for 24 years. My inspection of the concrete elements, steel components, operating mechanisms and general ancillary works, showed that, in my view, the system is extremely well-maintained by any standards.

#### **Operation of current fish screens at Balmoral intake: - Current approach velocity**

- 63 In order to calculate the approach velocity to the screen at the Balmoral intake I have followed a method currently followed by the US Department of the Interior, Bureau of Reclamation<sup>4</sup> to estimate the approach velocity through the irrigation intake/screen assembly.

- 64 The depth of water at the screen and above the concrete base of the intake structure is constant at about 2 m regardless of flow.

$$\text{Area of flow} = \text{depth (2 m)} \times \text{width (2 drum openings at 5 m each)} = 20 \text{ m}^2$$

Flow to irrigation system (m <sup>3</sup> /s)	approach velocity (m/s)
5 (maximum permitted take)	0.25
3.2 (measured flow)	0.16
2.5 (minimum at which scheme can operate)	0.125

Calculation based on flow/ area.

- 65 I note that the measured velocity (measured by on site visit Greg Burrell, date on 5 March 2009, Dr Allibone evidence, para 4.3) at 3.8 cumecs is the same as that calculated based on physical dimensions and hydraulic calculations. The minimum flow is that needed to operate the system. On this basis I consider it appropriate to conclude that the velocity estimates at other flow rates, as given above, are reliable.
- 66 What I have shown here is that the approach velocity of the Balmoral intake varies from 0.125 m/s to a maximum of 0.25 m/s at peak take. This is not in compliance with the Applicants' proposals.

<sup>4</sup> US Department of the Interior, Bureau of Reclamation: Water Resources Technical Publication, Fish Protection at Water Diversions, A guide for Planning and designing Fish Exclusion Facilities, April, 2006.

- 67 I note that to comply, a doubling of capacity and hence duplication of the existing facility would be required. In my view, this presents considerable difficulty from an engineering perspective, because of the topography around the existing intake. In my view, the costs of this work would involve an investment of at least \$400,000.

#### **Sweep velocity**

- 68 The estimation of sweep velocity at the Balmoral intake is a little academic. The screened intake will be subject to circulation patterns in the stilling pond, influenced by the irrigation take at the time, flood conditions at the intake, and wind.
- 69 Based on the orientation of the screened intakes within the stilling pond, my opinion is that sweeping velocity conditions will develop, but these have not been measured or analysed.
- 70 The general situation around the intakes is that fish escape routes are generous and given earlier comments. I do not think that sweep velocity is an issue of importance to this installation.
- 71 In my view, the Balmoral intake arrangements represent the best of the experience gained by Ministry of Works and Development (MWD) and benefitted specifically from experience. It will be certainly a strong candidate for the planned further investigations by the FSWP on performance of best practice installations.

#### **Fish recovery**

- 72 At the end of the season, the main intake gate at the river is closed and the pond is emptied by gravity into the irrigation channel through the fish screens. Once the pond level is low enough a fish recovery operation is undertaken. This is carried out by local fishermen and irrigators, and the recovered fish are returned to the river. After this is done, the pond is fully emptied for mechanical de-silting operations.

#### **Conclusions as to current fish screen design and operation at Balmoral intake**

- 73 In my opinion, the condition of all structures and ancillary infrastructure of the Balmoral intake are in first class condition and reflect an adequate and diligent asset maintenance programme.
- 74 The fish exclusion arrangements at the Balmoral intake comprise a number of components that work together to effectively exclude fish from entering the scheme, namely:

- (a) The constant return flow of about 2 m<sup>3</sup>/s across the ungated weir mid way along the pond will clearly provide opportunities for safe fish return for some fish entering the system. This return flow was estimated as described in the evidence of Dr Allibone.
- (b) The irrigation intake structure is located some distance downstream from these weirs, so fish are not encouraged by velocity to move to the proximity of the screens.
- (c) Provision is made with fish bypass arrangements at the screens to return fish that get close to the screen structure.
- (d) The approach velocities are relatively low even at maximum irrigation flow.
- (e) Trapped fish are removed at the end of the season using acceptable techniques.

**Current fish screen design compared with proposed WCO standard**

- 75 In order for the Balmoral intake to comply with the approach velocity of 0.12 m/s fish screen design standard sought by the Applicants for the WCO, an additional two drum screens (each 5 m by 2m diameter) would need to be installed by AIC, so that there would be a total of four drum screens at the intake.
- 76 I base this assessment on the estimate of approach velocity given previously of 0.25 m/s at maximum consented irrigation flow of 5 m<sup>3</sup>/s. To reduce this to 0.12m/s would require a doubling of the intake/screening structure capacity. This would prove to be a costly and difficult exercise given the site conditions, as described previously.
- 77 Based on the foregoing and my experience, I conclude that the Balmoral intake arrangements are an example of sound design, construction and maintenance.
- 78 In my view the existing fish exclusion arrangements at the Balmoral intake are robust. Based on my assessments, and the evidence of Dr Allibone as to minimal impacts on the fish resource of the existing arrangements, and the likely costs to AIC of doubling the size of the existing irrigation intake structure (which would be necessary if the Applicants' design standards are approved), my view is that changes cannot be justified.

**Conclusions**

79 It is my considered view that:

- (a) Adoption of the Applicants proposals for fish screen design regarding screen aperture size and approach velocity is inappropriate and unnecessary. The requirement for minimum sweep velocity is reasonable, but should not be included as a rigid parameter, because the objective may be realised by local circumstances;
- (b) The fish screen design standards sought by the Applicants appear to be based on achieving 100% exclusion of juvenile sports fish in order to sustain that fishery in the Hurunui River, whereas there is no evidence that such a level of exclusion is necessary to sustain the fishery;
- (c) The FSWP, of which one of the Applicants (Fish and Game) was a member, considers that further research is required in order to identify appropriate fish exclusion technology and arrangements for New Zealand conditions. The members of the FSWP agreed to undertake further investigations to clarify hydraulic and exclusion performance of existing installations and to trial innovative solutions. It is therefore premature if not inappropriate to propose that some aspects of fish screen design become prescriptive before this further research is undertaken;
- (d) Imposing the requirements on fish screen design sought by the Applicants will restrict innovation and investigation of new technologies appropriate to New Zealand conditions;
- (e) The adoption of the proposals would require extensive and costly modifications to the existing Balmoral irrigation scheme intake in circumstances where the existing fish screen design is both adequate.

**Terence David Heiler**  
23 March 2009