BEFORE THE HEARINGS PANEL

IN THE MATTER of hearings on submissions concerning the proposed One Plan notified by the Manawatu-Wanganui Regional Council

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SECTION 42A REPORT OF MR JAMES STUART LAMBIE
ON BEHALF OF HORIZONS REGIONAL COUNCIL

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1. INTRODUCTION

My qualifications/experience

1. My full name is James Stuart Lambie. I am an Environmental Scientist – Ecology with Horizons Regional Council. I have a Bachelor of Science (Massey University) and a Master of Applied Science in resource management (Lincoln University). I have more than 10 years post graduate experience in matters relating to terrestrial and freshwater ecology, with a focus on ecosystems inventory, assessment and monitoring.

2. I have worked for Horizons since May 2006. I started as Research Associate and accepted the role of Environmental Scientist – Ecology in February 2007. My role at Horizons includes technical investigations involving desk-top and in-field assessments of activities that have the potential to affect aquatic biodiversity and other instream ecological values. In this role, I have presented evidence at two wind farm resource consent hearings that included expert testimony relating to the effects of activities on aquatic ecosystems.

3. I am overseeing the implementation of two Envirolink (Foundation for Research, Science and Technology sponsored) projects investigating fish passage in various catchments in the Region. The Envirolink projects aim to identify structures that impede fish passage and prioritise restoration of fish passage, based on severity of restriction, ease of restoration, riparian habitat quality and availability of upstream fish habitat.

4. I manage the Horizons' Wetlands Inventory and Horizons' EcoBase (ecological database) and I am overseeing the implementation of a Horizons tailored version of the Cawthron Archival and Data Delivery Information System. In this role, I am not only responsible for the curation of biological information but also the interrogation of the databases and interpretation of existing data.

My role in the Proposed One Plan

5. I have been involved in technical support for the Proposed One Plan (POP) since February 2007, when I developed a process for identifying riparian sites of significance and consequently authored the technical report that underpins the Sites of Significance – Riparian (SOS-R) in the Proposed One Plan (Lambie; 2007a). This work was peer reviewed by Ian Saville, a leading local ornithologist, and Fiona Bancroft, a professional ornithologist and ecologist.

6. I have had input into the development of Sites of Significance – Aquatic (SOS-A) technical report, authored by McArthur *et al*. (2007) through the identification of significant sites for blue duck (whio) using the same process I developed for the SOS-R report. A brief review of the process identifying SOS-R for dotterel and SOS-A for whio (Lambie, 2007b) was accepted by the New Zealand Ornithological Society and published in the Atlas of Bird Distribution in New Zealand 1999-2004 (Robertson *et al*. (eds), 2007).

7. I co-authored the technical report on recreational fishery and spawning values (McArthur and Lambie, 2007). In this report we describe the critical habitat requirements for native (whitebait) fishery, trout fishery and trout spawning values. We identify the threats to those requirements and propose policy solutions to managing those threats. For ease of answering questions from the Hearing Panel, Kate McArthur and I have split our respective roles between defining the values and critical habitat requirements (Kate McArthur) and the activities that threaten the values (myself).

8. With Kate McArthur, I gave technical input into the Rivers Works Environmental Code of Practice (the Code) Part 3, assisting in the identification of Site Specific Special Standards and constructing the maps that appear in the Code. With Maree Clark, I provided technical support in the development of the information layers in Schedule D. I made specific comment in the Horizons staff submission with regard to the identification of new whio sites to be added to Table D.5 and revision of Map D:11.

9. I also assisted in the development of Schedule H, as a result of hearings on the Coast Chapter of the POP, and I contributed to the development of Schedule E Indigenous Biological Diversity Table E.3 and provided peer review for revisions of Schedule E.

Scope of evidence

10. The scope of my evidence covers four interrelated provisions under Chapter 16 – Structures and Activities involving the Beds of Rivers, Lakes and Artificial Watercourses, and Damming (the BRL provisions) – of the POP. Those provisions are:

11. **Sites of Significance – Riparian.** In this part of my evidence, I present the technical aspects of identifying the river reaches with the SOS-R value. I explain how particular reaches of river were identified as SOS-R, why certain indicator species have been chosen over all others, and what to extent structures and activities in the beds of rivers affect these species. I also highlight the ecological aspects that underpin POP

provisions catering for SOS-R. My evidence underpins the SOS-R evidence of Kate McArthur and should be read with her evidence.

12. **Water Management Values and Activities Involving the Beds of Rivers and Lakes.** In this part of my evidence, I highlight the tension between activities in beds of rivers and lakes and the Water Management Values the community places on the Region's rivers and lakes. I explain the ecological aspects that underpin the POP Permitted Activity Standard Conditions (Section 16.2). This section follows after the evidence of Kate McArthur and Maree Clark, and should be read with their evidence.

13. **Activities Undertaken by Horizons in Flood Control and Drainage Schemes.** In this part of my evidence, I describe how the Environmental Code of Practice for River Works (the Code), referred to in POP Rule 16-13, accommodates the Water Management Values, with particular attention to the Special Standards section of the Code. In this section I will also describe the mapping of Works Areas and how these Works Areas relate to the Flood Control / Drainage Water Management Value proposed as map and table Ba20 for the POP. This section follows after the evidence of Allan Cook, Kate McArthur, and Maree Clark and should be read with their evidence.

14. **Dams and Culverts.** In this part of my evidence, I discuss how the installation of dams and culverts can have a significant effect on instream biodiversity and ecology. I also present the building regulatory framework for dams, drawing on the expertise of Ian Lowe. I will explain how the conditions, standards, and terms of the POP serve to protect Water Management Values, lives and property.

15. With regard to the Water Management Values, and the conditions, standards and terms to protect those values, the scope of my expertise and evidence is limited to aquatic and terrestrial ecology and habitats. I am unable to comment specifically on matters arising from (for instance) engineering requirements or protection of infrastructure. It is within the scope of my expertise to provide any further information the committee might require on the effect of activities on the beds of rivers and lakes on Water Management Values.

16. I have read and agree to comply with the Environment Court's practice note, Expert Witnesses – Code of Conduct. The overriding duty to the Environment Court expressed in paragraph 5.2.1 of this Code will be treated as a duty to this Hearing Panel for the purpose of this hearing.

2. EXECUTIVE SUMMARY OF EVIDENCE

Sites of Significance – Riparian

17. Riparian biodiversity encompasses the community of species that inhabit the margins of the Region's rivers. Some of the species are rare, and unmitigated activities in the beds of rivers or on river margins during critical periods of their lifecycle would result in the certain loss of those species from the Region.

18. Using selection criteria specifically designed to identify birds with critical riparian habitat requirements, the wrybill (*Anarhynchus frontalis*), royal spoonbill (*Platalea regia*), banded dotterel (*Charadrius bicintus*), black-fronted dotterel (*Charadrius melanops*), and nankeen (rufous) night heron (*Nycticorax caledonicus*) were selected as the indicators for Sites of Significance – Riparian (SOS-R).

19. Whio (blue duck, *Hymenolanimus malacorhynchos*) was also identified using the same criteria, but the river reaches identified for whio have been apportioned to Sites of Significance – Aquatic (SOS-A) because this species is affected by activities other than those just confined to beds of rivers.

20. The critical tidal and mudflat habitat requirement of wading birds, as defined by the presence of spoonbill or wrybill, is mostly captured under the definition of "Saltmarsh" and is given a strong level of protection in the POP as a threatened habitat type in Schedule E. Some areas of wader habitat are not covered under this definition. Permitted Activity conditions for minor activities are probably not warranted, because the birds can move away from the disturbance. However, these sites should stay delineated in the POP as Water Management Values, to take into account for activities where the effect may be more than minor.

21. The critical sand and gravel nesting habitat requirements of gravel nesting birds, as defined by the presence of banded and black-fronted dotterel, is given an appropriate standard of protection from minor (permitted) activities with Permitted Activity conditions that cater for the dotterel nesting period.

22. The critical nesting and roosting habitat requirements of nankeen night heron are delineated in the POP as Water Management Values to take into account activities where the effect may be more than minor. There is no provision in the POP to account for effects on nankeen night heron where activities are minor. I believe this is an appropriate approach because the population of this species has increased in an

environment where there has previously been no explicit Regional Plan provisions protecting it.

23. The critical habitat requirements of whio are incorporated into the SOS-A, because managing effects does not readily fit into just managing activities in the beds of rivers and lakes. The critical stream habitat requirements of whio are provided for by a wide range of POP provisions related to protecting the quantity and quality of water. The critical riparian nesting habitat requirement of whio is provided for through the Schedule E Riparian Margin habitat definition linked to the SOS-A.

24. Horizons' submission identifies additional SOS-A for whio that arose as a result of information from DOC that arrived after the POP was notified. As a result, schedules and maps in the POP that identify the location and extent of whio SOS-A require amendment.

25. The proposed provisions in the POP adequately cater for the SOS-R values I have identified in my technical report, Riparian Sites of Significance based on the Habitat Requirements of Selected Bird Species (Lambie, 2007a).

Water body management values and activities involving the bed of rivers and lakes

26. Activities in the beds of rivers and lakes affect almost all of the Water Management Values identified by Kate McArthur and Maree Clark. Activities and effects range from those that disturb the bed and instream habitats of flora and fauna, placement of structures that impede access to habitats, discharges of silt and toxic substances, and changes to the morphology of rivers that can alter community composition.

27. The extent to which activities in the beds of rivers and lakes impact on Water Management Values depends on the scale and intensity of the activity, when the activity takes place, and where it takes place in relation to the values. Effects can range from ecologically benign effects of a ropeway over a watercourse to the permanently detrimental effects of de-watering a reach. For example, driving over the river bed in areas not identified for trout spawning, or outside of the spawning season, will not affect this value.

28. There are occasions where the ecological effects of activities in the bed of rivers and lakes will be minor, and can be permitted if constraints on timing and proximity to the

activity are taken into consideration. The Standard Conditions for Permitted Activities (Permitted Activity provisions) in Table 16.1 set out those constraints. I have reviewed the Permitted Activity provisions and believe they serve all of the Water Management Values that may be affected by the activities permitted by the POP. I am of the opinion that the provisions should generally remain as proposed.

29. The Permitted Activity provisions don't address the potential cumulative effect of re-suspended sediment on instream flora and fauna caused by independently permitted activities that disturb the bed. I have no evidence to support or refute the effectiveness of the sediment thresholds proposed in the Permitted Activity provisions, so have no measure of potential cumulative effect. The thresholds come from the operative Beds of Rivers and Lakes Plan and I am of the opinion that the same thresholds should be used, unless there is evidence to show they are too lenient.

30. I recommend five changes to ensure that the values represented in Table 16.1 align with protecting the Water Management Values identified by Kate McArthur and Maree Clark. Some of these are merely wording changes to ensure consistency, while others are to provide further protection to reach-specific values from the effects of re-suspended sediment.

i. Provisions (a) (maintaining flooding capacity); (f) (materials no longer required); and (l) and (m) (archaeological sites, wāhi tapu, and kōiwi), while serving to protect catchment-wide Water Management Values, do not contribute to sustaining ecosystems. It is my opinion they should be retained but sit under a different Value heading.

ii. The title of Native Fishery Value should be changed to Whitebait Migration Value. The exclusion dates should be changed to include between 15 August and 30 November, and the kōura fishery value should be removed so that this Permitted Activity provision reflects the Whitebait Migration Water Management Value.

iii. The condition that there shall be no removal of instream woody debris less than 2 m^3 in size should be moved from Trout Fishery (a reach-specific value) to Life Supporting Capacity (a catchment value) because instream woody debris is habitat to more organisms than just trout.

iv. To protect the amenity value of Trout Fishery, there needs to be a provision such that the activity shall not result in suspended sediment being conspicuous in reaches valued for trout fishery during weekends and public holidays. This provision will also provide a small degree of further protection to other instream biota from the effects of re-suspended sediment, albeit in association with trout fishing.

v. To limit the effect of Permitted Activity provisions (j) and (k) (works that change channel shape) on road and rail bridges, culverts, fords, water intakes, and discharge pipes, these types of structures should be listed against the Existing Infrastructure provisions.

Activities undertaken by the Regional Council in flood control and drainage schemes

31. The Rivers Works Environmental Code of Practice (the Code) lists all of the activities the Operations Group undertakes in the beds of rivers within the Works Areas prescribed. The Code limits the scale and scope of river and drainage activities and does not give the Operations Group *carte blanche* licence to undertake river or drainage activities without consent.

32. The Code is set out in three separate parts, each dealing with particular aspects of best practice river engineering that cater for protection of Water Management Values. Part One deals with generic standards for good practice. These emulate the Permitted Activity provisions from the POP and serve to protect the Life Supporting Capacity Water Management Value. Part Two deals with activity-by-activity effects and highlights the best practice standards that minimise these effects. Part Three deals with site-specific standards for site-specific Water Management Values.

33. I have critically appraised the Code and I am of the opinion that it will serve to protect the Water Management Values from activities undertaken by Horizons' Operation Group. The standards, terms and conditions provide an explicit and contract-like set of limitations to the activities that can be evaluated for compliance, in much the same way as consent conditions.

34. The Code now prescribes Works Areas within the Scheme Rating Area to limit the extent to which Rule 16-13 of the POP permits Horizons to undertake otherwise regulated activities. The sum of the river reaches within these Works Areas is synonymous with the Flood Control/Drainage Water Management Value regulated by POP Rule 16-14. Map Ba20 tabled by Maree Clark depicts the extent of this value in a format that is consistent with mapping other Water Management Values for the POP. Table Ba20 tabled by Maree Clark describes the full extent of this value and is included as an appendix in the Code. This ensures the two documents refer to the same river reach extents with reference to POP Rule 16-13.

35. I recommend that the Rivers Works Environmental Code of Practice be adopted.

36. I recommend that Table and Map Ba20 be incorporated into the POP to replace Schedule I.

37. I recommend including the Works Area of the Lower Whanganui Scheme in the Flood Control/Drainage Water Management Value.

Dams and culverts

38. Large dams (defined as being 3 m or greater in depth and with a capacity of 20,000 cubic metres) require building consent and are subject to the ongoing requirements of the dam safety scheme provisions of the Building Act (2004). The reasons for these legislative requirements stem from the risk to life and property that large dams pose. Dams that are not classified as large dams do not require building consent. However, they must be constructed in accordance with the requirements of the Building Code. When considering applications or providing advice regarding the construction of a dam, Horizons needs to give consideration to resource consent requirements under the RMA, and also to building and safety requirements under the Building Act (2004).

39. Under the Freshwater Fisheries Regulations (1983), dams, diversions, culverts and fords must not prevent the free passage of fish. The reason for this legislative requirement stems from the effect structures in the beds of rivers and lakes can have on the ecology and biodiversity of streams, rivers and lakes, by impeding fish passage. If a structure built since 1984 impedes the passage of fish, the Director-General of Conservation is to be consulted about the facilitation of fish passage. For structures built before 1984, Horizons is the regulating authority with regard to the provision of fish passage. Horizons needs to ensure fish passage is provided over dams, diversions, culverts and fords, to fulfil RMA requirements and to avoid conflict with DOC's regulatory mandate.

40. I have reviewed the conditions, standards and terms associated with the installation of small dams and culverts, which are Permitted Activities in the POP. I believe most of the provisions serve the Water Management Values that may be affected by small dams and culverts. I am of the opinion that the provisions should generally remain as proposed, as there are sensible ecological and engineering justifications for the standards and thresholds. There are also other legislative imperatives that the conditions and standards give regard to.

41. I recommend three changes to the conditions, standards and terms to ensure that the terms better reflect legislative requirements, or to make the conditions simpler. The proposed changes are:

i. Insert a standard condition that small dams have a maximum capacity less than 20,000 cubic metres, to ensure consistency with the definition of a large dam under the Building Act (2004).

ii. Change the maximum culvert diameter to 1.25 m. This will ensure the bed dimension conditions are consistent with other provisions for Permitted Activities for bed disturbance being up to 20 m^2 (all other culvert conditions being served).

iii. Delete the reference to a minimum culvert installation depth of 0.3 m. This measurement is superfluous, and a minimum depth of 20% of the culvert diameter will satisfy fish passage requirements.

I also recommend that a non-regulatory method that investigates the restoration of fish passage over historical structures be included as part of mitigating the effects of older dams and culverts on fish populations.

3. EVIDENCE

Sites of Significance – Riparian

42. Throughout this report, I use the term "riparian margin" in the literal sense (ie. equating simply to the margin of a river). Habitats in the riparian margin are a gradation of vegetation and substrates influenced by a river. The ecology of the communities of plants and animals in riparian habitats differ from the ecology of terrestrial and instream communities, because the communities include species with specific adaptations to periodic inundation and drying.

43. Some species have distinct aquatic and terrestrial phases with an obligate riparian margin habitat requirement. By obligate riparian margin requirement, I mean the species must undergo a part or all of its lifecycle in the riparian margin. Examples of native animals with obligate riparian requirements include the inanga, a fish that spawns in the marginal vegetation of estuaries during king tide, and the whio (or blue duck), which must nest on the river margin, but otherwise spends much of its time in the channel of the river.

44. Other species have a facultative riparian margin habitat requirement that is river-biased. By facultative riparian margin habitat requirement, I mean their habitat requirements are not necessarily tied to the river environment. However, because the habitat is river-

biased, these species are more often located on the margin or bed of the river than in other places. Examples of native animals with facultative riparian requirements include the banded dotterel and the black-fronted dotterel, which prefer to nest in exposed gravel and sand areas. The timing of nesting is coincident with low river flows and they have the adaptive ability to rapidly establish a new clutch of eggs if flooding destroys the nest early in the nesting season.

45. Some of the species that have specific requirements of riparian margins are now rare. Unmitigated activities in the beds of rivers, or on river margins during critical periods of their lifecycle, would result in the certain loss of those species from the Region, thus affecting the Region's biodiversity. Protection of the biodiversity of the Region's riparian margins from activities in beds of rivers therefore deserves a dedicated investigation into where the significant riparian habitats are located.

46. The purpose of the Sites of Significance – Riparian (SOS-R) is to give recognition to significant habitats of indigenous fauna that may be affected by uses of beds of rivers. My technical report, Riparian Sites of Significance Based on the Habitat Requirements of Selected Bird Species (Lambie, 2007a) contributes to the identification of SOS-R by identifying river reaches that are known habitats of riparian birds. The analytical scope of my investigation was narrow, which leads to omissions, not only concerning the identification of significant riparian habitats of other riparian fauna, but also flora. The obvious omissions are detailed in Appendix 2 of my technical report (Lambie, 2007a; pg 20). Birds were used as an indicator group because avian species distribution information is more readily available than most other taxa.

47. The criteria and justification for the selection of certain bird species over others is detailed in Section 2 of my report (Lambie, 2007a; Table 1, pg 3). The species selected have specific or obligate habitat requirements of riparian margins. Some are selected because they are threatened, or because they are a "good" indicator species. One is selected on the basis that the species only breeds in Horizons' Region. A good indicator species is one that is easily recognised but is not so abundant as to cause all riparian margins to be significant. Protection of the habitat for the indicator species protects the habitat of rarer birds with the same habitat requirements.

48. Using the selection criteria, wrybill (*Anarhynchus frontalis*), royal spoonbill (*Platalea regia*), banded dotterel (*Charadrius bicintus*), black-fronted dotterel (*Charadrius melanops*), and nankeen (rufous) night heron (*Nycticorax caledonicus*) were selected as the indicators for SOS-R. Whio (blue duck, *Hymenolanimus malacorhynchos*) was also

identified using the same criteria. The analytical approach to identify SOS-R was used to identify SOS-A for whio, so for completeness I will describe that here also.

49. The data sources and mapping methodology are described in my technical report (Lambie, 2007a; Pg 8). I used provisional unpublished data from the New Zealand Ornithological Society's Bird Atlas of New Zealand 1999-2004 (Robertson *et al*., 2007) as a regional source of bird distribution data for the selected species. The atlas data are 10 km by 10 km grid squares that depict the presence of each bird species, based on thousands of hours of volunteer observations between December 1999 and November 2004 (Robertson *et al*., 2007). Additional dotterel data were sourced from the Department of Conservation (DOC) and the New Zealand Defence Force, as well as anecdotal observations by Horizons staff. Additional whio information was sourced from DOC. In relation to whio, further information came to light just after the Proposed One Plan was notified and Horizons' submission proposes that these sites should be included in Table D.5 and Map D:11. Nankeen night heron information was sourced from Jim Campbell of DOC, Wanganui.

50. I refined the identification of river reaches to appropriately depict the critical habitat requirements of the selected species, by creating separate habitat typology information layer that reflects their critical habitat requirements (Lambie, 2007a; Table 2, pg 7). For gravel and sand habitats (for dotterel) I used the New Zealand Land Resources Inventory to identify river reaches likely to contain gravel and sand beaches. For tidal mud/silt habitats (for waders such as royal spoonbill and wrybill), I limited the extent of my river depictions based on tidal reaches to depictions based on anecdotal information of tidal extent and scrutinising aerial photographs for substrates that appear to include mud and silt. For nankeen night heron and whio, I did not need to refine river reaches using habitat typologies, because the river reaches I have identified are based on known distributions.

51. I then overlaid the bird distribution data and river reach typology with the Horizons' modified River Environment Classification, to identify the SOS-R and SOS-A (for whio). A description of the River Environment Classification is provided in the evidence of Maree Clark. I vetted the identified sites, visually scrutinising underlying photographs and removing any reaches that were obviously not critical habitats (Lambie, 2007a; pg 9). The maps were reviewed by DOC staff for corrections and accuracy and the report was also peer reviewed to verify the validity of the methodology.

52. The critical habitat requirements, and specific activities that threaten the selected SOS-R species, are listed in Table 1 of Lambie (2007a; pg 5). Discharges to a river, such as oil spills or toxins that affect Life Supporting Capacity may affect SOS-R. Introduced predators are also a predominant threat to the species defined in the SOS-R, particularly for ground nesting birds such as dotterel. However, since discharges and predation are not directly related to the use of river beds, they were left out of Table 1. The critical habitat requirements and activities that threaten whio are described in McArthur *et al*. (2007, pg 44).

53. For the waders, the specific threats are activities in the river bed that affect the availability of feeding habitat. These include dredging of mudflats and silt beds, vehicular activity and removal of favoured roosting sites. In my technical report, I state that the waders are vulnerable to these activities at any time of the year. For clarification, waders are vulnerable to feeding habitat loss at any time of the year. They are most vulnerable to vehicular disturbance at roosting sites and they are most vulnerable to roost removal when they are moulting, because their ability to fly is diminished.

54. Table 16.1 of the POP lists the performance conditions for Permitted Activities under Bed of Rivers and Lakes (BRL) provisions. Minor disturbances of mud and silt habitats, and removal of structures that might be roosts, are Permitted Activities in the POP BRL provisions. However, there are no performance conditions to cater for the critical habitat requirements of waders in Table 16.1. Specific performance conditions in Table 16.1 for Permitted Activities in the critical habitats of waders are not necessary.

55. I am of the opinion that most of the critical wader habitat of Horizons' Region is captured under the Saltmarsh wetland habitat description (identified as a threatened habitat in Table E.1 of "Version 5 Schedule E" of the POP). This definition includes open expanses of estuarine mudflat substrate. This habitat description captures much of the extent of the estuarine feeding and roosting habitats of coastal waders like wrybill.

56. A number of river reaches labelled as SOS-R for waders are not captured under the Schedule E definition of Saltmarsh. This includes wader feeding habitat on the Whanganui River toward Kaiwhaiki, where sections of the river have tidal mudflats but the absence of salt marsh vegetation indicates that the flats are not inundated with saline or brackish water.

57. I am of the opinion that the scale of the effects of permitted bed disturbance (20 square metres of bed) on the values in such reaches is minor. The waders will simply move

away from the disturbance and feed elsewhere. On the other hand, the scale of bed disturbance activities that are not permitted could result in permanent disruption of this habitat. A conceivable example would be to dredge the tidal flat margins of the Whanganui River from Cobham Bridge to Upokongaro, to aid navigation. Therefore, I believe the identified SOS-R that are not protected by Schedule E definition of Saltmarsh should remain in the POP as values to consider for consenting activities where the effects may be more than minor.

58. For banded and black-fronted dotterel, the specific threats include any activity that disturbs or reduces the extent of gravel and sand nesting habitat. These include gravel extraction, vehicular activity and damming. Dotterels are most vulnerable during the nesting period, from the timing of egg laying through to when the chicks leave the nest. Floods that wipe out nests can occur during this time. Dotterel will quickly re-establish a new nest (within a week after a flood), and successfully raise a replacement brood over the general nesting period. Dotterel are also vulnerable to disturbance at roosting sites.

59. Conditions are required to limit the scale and timing of bed disturbances, particularly gravel extraction, to provide for dotterel nesting requirements. Under the POP, small-scale gravel extraction and other minor disturbances of gravel and sand beds are a Permitted Activity. “Small-scale” is up to 50 cubic metres of bed material. This scale is not based on any empirical observations of effects on dotterel but is based instead on balancing competing needs for retaining gravel in rivers and providing for a reasonable amount of aggregate for domestic or small-scale use.

60. What might seem a minor quantity of gravel removed from the river as a whole may be detrimental to the nesting success of a pair of dotterel. Therefore, minor gravel extractions may or may not be reasonably assumed to result in only minor effects on regional dotterel populations. Based on precaution, I have formed the opinion that minor gravel takes can remain a Permitted Activity so long as there are conditions that limit the timing of the take to occur at times that are mainly outside the dotterel nesting period.

61. The Permitted Activity conditions in Table 16.1 provide for the nesting requirements of dotterel by specifying a critical time period to avoid gravel extraction, between 1 August and 31 December in SOS-R, unless there is cause to believe the dotterel are not nesting there (ie. a flood has run over the beach seven days before extraction, or extraction has been continuous). This time frame is presently applied as a standard condition for gravel consents and is based on advice received from DOC.

62. In my technical report, I identify that nesting for banded dotterel starts “around July”. This would suggest the 1 August start date stipulated by DOC is too early. However, I used the term “around July” to summarise conflicting banded dotterel egg laying dates (July and August) reported in two ornithological references (Heather and Robertson; 1996, and Falla *et al*.; 1981). 1 August is a reasonable and appropriate day.

63. In my technical report, I identify that black-fronted dotterel “fledged by February”, which would suggest the 31 December finish date stipulated by DOC is too early. A fixed date for when black-fronted dotterel chicks leave the nest is difficult to postulate, given that there are variations on the timing of egg-laying, and thus fledging date, between years. Heather and Robertson (1996) report that black-fronted dotterel eggs are laid in August to February, “…early in Hawke’s Bay where river beds are wider, and late in Wairarapa where floods are common in early summer.” (Heather and Robertson, 1996; pg 304). Falla *et al*. (1981) report that eggs are laid September to January.

64. I settled on the assumption that the Manawatu-Wanganui regional populations of dotterel lay eggs from the start of the September with egg laying tapering off in early January, as suggested by Falla *et al*. (1981). These dates fall in the middle of the period posed by Heather and Robertson (1996). Incubation takes 22-26 days, which would mean the last of the hatching would be some time in late January. Within days of hatching, chicks are able to leave the nest, and I made the assumption that the critical nesting period is over when the young can move away from minor disturbances, even though they are still unable to fly. Therefore, my conclusion was that the critical period would be over by February.

65. I do not dispute the dates supplied by DOC in its earlier advice. DOC staff have a better knowledge of the breeding and nesting dates of the Region’s dotterel and therefore have a better understanding of when dotterel are most at risk from bed disturbance. I do maintain that there is a small risk that individual pairs will be detrimentally disturbed, particularly if the breeding season has been delayed by floods. However, the effect of such disturbance on the dotterel population in the Region is likely to be negligible, based on the presumption that, on average, the bulk of the breeding is likely to be completed by 31 December.

66. Nankeen night heron are widely distributed in Australia and the south west pacific (Falla *et al*., 1981). Attempts to liberate nankeen night heron in 1852 were unsuccessful and it is believed that the birds presently in New Zealand arise from self-introduced stragglers. The species is therefore considered native in a legal sense. The two Whanganui River

reaches identified as SOS-R are thought to be among only a few places in New Zealand where native populations of nankeen night heron are consistently breeding (Heather and Robertson, 1996). The Whanganui population has expanded from nine in 1994 (reported in Heather and Robertson (1996)) to 15 to 30 birds reported to me by Jim Campbell of DOC in 2007. For nankeen night heron, the main threat is the complete removal of willow trees which provide roosting and nesting habitat.

67. There are no policies proposed to protect nankeen night heron roosting and nesting habitat under either Chapter 16 or in Schedule E. Any policy consideration would need to balance the importance of Whanganui populations as a breeding stronghold for this species in New Zealand over the fact that the species is a recent coloniser and is not threatened.

68. In my opinion, the reaches of the Whanganui River where nankeen night heron breed are significant habitats, for the simple reason that this is a national breeding stronghold. Therefore, they should stay mapped as SOS-R. However, it appears that threats to the population are minimal. Conditional circumstances seem to have prevented detrimental disturbance over the last 10 years in an environment with no regional rules or methods. I am of the opinion then that a regional policy is unnecessary and conservation policy for habitats of nankeen night heron is better left to DOC.

69. Whio are obligate river users – even when flying, they prefer river corridors – spending most of their time either in the bed of the river or on the river bank. The whio is nationally endangered and requires active intervention to sustain populations of the species. Aside from the detrimental effects of introduced predators, the causes of the decline of whio include loss of river margin habitat, degradation of water quality through changes in land use, and loss of aquatic habitat through damming and diversion.

70. The critical habitat requirements of whio are incorporated into the SOS-A, because managing effects does not readily fit into just managing activities in the beds of rivers and lakes. The scope of activities that affect whio is wider than those associated with the beds of rivers and lakes. It has requirements for water quantity, water quality, riparian habitat, and food resources that are similar to many native fish and trout (McArthur *et a*l., 2007). The SOS-A status also means that that critical nesting extent for whio is captured by the Riparian Margin At-Risk habitat identified in Table E.1 of Version 5 Schedule E of the POP. I am of the opinion that the nationally endangered threat status of whio justifies the stringent position that SOS-A status provides under the POP.

Reasoning behind the SOS-R approach

71. An important question is, Why were SOS-R identified separately from habitat types listed in Schedule E? The main reason is that, while Schedule E recognises physical substrate, river substrate habitat definitions such as “gravels”, “sands” and “silts” are too broad to usefully capture the biodiversity values associated with them, without causing all riparian margins to be captured. Habitats based solely on un-vegetated gravel, sand, and silt are therefore excluded from Schedule E and so there arises a gap in the adequate protection of significant riparian habitats of indigenous fauna that use those habitats. Schedule E is also concerned with activities wider than the uses of beds of rivers, whereas protection of the SOS-R can be related entirely to limiting the effects of activities in beds of rivers.

72. In contrast to the above problem, the riparian margins of wetlands and lakes were not considered in the SOS-R analysis, because those margins are adequately captured by Schedule E. Estuarine environments were included in the SOS-R analysis, because these environments are part of the river bed. However, in my opinion, the Schedule E approach is the more appropriate vehicle for the protection of estuarine SOS-R values.

73. Another important question is, Why are SOS-R separate from SOS-A? Activities that threaten the viability of populations of species in the SOS-A include activities associated with water quantity and water quality, not just activities within the beds of rivers and lakes. The protection of the SOS-R can be related entirely to limiting the effects of activities in beds of rivers.

74. In general, the SOS-R approach gives flexibility for continued use of the river bed than can otherwise be achieved by merging SOS-R into SOS-A or Schedule E, while maintaining some of the biodiversity values that are inherently “riparian”. In specific relation to the protection of the critical nesting requirements for dotterel, the SOS-R approach effectively frees up gravel resources in places where the birds are not known to be present, or at times outside the critical nesting period.

Recommendations

75. (1) As per Horizons’ submission, amend Table D.5 and Map D:11 to include the most-up-to-date list of sites of significance (SOS-A) containing whio, as highlighted in Appendix 4 of that submission.

76. (2) Retain unchanged the proposed rules and Permitted Activity standards relating to small-scale gravel extraction and the protection of the critical habitat requirements for dotterel.

77. (3) Retain unchanged the extent of the SOS-R in Map D:12 as presented in the POP.

Water body management values and activities involving the bed of rivers and lakes

78. There are still pristine catchments in Horizons' Region, and even modified river reaches and lakes are valued by the Region's communities as places to recreate and enjoy a sense of the outdoors. However, accommodating for other demands puts pressure on the natural values we so enjoy. Such demands include flood protection, the building of infrastructure within the beds of rivers and lakes (eg. bridge piers, road culverts, water intake and discharge pipes), the removal of gravel for such infrastructure or flood protection, and dams for water supply and hydroelectricity. The use of the Regions' river and lake beds continues to modify the physical characteristics and ecology of many of the Region's waterways.

79. In balancing the economic, cultural, social and environmental importance placed on rivers and lakes, it is assumed from the outset that the regional community desires that activities in the beds of lakes and rivers do not result in degradation of the other values placed on lakes and rivers. In their evidence, Maree Clark and Kate McArthur describe the Water Management Values, which are a revised set of community values to be maintained and protected from unsustainable management practices. My evidence describes the kinds of activities in the beds of rivers and lakes that affect the Water Management Values and explains the ecological aspects that underpin the Permitted Activity Standard Conditions (Table 16.1 of the POP).

Activities and effects on values

80. This is a summary of activities associated with uses of beds of rivers and lakes, with examples of associated effects on the Water Management Values. It is by no means an exhaustive list, but it demonstrates the range of activities and ecological effects.

81. **Structures in, on, over or under the bed of a river or lake.** The activities include erecting, placing, extending, or demolishing structures. Structures include not only

buildings, bridges, fords, weirs, and dams, but also flood control measures like grade control structures, rock walls, and groynes. Structures also include lines, cables, pipelines and ropeways.

82. From an ecological perspective, structures that occupy the river or lake bed can affect all of the ecosystem, and recreational and cultural Water Management Values. Effects range from ecologically benign effects of a ropeway on natural state, aesthetics, and amenity, to the detrimental ecological effect that an impediment to fish passage such as a dam, weir or grade control structure might have on Life Supporting Capacity, SOS-A, inanga spawning, whitebait migration, mauri, or trout spawning. A ford, while permitting the passage of fish, can detract from the natural state, may smother what once was fish spawning habitat, and represents a discontinuation in the natural river bed from the perspective of aquatic macro-invertebrate habitats. A building occupying a pier on a tidal mud flat can exclude waders from valuable feeding grounds.

83. The action of placing or demolishing a structure on a river or lake bed can result in the release of built-up bed sediment, which in turn affects all of the ecosystem, recreational and cultural, and water use Water Management Values. From an ecological perspective, the negative effects of sediment re-suspension on the Water Management Values can range from quite minor effects, such a discolouration of the water that affects amenity, to un-seasonal deposits of silt on trout spawning beds or during migration of sediment sensitive fish that affect the population ecology of those species. Suspended sediment affects the depth to which light penetrates the water and so affects plant and algal communities.

84. Hard engineering structures built on a river bank, although usually out of the water, can also cause detrimental impacts. By hard engineering, I mean engineering the river and bank to constrain and direct flow to such an extent that the river losses its natural meander pattern. Forced river shapes can change the physics of the river, which can alter the ratio of runs, pools and riffles. One outcome of hard engineering is for the river to become one long run designed specifically to convey flood flows. The river loses its gravel beaches and pools, and so loses the habitats of the many river species that rely on habitat complexity.

85. **Disturbance of a river or lake bed.** Such activities include any excavating, drilling, or tunnelling of the bed, introducing or removing plants, destruction of the habitat of plants or animals, or reclamation of the bed. Activities that disturb the bed include not only the extraction of gravel but can also include gravel repositioning, extraction of silt and sand,

placement of rock protection work, removing logs, and other flood protection activities. The use of machinery and the control of weeds in the bed of a lake or river also fall under the term “disturbance”.

86. Bed disturbances can affect all of the ecosystem, recreational and cultural water use, and social / economic Water Management Values. Effects range from an ecologically benign tunnel under the bed to the detrimental ecological effect of the loss of gravel habitat that gravel over-extraction has on Life Supporting Capacity, SOS-A, SOS-R, mauri, and trout spawning. Removal of bed material from near existing infrastructure can affect the integrity of the structure.

87. Soft engineering techniques, such as repositioning of gravel and beach raking, can also cause the re-release of built-up bed sediment that affects ecosystem, recreational and cultural, and water use Water Management Values in ways I have already described. By soft engineering, I mean techniques that guide the active channel to take a particular course, but do not result in permanently fixed shape.

88. River engineering activities result in other disruptions of the bed that can affect life supporting capacity. Driving over the bed can physically disturb spawning habitat and destroy the interstitial habitat of macro-invertebrates. Depending on the timing and frequency of crossings, the ecological effects may be short-lived and minor, with macro-invertebrates re-colonising gravels within days of disturbance. However, during trout spawning, the activity could ruin the productivity of the spawning bed for the entire season. Removal of woody debris, while seemingly innocuous, removes instream habitat for fish and invertebrates.

89. **Diversion or damming of water.** Such activities include structures that force water to go in a direction other than the direction that would be conveyed by the natural bed, or cause water to pond where it would otherwise be running freely down a gradient.

90. The ecological effects of diversions range from the positive effects of a temporary bund (usually built in part of the bed to avoid sediment release to the rest of the water body) to the complete de-watering of a bed which will have detrimental effects on all of the ecosystem, recreational and cultural, and water use Water Management Values. A diversion is often linked to abstraction (the effects of which are covered in other evidence) but even where the water is placed back into the originating river, the channel between diversion and outfall has less water and therefore less aquatic habitat than upstream and downstream, creating an ecological constriction in the river. The effects

may be negligible for small or temporary diversions, depending on the timing and period of the temporary diversion and length.

91. The long-term ecological effect of damming a river arises from the change in the habitat from run – pool – riffle sequence to one much larger pool or lake. Fish and macro-invertebrates that require stony riffles disappear as the bed substrate changes to silt. Plant and animal communities adjust from being predominantly river-like, to predominantly lake-like. The dam structure itself is likely to impede fish passage with knock-on effects on upstream fish community structure, by excluding some species over others or by limiting recruitment of migrating juveniles. The change in community structure itself is an effect on life supporting capacity and natural state. The negative consequence of the change in community structure is the loss of species that can ensue, and the risk of losses in regional biodiversity as a result. I explore further ecological effects of dams under Dams and Culverts, below.

92. **Discharges not inherent to the bed.** In relation to activities in the beds of rivers and lakes, discharges include material on or in the bed that are not inherent to the bed. These include concrete (whether that be rubble, cured forms, or freshly poured forms), rocks, litter, and plant fragments. Discharges include potential toxicants coming from those materials, or toxicants leaking out of the machinery used; they may also include sediment that is not readily inherent to the bed, even though the sediment may have originated from the river (eg. sediment that has been washed off extracted gravel, or bank sediment disrupted by vegetation clearance, running into the river after a rain event.

93. Discharges of compounds such as fuel and oil films from machinery working in the river bed are likely to have immediately dire effects on instream organisms if the concentrations are eco-toxic, so affecting ecosystem, recreation and cultural, and water use Water Management Values. Even small quantities of grease and film detract from amenity and aesthetics. The accidental introduction of biological hazards such as *Didymosphenia geminata* ("Didymo") from machinery could result in large-scale and permanent negative consequences for the ecosystem, and recreational and cultural values of the Region's rivers. Sediment that is not inherent to the bed increases sediment concentrations in the water column and bed-load sediment, exacerbating the sediment effects I describe above. Due to the potential for discharges, even activities in artificial beds can affect downstream water management values in the parent river.

94. Leachate from uncured cement is alkaline and toxic to aquatic organisms. Even in cured form the dust of concrete is alkaline and may affect in-steam biota. Aside from the negative effect building rubble has on amenity and aesthetics, the structure, texture and density of concrete and brick differs from natural rock, and so could affect the natural state Water Management Value if placed in those zones. Building rubble as a bed material physically behaves differently to natural river substrates, potentially impinging on life supporting capacity. In turn, concrete in either raw of cured form can have negative ecological consequences to SOS-A, SOS-R, inanga spawning, and trout spawning.

Scale and timing

95. The extent to which activities in the beds of rivers and lakes impact on Water Management Values depends on the scale or intensity of the activity. A ropeway over a watercourse is ecologically benign; and while a single pass of machinery over a river bed will have temporary effects, multiple crossings over multiple days will have much longer lived effects. Minor releases of sediment that do not change the clarity of the water are unlikely to affect instream biota, and even a short burst of disturbed sediment that looks terrible (eg. from a singe river crossing) will affect biota on a localised scale only.

96. The extent to which activities in the beds of rivers and lakes impact on Water Management Values also depends on where the activity takes place in relation to proximity of the values, and when the activity takes place, if the values have a seasonal aspect to them. For example, driving over the river bed in areas not identified for trout spawning, or outside of the spawning season, does not affect this value. Releases of sediment during a flood that do not change the background (upstream) colour of the water can hardly be blamed for ecological deterioration. However, releases of the same amount of sediment during the redfin bully juvenile migration, for example, may affect recruitment of that species for that season.

Permitted activity standards

97. Following from above, there are occasions when we can be confident that the ecological effects on Water Management Values will be minor and activities in the bed of rivers and lakes can be permitted. However, the effects may not be null or there are constraints on timing and proximity of the activity that need to be explicitly stated so as to ensure the effects are avoided or minimised. A mechanism by which such constraints to permitted

activities might be made explicit has been proposed, and is embodied as Standard Conditions for Permitted Activities (Permitted Activity provisions) set out in Table 16.1 of the Proposed One Plan.

98. To explain the ecological aspects that underpin the Permitted Activity provisions, I critically evaluate the Permitted Activity provisions, showing where they provide for (or detract from) protecting ecological aspects of the Water Management Values. This evaluation is intentionally structured to follow the layout of Table 16.1 and so may appear planning focused.

99. **Life Supporting Capacity.** This set of Permitted Activity provisions specifically capture catchment-wide effects of activities on all catchment-wide Water Management Values. The provisions include elements that protect the Life Supporting Capacity Water Management Value. There are also elements of Social / Economic Values that are not related to maintaining healthy aquatic life or ecosystems, such as the ability to convey floods and protection of cultural and historic values.

100. The provisions under Life Supporting Capacity that do not contribute to sustaining ecosystems are: (a) (maintaining flooding capacity); (f) (materials no longer required); and (l) and (m) (archaeological sites, wāhi tapu, and kōiwi). It is my opinion that these provisions contribute to assuring permitted activities do not affect other values and so should remain as catchment-wide Permitted Activity provisions; they just do not belong under the title of Life Supporting Capacity.

101. Permitted Activity provisions (b), (c), (d), (e) and (g) maintain the Life Supporting Capacity Water Management Value by placing thresholds on toxic contaminants and sediment inherent to the bed. Being catchment-wide standards, these provisions also give a standard of protection to site-specific Ecosystem, and Recreational and Cultural Values that are sensitive to contaminants.

102. Re-suspended sediment inherent to the bed can affect aquatic ecosystems, and affects the amenity aspects of the Trout Fishery Value and Amenity Value. Therefore, it is necessary to have sediment thresholds that limit the duration and quantity of sediment re-suspended in the water column.

103. Permitted Activity provision (c) puts a five-day, 12-hour threshold on sediment re-suspension to avoid continuous sediment discharges. This is an existing threshold on the operative Beds of Rivers and Lakes Plan. It is not based on empirical evidence of

effects but rather based on the need to draw the line. The threshold carries the risk that the disturbance event will still result in a continuous plume of re-released sediment after cessation of the activity.

104. Provision (d) puts a sediment load limit (as measured by a change no greater than 30% in visual clarity more than 24 hours after completion) on re-suspended sediment. This is an existing threshold on the operative Beds of Rivers and Lakes Plan. It is based on the ability to perceive a conspicuous change in visual clarity, as a relatively simple means of measuring, monitoring, and enforcing compliance (Ausseil and Clark, 2007).

105. Ausseil and Clark (2007; pg 24) provide referenced discussion on values protected by the visual clarity thresholds in the POP. The authors cite the need for a maximum clarity standard of 20% in places where protection of water clarity is particularly important (eg. presence of sensitive species) and 30% elsewhere. This recommendation is carried through into the Water Quality Standards for Water Management Sub-zones (Table D.17) that apply to continuous discharges in sub-zones where the values in the sub-zone do not warrant the more stringent 20% threshold.

106. The assumption in Permitted Activity provision (d) is that, as long as re-suspended sediment results in a change in visual clarity of less than 30% after 24 hours, the sediment released up to that time is ecologically inconsequential to Life Supporting Capacity Values. This assumption carries an unspecified degree of risk that re-suspended sediment contributes to a clarity change that is well in excess of 30% during the activity. The only solution is to constrain the activity to one-off, short duration events (ie. as prescribed in provision (c)).

107. Therefore, Life Supporting Capacity Permitted Activity provisions (c) and (d) work together, and neither provision is by itself effective at constraining re-suspended sediment. I believe the provisions together minimise the effects of re-suspended sediment. The provisions only manage the quantity of re-suspended sediment by constraining one-off activities, and may not control the cumulative effect of a continuous string of independent activities. As I have no evidence to support or refute the exact nature of the effects re-suspended sediment has on Life Supporting Capacity, I can only restate my opinion that I believe a duration and contamination threshold is necessary.

108. Provided that the POP caters for places where, or times when, sensitive species require low sediment (eg. provisions preventing activities in SOS-A, provisions to prevent the use of mobile machinery that disturbs the bed during critical spawning times in critical

places, and controls on discharges of sediment that are not inherent to the bed) I see no reason to change the present Life Supporting Capacity provisions (c); and (d) as they are proposed, unless empirical evidence shows these thresholds are set too leniently.

109. Permitted Activity provision (h) requires that activities be undertaken in a manner that provides for the safe passage of fish. The provision applies to all catchments and is intended to avoid effects on the Life Supporting Capacity of aquatic ecosystems that are caused by changes to fish ecology. The provision also serves to sustain site-specific fish-related values. The maintenance of fish passage is a legal requirement under Fresh Water Fisheries Regulations, as described in Dams and Culverts below, that is also served by this provision.

110. Permitted Activity Provision (l) requires that diversions: shall be temporary, shall be within the bed of the river, shall not exceed 100 m in length, shall not be between catchments, shall not involve a lake (except artificial lakes), and the diversion channel shall have sufficient capacity to carry the same flow as the original bed. This provision is a catch-all that protects ecosystem and recreational and cultural Water Management Values from the negative effects of permanent diversions. The 100 m threshold arises from the operative BRL plan and limits the scale of temporary diversions so that the effects, while potentially severe, remain localised.

111. Permitted Activity provision (j) requires that, “Upon completion of any channel bank works, the banks shall be reinstated to a natural contour and re-vegetated”. Appropriate bank contouring prevents lateral erosion of steep and under-cut banks. In modified landscapes where lateral erosion is exacerbated by modern land uses, contouring and subsequent re-vegetation is often beneficial to aquatic faunal values, because the activity reduces overall sediment input. However, unnecessary bank contouring, such as smoothing the bank contour solely for visual landscape reasons, disrupts riparian marginal vegetation and risks greater overall sediment inputs than would be controlled by contouring. Contouring removes under-cut banks which provide cover protection for fish.

112. The contour standard does not permit bank contouring for landscaping reasons alone but is instead an expectation that, when channel work takes place, the end result does not detract from the apparent naturalness of the river environment. The provision is beneficial to Life Supporting Capacity, even though it mainly serves aesthetic values.

113. Under provision (k), any permanent straightening or channelling of a river must not exceed a length equal to two times the bed width of the river in any 2 km length of the river in any 12-month period. This provision creates a threshold on changes to the natural meander pattern of a river and so minimising the effects that channel straightening has on the ratio of runs, pools, and riffles, and on beach formation. The limits are not based on observed effects, but on the practicality of implementation and monitoring. The provision is beneficial to all ecological values that rely on the formation of runs, pool, riffles, and beaches.

114. **Riparian Habitat** provision (n) protects the critical period for nesting by gravel-nesting birds (which is indicated as beaches used by banded and black-fronted dotterel) in the SOS-R Water Management Value. The dates between 1 August and 31 December represent the bulk of the time these birds will be sitting on eggs and unable to move away from disturbances on beaches. The exceptions to the exclusion dates accommodate the extraction of gravel from SOS-R at times when it is unlikely the birds will be nesting (specifically when a flood has destroyed nesting attempts, or gravel extraction activities prior to the nesting season have prevented nest establishment).

115. The Riparian Habitat condition does not protect the critical habitat requirements of estuarine wader feeding and roosting habitat, or nankeen night heron nesting / roosting habitat, from Permitted Activities. I am of the opinion that protection of the wader SOS-R from Permitted Activities using Permitted Activity provisions is unnecessary because better protection is afforded through Schedule E of the POP. I am also of the opinion that protection of the nankeen night heron SOS-R from Permitted Activities using Permitted Activity provisions is unnecessary because they are not threatened by Permitted Activities.

116. **Inanga spawning** provision (o) protects the critical values associated with the Inanga Spawning Water Management Value. The provision protects the spawning beds, identified in specific reaches, from disturbance during the spawning period.

117. **Native fishery** provision (p) specifically protects critical values associated with the Whitebait Migration Water Management Value. The provision ensures that sediment re-suspension caused by disturbance in the active flowing channel does not occur in reaches identified as important for whitebait fishery during the migration period. While this provision protects the angling value of the whitebait fishery (which includes aesthetic values attached to water clarity), it also serves to ensure that the water is clear enough for the fish to migrate through the fishery reaches and into adult habitat further upstream.

118. As highlighted in McArthur *et al.* (2007), the whitebaiting season is between 15 August and 30 November, although the juveniles of the native fish taxa that comprise 'whitebait' vary greatly in their timing for migration from marine to freshwater environments, depending on the species. To protect the amenity value of the fishery, the period covered by provision (p) (i) should be amended to reflect those dates. There have been no reaches mapped for kōura and therefore provision (p) (ii) cannot be given effect to. This provision should be removed and the title of this Permitted Activity provision should be changed to relate to whitebait migration rather than native fishery.

119. **Trout Spawning** provision (q) specifically provides for successful egg deposition, egg and fry development, and alevin emergence for brown and rainbow trout in reaches identified for the Trout Spawning Water Management Value. The development of eggs and fry within spawning redds is a critical aspect of successful juvenile trout recruitment (McArthur and Lambie, 2007; pg 10). During the development period, the redds must remain physically undisturbed and sediment deposition must be low. The provision ensures that sediment discharge and direct disturbance of the bed does not take place in water bodies valued for trout spawning during the spawning season.

120. The proposed exclusion period of 1 May to 30 September spawning period is longer than the period in the current Beds of Rivers and Lakes Plan (1 May to 1 September). The reason for this extension to the exclusion period is to cover the main spawning and egg development periods of both brown and rainbow trout. For both species, the time taken for eggs to mature is quite variable and the extended exclusion period accounts for this variability.

121. It is important to note that the provision protects the spawning period for trout within reaches where spawning habitat is renowned, while permitting activities in other reaches where spawning is otherwise not a significant aspect of sustaining trout populations. In the current Beds of Rivers and Lakes Plan the exclusion period is a blanket condition to any consent for activities in beds of rivers. The proposed provision is a more targeted effects-based approach.

122. **Trout Fishery** provision (r) specifically protects the Trout Fishery Water Management Value by ensuring the continued presence of instream cover for trout, particularly in the absence of bank side overhangs and shade. The threshold to retain woody debris of sizes up to 2 m^3 is not scientifically derived. Instead, it is a figure that can be readily identified and tested for compliance, and is of a size that (presumably) does not obstruct

flood flows or damage infrastructure if picked up by a flood. The presumption carries some risk that smaller debris will increase the risk of flooding or erosion, so these exceptions are highlighted in the provision.

123. Aside from offering shelter for trout, woody debris adds to channel complexity and morphology; it also provides shelter for other fish and habitat for native invertebrates. I am of the opinion that this provision is better suited to sitting under Life Supporting Capacity, where it may be applied to all instream woody debris in all rivers.

124. **Amenity** provisions (s), (t) and (u) provide for the maintenance of existing opportunities to enjoy rivers and lakes without being affected by activities in the beds of rivers and lakes, and as such provide for the Amenity Water Management Value. I believe the thresholds (conspicuousness and timing to avoid weekends and holidays) for suspended sediment are pertinent to the amenity attached to the Trout Fishery Water Management Value. In my opinion, the Trout Fishery provision would benefit from having a sediment clause related to conspicuousness during public holidays and weekends. This would not only benefit the amenity component of the Trout Fishery Value, but serve to provide at least a little more protection to all aquatic biota living in trout fishery areas from the effects of suspended sediment.

125. **Existing Infrastructure** provision (v) protects the integrity of Horizons' water-level monitoring stations and the integrity of the flow-volume calculation where the profile of the river bed in the vicinity of the flow recorder must be known. The threshold distances are based on past negative experiences where rating curves have been disrupted by instream activities in the vicinity of flow recorders. In contrasting this Permitted Activity provision with the existing Infrastructure Water Management Value, there is the need to consider provisions (j) and (k), which limit the effect of permitting channel straightening on other existing infrastructure such as bridges, culverts, fords, water intakes and discharge pipes. I am not qualified to advise on what the most appropriate buffer distance should be.

Recommendations

126. (1) Move Permitted Activity provisions (a), (f), (l) and (m) from the Life Supporting Capacity Value to another catchment-wide value description.

127. (2) Change the title of Native Fishery Value to Whitebait Migration Value, and change the exclusion dates to include between 15 August and 30 November (the whitebait fishing season). Remove the Kōura Fishery Value.

128. (3) Move the condition that there shall be no removal of instream woody debris less than 2 m^3 in size from Trout Fishery Value (a reach-specific value) to Life Supporting Capacity Value (a catchment value) because instream woody debris is habitat to more organisms than just trout.

129. (4) Add a condition to the Trout Fishery Value, such that the activity shall not result in suspended sediment being conspicuous in reaches valued for trout fishery during weekends and public holidays.

130. (5) To limit the effect of Permitted Activity provisions (i) and (k) on existing infrastructure, road and rail bridges, fords and culverts, intake and discharge sites should be added to the Existing Infrastructure provisions, along with appropriate buffer distances.

Activities undertaken by Horizons in flood control and drainage schemes

131. My evidence describes how the Code accommodates the Water Management Values, how the special standards were derived, and how the Flood Control/Drainage Water Management Value information was derived on the basis of mapping Works Areas for the Code. My evidence should be read with relation to the evidence of my colleagues, Allan Cook, Kate McArthur and Maree Clark. Allan Cook provides the context to flood and control and drainage schemes. Kate McArthur provides the context to Water Management Values. Maree Clark tables the spatial extent of the Flood Control / Drainage Water Management Value prescribed in Schedule Ba20.

132. The Code sets out best practice standards that apply to all river and drainage activities undertaken by Horizons' Operations Group. As stated in Allan Cook's evidence, by agreeing to meet standards for good practice that avoid, mitigate or minimise adverse environmental impacts within drainage schemes, scheme managers achieve improved environmental outcomes, among other things.

133. As the basis for my review of the Code, I have been drawing mainly from the version dated July 2007. However, considerable inroads have been made on making the Code best practice standards more explicit. I have endeavoured to keep my review of the

Code current, which means that this review includes proposed changes and amendments up to the version dated August 2009.

134. The Code lists all of the activities the Operations Group undertakes in the beds of rivers. These activities only occur within Works Areas depicted in the maps attached to Part Two of the Code. The approach undertaken limits the scale and scope of river and drainage activities under the Code. The Code does not give the Operations Group *carte blanche* licence to undertake river or drainage activities throughout a Scheme Rating Area, or other parts of the Region, for activities not listed in the Code, or activities above the thresholds and limits detailed in the Code.

135. Part One (Generic Standards for Good Practice) of the Code sets out a number of Good Practice Standards that apply to all river and drainage activities. Recent proposed improvements to this part include describing the means by which change in river morphology will be measured. Linked to these measurements is a set of clauses that instruct that where river management activities are shown to result in significant shortages of pools and riffles, or where river management activities reduce in the number of meanders, then the changes to river morphology are to be remedied. The set of clauses relating to channel morphology cater for those Water Management Values relating to ecosystem values – particularly Life Supporting Capacity, SOS-A, and SOS-R; and recreational and cultural values such as amenity, mauri, trout fishery and spawning, and aesthetics – that may otherwise be affected by unmitigated channel straightening and "hard engineering" flood control measures that affect river natural character, form and function.

136. Part One of the Code also lists generic standards to limit the use of machinery in the river bed (ie. minimising sediment re-release and disturbance of spawning beds relating to ecosystem values and recreational values), to avoid hydrocarbon spillages to water, toxic materials, and releases of uncured concrete (avoiding eco-toxic effects and protecting the quality of water supplies so protecting ecosystem, recreational/cultural, and water use values), to re-instate recreational access post-works (mitigating exclusion effects in relation to recreational and cultural use values) and maintain fish passage as far as practicable (minimising impediments to fish and so minimising effects on related ecosystem values and recreational values). Except for the "practicability" clause on fish passage, the Part One generic standards closely follow the terms and conditions for POP Permitted Activities for Life Supporting Capacity. I am therefore of the opinion that this part of the Code serves to protect Water Management Values from minor river management activities.

137. I have assessed all of the clauses that have a practicability component. My conclusion is that instances where an avoidance activity is not practicable, the activities or effects are either temporary or there is an alternate remedial or mitigation strategy to minimise effects. In my opinion, where clauses for practicability are used, the environmental outcomes of alternative decisions would be managed in such a way that would minimise the effect of the activity on Water Management Values. The practicability assessment and documentation procedure provide a robust and auditable means by which decisions not to use best practice can be checked and critiqued by external parties, and means by which poor decisions are policed.

138. Part Two (Good Practice Standards for Activities) lists all of the activities the Operations Group undertake. The potential adverse effects of specific river management activities are acknowledged and followed by standards for good practice that are designed to further minimise effects. Each activity is concluded with a set of standards that provide a means by which measures to manage effects on Water Management Values can be independently checked for compliance, in much the same way as conditions of consent do. The standards provide appropriate limitations or conditions to the extent of activities to the point where the adverse effects on the Water Management Values are, in my opinion, avoided, remedied or mitigated.

139. One of the most substantive improvements to Part Two is to cease using the Scheme Rating Area to depict the areal extent of the scope of the Code and instead use Works Areas. Works Areas depict river reaches or catchments that are subject to ongoing flood control engineering or drainage activities. By mapping the Works Areas, the conflict between flood control/drainage activities and other the other Water Management Values, is far easier to interpret. Later in my evidence I describe how the Flood Control/Drainage Water Management Value for the POP was derived from the Works Areas.

140. Part Three (Special Standards for Activities Undertaken in Sites of Special Environmental Value as Noted in the One Plan) is the key to assuring that river and drainage activities do not adversely impact on site-specific Trout Spawning, Inanga Spawning, Whitebait Migration, SOS-A, and SOS-R Water Management Values.

141. Part Three contains both Generic Standards, to be applied in all sites at all times, and Site-Specific Standards, where compromises or exceptions have been made to accommodate activities while minimising effects on Water Management Values.

142. In terms of managing effects from an ecological perspective, the Generic Special Standards serve for the protection of trout spawning, whitebait fishery (whitebait migration) and inanga spawning by avoiding instream activities in these sites during the spawning season, in a similar way as would be managed as Permitted Activities. In the specific case of inanga, year-round provision is made to maintain the bank-side spawning habitat for this fish species. The effects of removing shade and consequential sediment that might arise as a result of tree clearance activities alongside SOS A1 to A149 (which are SOS-A sites within the scheme areas as of April 2007) are also minimised. These generic standards serve a level of control normally included as consent conditions, and therefore I am of the opinion that the effects on Water Management Values are minimised.

143. Site Specific Standards cover special standards to apply to SOS-R and SOS-A which fall into Scheme Rating Areas (as mapped in April 2007), or in the case of the Lower Whanganui Scheme, within the Works Area. The Scheme Rating Area approach came about because they were originally used to define the extent of the Code. The list of Site Specific Standards have not been reduced to reflect the reduced extent of the Code through using Works Areas because there is some benefit to retaining them. The main benefit is that the Code still gives due consideration of those sites that, while not in any proposed Works Areas, might be indirectly affected by certain river or drainage activities, such as grade control structures that affect the passage of fish.

144. For the SOS-R, the same approach is taken as for the Riparian Habitat Permitted Activity conditions, where the conditions have been applied to avoid effects in critical habitats during critical times of the year. There are two general exceptions to the Permitted Activity Standards for Riparian habitat:

i. Where wader habitat overlaps a works area, Site Specific Special Standards have been designed to cater for waders. This provides more protection to wader feeding and roosting habitat than provided for under the POP Table 16.1 Permitted Activity provisions.

ii. Customary gravel extraction sites listed in Table 3.1 of the Code (April 2007) are proposed to be exempt from the dotterel exclusion conditions, potentially providing less protection to nesting dotterel than provided for under the POP Table 16.1 Permitted Activity provision. The need for exempted reaches has been questioned and this table may be removed from the final version of the COP. In my opinion, exemption of customary gravel extraction sites is of little consequence to the nesting success of dotterel at a regional scale. In such sites, it is more

often the case that extraction or disturbance is continuous and not interrupted for more than seven days (thus satisfying the Permitted Activity provisions anyway). The scale of the extraction is such (100m either side of the map reference cited) that the effect on nesting dotterel is likely to be minimal.

145. For the SOS-A, specific exclusion dates or conditions contained in the special standards are based on the critical habitat requirements identified in McArthur *et al*. (2007) specifically catering to the species being protected by SOS-A status. The special standards specifically avoid disturbances to the bed during the spawning period of the species listed at each site; avoid or limit releases of sediment during spawning and/or migration periods; retain instream heterogeneity and overhanging vegetation in areas where fish sensitive to these conditions are found; and ensure that there are no structures downstream of SOS-A that would impede the passage of the fish species the SOS-A are supposed to protect.

146. In a number of instances, the overlapping spawning and migration periods of the fish catered for in the SOS-A, combined with generic exclusions for trout spawning, would result in exclusion dates that would severely restrict the ability to undertake any instream work in Works Areas. In these instances, a focus has been placed on exclusion dates for the most sensitive species or the most sensitive periods. The instances are:

i. For kōaro in the South East Ruahine Scheme, consent is required to undertake any instream work between 1 April and 1 June, thus avoiding bed disturbances during April and May of the spawning season. The recruitment season, from 1 August to 31 December, has been left unprotected by the special standards. Kōaro whitebait migration is not as affected by suspended sediment as that of other fish, and the focus on adult spawning provides an ecologically appropriate compromise.

ii. For dwarf galaxias in the Tamaki Stream, from Top Grass Road to the confluence of Tamaki East and Tamaki West, the approach has been taken to avoid work during spawning season, from 1 September to 31 December, where practicable – as opposed to avoiding work at all times. Where avoiding instream work is not practicable, limiting sediment discharges to no more than 25% of the wetted channel provides an ecologically appropriate compromise. The 25% width provides a physical limitation to space needed for temporary bunding and is assumed to ensure that sediment is not conspicuous after mixing.

iii. The Tokomaru River between the confluence of the Manawatu River and SH 57 is habitat for redfin, banded kōkopu, and kōaro. To avoid work over the critical spawning and migration period of redfin bully, and migration of banded kōkopu

and kōaro, consent is required for the period between 1 July and 1 March. Allowing for instream work outside this period forgoes protection to the spawning period of banded kōkopu and kōaro. Note the Works Area covers about one sixth of the SOS-A and so this compromise is assumed to have only a minor effect on the spawning areas of banded kōkopu and kōaro in the Tokomaru River.

147. The exclusion dates and compromises are somewhat experimental because we don't know exactly which dates and which species to prioritise by. Special protection of native fish spawning areas, and special attention to native fish migration, is absolutely essential to the retention of fish biodiversity in Horizons' Region. The Code attempts to provide for these values while also providing for flood protection.

Mapping of the Works Area and proposed depiction as Flood Control and Drainage Water Management Value in the One Plan

148. The common interpretation of the Code maps and Schedule I of the POP is that flood control or drainage activity occurs throughout the entirety if the zones marked on those maps. This interpretation is fuelled by POP rules 16-13 and 16-14 because the scope of these rules presently applies to river and drainage schemes. This common interpretation of works potentially occurring everywhere within the zone is not necessarily the case, and it wasn't the intention to generally permit Horizons to undertake activities within scheme rating areas, that would otherwise by regulated. It is also unreasonable to exclude other resource users from undertaking permitted activities within schemes if there are no flood control or drainage assets that would be affected by the activity.

149. The most significant change to the maps in Part Two of Code is to define and depict the Works Areas instead of using scheme boundaries. These areas depict where in-stream and bank-side activities that are otherwise regulated by other POP rules, are undertaken by Horizons. It is my opinion that these areas should be used to define the limit of the scope of the permitted activity status that the Code provides under Rule 16-13. I am also of the opinion that these areas best depict where it is desirable to restrict others from undertaking activities that affect the value of flood control and drainage assets. To my mind, the sum of the Works Areas is therefore synonymous with the Flood Control/Drainage Water Management values proposed for Schedule B and intended to be protected though POP Rule 16-14. Schedule I of the POP therefore requires amending to refer to the sum of the Works Areas. The proposed amendment is tabled by Maree Clark as Map and Table Ba20.

150. Where possible the Works Areas in the Code maps are drawn as reach specific values. The exceptions to this are the Drainage Schemes and parts of Flood Protection Schemes with a large drainage component to them. The information that is available for mapping the real location of water ways, drains, and tributaries is too coarse (e.g. the topographic map for rivers are at 1:50,000 scale), and / or is error-prone on flat land (e.g. the River Environment Classification river reach depictions), or is not yet available in digital format (e.g. Horizons drainage assets are still being digitised from paper maps and so cannot be portrayed to you today).

151. By way of example, Figure 1 below shows at a very local scale (1:5000) the drainage network of the Arawhata Drain which is part of the Hokio Drainage Scheme and lies immediately south of Lake Horowhenua. The Arawhata Stream drains to Lake Horowhenua which itself drains into the Hokio Stream and on the sea approximately 5 kilometres to the west. The light blue line is the topographic map depiction of rivers and the dark blue line is the River Environment Classification (REC) depiction. These data do not depict the exact location of drains and both miss finer details. The risk in using these data to portray the Works Area is that parts of the Hokio Scheme drainage network would then be omitted from the Code.

152. For the drainage areas, a zone-based mapping technique is the best way to portray the extent of the activity. The zones are based on the drainage scheme rating area because these depict the areal extent of the drainage network. Going back to the Arawhata Drain example, you will note the use of this zoning based system to describe the Works Area in the Code map for the Hokio Scheme.

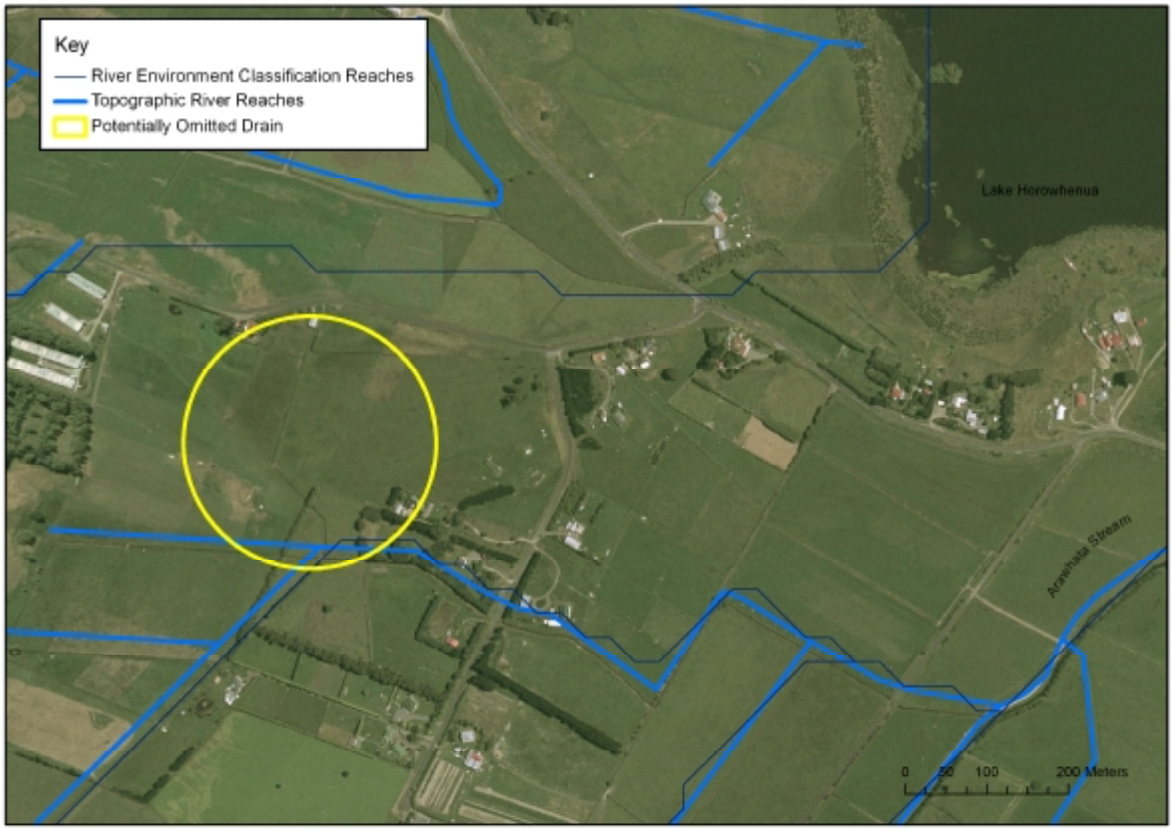

Figure 1. Potentially omitted drain of the Arawhata Stream (Hokio Drainage Scheme) and other inaccuracies at fine scale (1:5000) if currently available digital information is used to prescribe the Works Areas in the Code.

153. In addition to the drainage schemes, the areal extent of Horizons' activity in the South East Ruahine schemes is so extensive, that displaying the entire catchment as the Works Area is the only accurate way of depicting the activity. The zone for the South East Rauhine Scheme was derived by selecting all of the Water Management Sub-zones upstream of the Manawatu Gorge and cutting them where the Manawatu River runs though, so yielding all of the catchments on the true right of the Manawatu River that are subject to flood control activities.

154. So, a mix of reach-based and zone-based maps are used in the Code to depict the Works Area. However, because the drainage zones do not necessarily conform to the Water Management Zone Framework and because the Flood Control/Drainage Water Management Value is a reach-based value, it is still desirable to somehow show the waterways in these zones as reaches for the POP. I did this by overlaying all zone-based Works Areas with the REC river reaches and used this reach representation in Map Ba20. I used the REC to keep the depiction of the Flood Control/Drainage Water

Management Value consistent with the depiction of all of the other Water Management Values in the POP.

155. Yielding river reaches from zones to represent the Flood Control/Drainage Water Management Value still leaves us with the quandary with how best to describe drainage networks that cannot be accurately mapped. I dealt with this by describing those reaches within zones as running from the confluence of the river main stem to "source". By doing so, the text Table Ba20 captures the actual extent of the drainage network that is intended to be served by POP rules 16-13 and 16-14. Going back to the Arawhata drain example, you will note in the text in Table Ba20 that the Hokio Stream and tributaries covered by the Flood Control/Drainage Value are described as being from the Coastal Marine Area to source

156. I am of the opinion that the textual description of the extent of the Flood Control/Drainage Water Management Value is the key to assuring the Code and the POP reflect the river reaches that are intended to be served by POP rules 16-13 and 16-14. The August 2009 version of the Code incorporates the text of Table Ba20 as an appendix. A difference between the two documents on how the reaches are depicted in maps is irrelevant in my opinion. The maps should show something relevant to the scale at which the maps are portrayed. At the regional scale of the POP map I believe the reaches should be depicted using the River Environment Classification river reaches. This approach keeps Map Ba20 consistent with other POP maps and the map is at such a scale that the errors on flat land are imperceptible. For the Code I believe drainage networks as zone-based Works Areas more accurately reflect the extent of works at the finer scale.

157. While we were developing the new Code maps, the Lower Whanganui Scheme came into inception. The Works Area for that scheme has been included as a reach in the Flood Control/Drainage Water Management Value. Inclusion of Lower Whanganui is therefore a new addition to the extent of Flood Control/Drainage Water Management Value originally depicted in Schedule I. I have checked this addition against other ecological Water Management Values, concluding that there needs to be a Site Specific Standard for SOS-R in this works area to accommodate the critical habitat requirements of dotterel and waders. I am satisfied the Site Specific Standards that appear in the August 2009 version of the Code cater for the SOS-R that are in this Works Area.

The environmental code of practice for river works and the bigger picture of river management

158. An inevitable outcome of river engineering – particularly the creation of stop banks and hard engineering that prevents meander cut and wetland formation – is that the river loses its connection to and influence over the flood plain. This loss of river influence over the flood plain affects the dynamics of flood plain forests and wetlands and affects the ecological connectivity of flood plain streams to the parent river. In places, the Environmental Code of Practice for River Works acknowledges such loss of connectivity is a concern (eg. clause 10 of Stop banks requires consideration of the effects of stop banks on flood plains), but the focus of the Code on managing the river management activities of Horizons Operations Group means it cannot adequately provide for holistic river management.

159. The Code also cannot be used to address the cumulative impacts of activities in beds of rivers for any activities undertaken outside the Works Areas, by any person. Cumulative effects are a set of issues far larger than that which can be addressed and managed by river engineering in specific Works Areas. I am of the opinion that the "bigger picture" of managing the effects of activities in the beds of rivers that include large-scale cumulative effects of forced changes to river shape on Water Management Values, is addressed by the POP and should not be part of the Code.

Recommendations

160. (1) Adopt the Environmental Code of Practice for River Works. The Code sufficiently controls the scale of effects of river engineering activities on Water Management Values. Where there are compromises between avoiding effects on Water Management Values and the need to undertake activities, the standards and thresholds ensure there are means to minimise the effects in a similar way to resource consent conditions.

161. (2) Adopt Map and Table Ba20 in to the POP to replace Schedule I.

162. (3) Adopt the inclusion of the Lower Whanganui Scheme into the scope of the Code and as an additional reach to the Flood Control/Drainage Water Management Value.

Dams and culverts

163. Culverts and dams can have a significant effect on instream biodiversity and ecology in a number of ways. Narrow culverts constrict the width of the stream bed, causing water flows that are faster than fish can swim against. Erosion of the stream bed around a culvert invert or ford footing causes the culvert or ford to be perched above the river bed, creating an insurmountable wall in much the same manner as dams and weirs do, and impeding the passage of fish. For migratory and non-migratory fish alike, upstream impediment to passage delays or inhibits post-flood re-population of river reaches. For migratory fish, barriers impede adult migration to and from the sea. They also can impede juvenile recruitment to the top of the catchment, and can disproportionately affect fish diversity by selectively allowing fish species that can navigate structures to populate reaches that poor climbers may have also been able to populate pre-construction. In these ways, instream structures that impede fish passage affect the biological requirements of critical life phases of migratory fish, and affect the population dynamics of all fish. Affecting fish population dynamics is likely to have consequential knock-on effects on the entire river ecosystem.

164. The disturbance of the stream or river bed during the placement of a culvert or dam construction can release sediment in quantities higher than expected during normal floods, at a time when the waterway is otherwise running clear. This sediment can have adverse effects on the spawning beds and rock crevice refuges of fish by filling interstices with silt. In extreme situations, sediment clogs the gills of fish and invertebrates, causing them to suffocate. Also during the building phase, the use of mobile machinery in the river bed can disturb nesting birds and disrupt fish spawning.

165. As a consequence of water takes usually associated with dams, or dams with no provision for maintaining residual flows, dams prolong the low flow period of the river. The altered hydrological regime also has knock-on water quality and quantity effects, affecting all but the most tolerant insteam biota. By turning river reaches into lakes, dams permanently alter the riffle – run – pool sequence of a river, affecting all manner of fish, invertebrates and river birds that require habitat heterogeneity.

166. Large and/or poorly built dams also pose a significant threat to life and property, particularly in the event that they fail. Poor design height considerations and spillways that do not sufficiently provide for modest flood events can result in unwanted water encroachment onto neighbouring properties.

167. The purpose of this part of my evidence is to describe the standards relating to dams and culverts and convey how the conditions, standards and terms of POP Rule 16-8 (new and existing small dams), Rule 16-9 (other existing dams), and Rule 16-11 (culverts) serve to protect Water Management Values. For completeness, I dwell on other regulatory requirements (namely the Building Act 2004 and Freshwater Fisheries Regulations 1983) where these laws require or otherwise support certain conditions on dams and culverts that are iterated in Chapter 16 of the POP, but I am not an expert on these regulatory requirements.

Overview of building act requirements for dams

168. On Waitangi Day, 1997, the Opuha Dam, which was under construction in South Canterbury, collapsed. While no loss of life occurred, neighbouring downstream property was destroyed. At the time, the Building Act (1991) regulated the construction of dams and building work carried out on large dams. Regulation was a function carried out by Territorial Authorities. While that Act required a building consent, Project Information Memorandum (PIM) and Certificate of Code Compliance for building work on large dams, there was no provision for ongoing safety management in that Act, and the risk management of dams was unregulated.

169. Dam building requirements are now covered by, and have been expanded under, the Building Act 2004 (BA 2004). In July 2008 the Building (Dam Safety) Regulations came into effect, with a 24-month transitional period before the scheme comes into force. The BA 2004 and associated regulations provide a clear and comprehensive regulatory scheme for ongoing safety management once dams are commissioned. Regional Councils have the sole responsibility for managing this regulatory environment, which Horizons contracts to Environment Waikato.

170. Section 7 of the BA 2004 defines a dam as an artificial barrier, with its appurtenant structures, that is constructed to hold back water or other fluid under constant pressure so as to form a reservoir where it is used for the storage, control, or diversion of water or other fluid. This definition includes flood control dams, natural features that have been significantly modified to function as dams, and canals, but does not include a stop bank designed to control flood waters.

171. The BA 2004 defines a large dam as one that retains three or more metres depth, and holds 20,000 or more cubic metres volume, of water or other fluid. Any large dam needs

to comply with ongoing requirements of the dam safety regime (Sub-part 7 of the Act; Safety of dams).

172. In relation to depth, a Department of Building and Housing document published in September 2008 titled Dam Safety Scheme – Guidance for regional authorities and owners (appendix D: Glossary of terms) defines depth as the height of the reservoir at the base of the upstream dam wall or artificial barrier.

173. In relation to building consent requirements, Section 7 of the BA 2004 defines a building as a temporary or permanent movable or immovable structure. Given this definition, a dam is classed as being a building. All dams are therefore subject to the same regulatory requirements such as a house or other structure (ie. they require building consent).

174. An exemption to the requirement for building consent is provided for under Schedule 1 of the Act, where it is specified that a building consent is not required for the construction of any dam that is not a large dam. However, under Section 17, all building work must comply with the building code to the extent required by the Act, whether or not a building consent is required in respect of that building work.

Overview of freshwater fisheries legislation and the provision of fish passage

175. The prevention of fish from accessing otherwise suitable habitat is often cited as one of the most significant causes of decline in freshwater fish populations in New Zealand (eg. Boubée *et al*., 2000; James and Joy, 2008). Fish passage refers to the requirement for fish species and populations (migratory or otherwise) to be able to swim without unnatural impediment from one part of a river system to another. Fish barriers are alterations to the natural stream/river gradient, velocity, riffle length, temperature, and chemical characteristics that create conditions exceeding the finite swimming abilities of fish.

176. The Department of Conservation is the regulating authority requiring provision for fish passage. The provision is set out in Part 6 of the Freshwater Fisheries Regulations 1983 (FWFR 1983), which has very succinct requirements regarding the egress of fish past any structure in the bed of a river, including:

i. Culverts or fords shall not be constructed in any natural river, stream or water in such a way that impedes the passage of fish;

ii. The Director-General of Conservation may require that a fish facility be built for any dam or diversion structure located in any natural river, stream or water; and

iii. The occupier shall maintain fords and culverts and fish facilities for dams and diversions as to allow the free passage of fish.

177. The ability of fish to swim, jump, or climb upstream or downstream past any structure, including waterfalls, rapids, and boulder stacks, varies between species. Therefore, the specific requirement for fish passage depends on species that would be naturally present on the river/stream if human-made structures were absent. While the regulations do not specifically cater for natural fish ecology, the Director-General of Conservation can specify the critical components of a fish passage facility or may give written approval for structures to be exempt from the fish passage provisions of the FWFR 1983. Therefore, that regulation has some flexibility for practicable and appropriate provisions for fish passage.

178. As the regulating authority for the construction and maintenance of dams, fords and culverts, and the effect of those structures on public safety and life supporting capacity of beds of rivers, Horizons must consider how rules regarding the passage of fish might conflict or duplicate the mandate of DOC. This has been achieved by requiring fish passage as a provision for all Permitted Activities, including the installation of fords and culverts.

179. Any legally existing dam or diversion structures subject to a water right issued under the provisions of the Water and Soil Conservation Act 1967 prior to 1 January 1984 are exempt from the provisions of the FWFR 1983. In such cases, Horizons is the inherent regulating authority for any retrospective provision of fish passage on dams built prior to 1984.

Proposed One Plan standards for dams and culverts

180. The POP contains various rule streams in Chapter 16 relating to standards, conditions and terms for dams and culverts. In this section, I will provide the technical justification for those standards, conditions and terms of dams and culverts.

181. Each activity associated with the installation and use of a dam or culvert has a scale of effect associated with it, depending on where the activity takes place and the values that may be affected by it. There needs to be limitations on the scope of the Permitted Activity status for all dams and culverts in places where the Water Management Values

– such as nationally significant trout fishery, regionally significant trout fishery, and whio strongholds – are so sensitive that even small environmental perturbations affect those values. Rules that protect these regionally significant resources from any disturbances of the bed are, in my opinion, justified on the basis that any disturbance of the bed is likely to have a significant effect on the Water Management Values.

182. In the POP, new and existing small dams are Permitted Activities as long as they are not covered under rules restricting activities in rivers with highly sensitive Water Management Values. The dams must comply with a suite of specific conditions that are listed in POP Rule 16-8, as well as the general Permitted Activity provision of Table 16.1 (notably conditions for Life Supporting Capacity).

183. Within the suite of conditions in POP Rule 16-8, the justification for the height definition for a small dam comes directly from the BA 2004. A capacity limit of less than 20,000 cubic metres is missing from the definition of a small dam. The capacity requirement should be included as a condition of new and existing small dams, for consistency with BA requirements.

184. The catchment size definition for a small dam relates to the water yield expected to arise from a catchment of 50 hectares or smaller during low flows, and the effect of removing that flow from the parent river. At mean annual low flow, a catchment of 50 hectares yields a contribution to the mean annual low flow that is lower than the permitted take volume. The removal of that volume is therefore considered minor. By being low flow volume streams, streams arising from catchments smaller than 50 ha also tend not to be trout spawning habitat. While the streams provide habitat for eel and kōura, these species are able to find habitat in dams as well, so long as sufficient consideration is given for their ability to climb from lower reaches of the stream into the dam. Thus, the effect that dams in catchments of 50 hectares or less have on instream ecological values is likely to be minor.

185. If the dam is on a perennial stream, the above presumption of the dam having only minor effects cannot be relied on, because the dam may impinge on the perennial habitats of native fish and trout. Hence, there is a requirement for maintaining a residual flow over dams in permanently flowing watercourses. Without residual flow, any fish passage requirements are unlikely to be met. Without residual flow, the dam could also prolong the low flow period of the river, which has associated ecological effects.

186. Over-topping a dam that has no adequate armouring or spillway erodes the dam wall and foot. Such erosion inevitably results in dam failure. A spillway that permits the

passage of the probable maximum flood without overtopping is an appropriate engineering standard that ensures the intent of the BA 2004 is met.

187. The requirement that the pond area not encroach on neighbours' property is a common-sense safeguard to protect neighbouring property. Since a dam is a building, and buildings usually have setbacks, then is logical and reasonable for there to be a provision that water impounded by a dam must be at least contained within the property of the dam owner.

188. In specific relation to dams and their effects on ecological values, the effects associated with release of sediment during dam construction and maintenance, mobile machinery in the bed of the river, and the restriction of fish passage, are covered by POP Rule 16-8 conditions (g) or (h), with the cross-reference to Permitted Activity provisions. Under these provisions, the building and maintenance of a small dam and damming of water must still give regard to the effect on Water Management Values like Life Supporting Capacity, Riparian Habitat, Inanga and Trout Spawning, and Whitebait Migration.

189. With regard to existing large dams, while these dams conformed to the law when they were built, modern day environmental and safety considerations need to be applied to the activity of damming water in order to safeguard life supporting capacity and public safety. In my opinion, reserving control over the damming of water by existing large dams is justifiable, especially since dams built before 1984 are likely to require reconsideration of their effects on fish passage.

190. In the POP, culverts are permitted as long as they are not covered under rules restricting activities in rivers with highly sensitive Water Management Values. Culverts must comply with a suite of specific conditions that are listed in POP Rule 16-11, as well as the general Permitted Activity provision of Table 16.1 (notably conditions for Life Supporting Capacity).

191. In most circumstances, one large culvert is better than several smaller ones. Debris blockage is less likely and water velocity will be lower (Boubée *et al*., 1999; pg 27). POP Rule 16-11 condition (b) accommodates this advice. Condition (i) also covers the issue of accumulated debris, and there may be certain circumstances where multiple barrels are appropriate (see Boubée, *et al*., 1999; pg 27). POP Rule 16-12 for fords would also otherwise permit multi-barrel structures. Therefore, condition (b) seems redundant or contradictory. However, condition (b) prevents the otherwise permissible placement of, say, four 0.3 metre diameter culverts into a 1.2 metre wide stream, which

would be ecologically better off with a single barrel 1.2 metres wide. The wider barrel would be more fish-friendly, because it emulates the natural width of the stream. Therefore, I believe the condition to avoid multi-barrel culverts should remain.

192. The 20 metre specification for culvert length in POP Rule 16-11 is consistent with the considerations provided in Figure 5 of Boubée *et al*. (2000; pg 27). A culvert less than 20 metres is unlikely to need any further special requirements or additional structures to permit fish passage, as long as the slope of the culvert follows the slope of the stream bed, the culvert width is equal to or greater than the stream, and the culvert invert is below the stream bed. This condition has ecological justification.

193. There are no explicit limits to culvert width with regard to fish passage. Fish passage can be expected if the culvert is sufficiently large and is installed below the natural stream bed so that the natural bed-load movement forms a stable bed inside the culvert. To achieve this, the width of a culvert should be equal or greater than the average width of the stream bed and the culvert should be placed at a depth below the existing bed of at least 20% of the width of the culvert (Boubée *et al*., 1999; pg 50). The conditions on culvert specification relating to culvert diameter in relation to the width of the stream, installation depth, alignment and gradient (Rule 16-11 conditions (c) (iii), (c) (v), and (d) are consistent with the advice of Boubée *et al*., 1999.

194. The POP Rule 16-11 condition (c) (ii) specifies a minimum culvert diameter of 0.3 metres. This is not an explicit ecological requirement in narrow streams, but does serve the fish passage requirement. Instead, the minimum size is a guide to ensure that small streams will have installations able to convey flood debris. Smaller installations would place greater onus on the culvert owner to regularly clear the culvert of debris, when a larger culvert would not require the same level of maintenance. Therefore, I believe the condition should remain, if only to provide guidance that avoids the need for regular maintenance.

195. I believe a maximum culvert diameter is required as a guide, beyond which the scale of the activity of placing the culvert is likely to have a measurable effect down-stream. POP Rule 16-11 condition (c) (ii) specifies a culvert diameter of 1.2 metres as this guide. Based on other conditions being served (ie. that the culvert shall be at a depth below the bed of 20% of the culvert width; that structures shall not occupy more than 20 square meters of the bed; and that a culvert be no longer than 20 m) a culvert 20 m long, of a diameter of 1.25 m, buried 20% of the culvert width would allow a 20 m square bed to

form. I believe a sensible maximum culvert width, as part of a Permitted Activity standard, would be 1.25 m.

196. Boubée *et al*. (1999) state the level of the culvert invert in relation to the stream bed is the "…most important design criterion for fish passage". (pg 19). In this section, the authors also observe from other research that "…pipes under 3 m in diameter should be buried to a depth of 0.3-0.6 m and pipes greater than 3 m to a depth of one-fifth of their diameter". Accepting this advice from Boubée *et al*. (1999) renders a 300 mm culvert diameter untenable, as it would have to be buried completely, and limits the capacity of culverts under 500 mm to convey flood water and debris. In my opinion, the advice from pg 50 of Boubée *et al*. (1999) provides sufficient guidance for fish-friendly culvert installations. That guidance is simply that the culvert invert should be below the stream bed by at least 20% of the width of the culvert at the downstream end of the stream bed. For simplicity, I believe the installation depth condition should follow this advice. Therefore, the 0.3 m depth condition (c) (v) is superfluous.

197. Culverts perched above the stream bed impede fish passage (James and Joy, 2008). Rule 16-11 conditions (f) and (h) serve to avoid or remedy culverts perched above the stream bed as a result of erosion around the culvert inverts.

198. A maximum fill height above a culvert is required to allow water to pass over the causeway in the event weather conditions exceed the capacity of the culvert. Without such a condition, there is a risk of water backing up and the causeway bursting, having the same downstream effect on ecological values and infrastructure that a dam rupture would. Two metres fill height above a culvert is posed as a useful rule of thumb but is not guided by ecological principles. Likewise, Rule 19-11 condition (e) incorporates engineering requirements, without which there is a risk that water back-up will frequently damage the causeway. Otherwise, I am not qualified to comment on the specifics of these conditions.

199. In specific relation to the installation of, and the effects on, ecological values, the effects associated with release of sediment and mobile machinery during culvert construction and maintenance, are covered by POP Rule 16-11 conditions (g) and (j), with reference to sediment release and the cross-reference to Permitted Activity provisions. Under these provisions, the building and maintenance of a culvert must still give regard to the effect on Water Management Values like Life Supporting Capacity, Riparian Habitat, Inanga Spawning, Trout Spawning, and Whitebait Migration.

Retrofitting fish passage – the need for non-regulatory activity

200. There are numerous examples of dams and culverts throughout the Region that impede the passage of fish in places where reinstating fish passage may reverse the decline in fish numbers and diversity (eg. James and Joy, 2008; James and Joy, 2009). Some of the structures are very old – for instance the Rabbit Weir on the Akitio River was constructed in the 1860s in an attempt to stem the rabbit invasion from the Wairarapa into Hawkes' Bay. The ecosystems above such structures are likely to have adjusted to the change in fish community, and yet there is opportunity to reverse the damage done. The structures still have a lot of life left in them and will continue to affect stream ecology for years to come.

201. Since older structures probably conformed to the laws of the time, and the question arises as to how much responsibility and cost should be placed on the current owner of the dam or culvert to restore fish passage? This is a particularly difficult question if the decision requires retrofitting a fish passage facility. Constructing effective fish passage requires a mix of art and science, and a lot of fish monitoring. Some dams and culverts might be impeding pest predatory fish to the benefit of threatened native fish. Some structures may simply be in places so devoid of good upstream habitat that a fish passage facility would be pointless. Therefore, blanket rules requiring the retrofitting of fish passage will not always result in cost- effective or fair solutions to remedy the decline in native fish diversity and abundance. A non-regulatory method would be a useful approach to redressing the mistakes of the past.

202. A non-regulatory option for reinstating fish passage should not replace the specific conditions requiring provision of fish passage for new dams and culverts. Building effective fish passage into new structures avoids repeating past mistakes, is far more cost-effective than retrofitting, and appropriately places responsibility on the structure owner.

Recommendations

203. (1) Retain most of the standards and conditions on permitted small dams and culverts as they are. There are sensible ecological and engineering justifications for the standards and thresholds. There are also other legislative imperatives that the conditions and standards give regard to.

204. (2) Insert a standard condition that small dams have a maximum capacity less than 20,000 cubic metres, to ensure consistency with the BA 2004.

205. (3) Change the maximum culvert diameter to 1.25 m. This will ensure the bed dimension conditions are consistent with other provisions for Permitted Activities for bed disturbance being up to 20 m square (all other culvert conditions being served).

206. (4) Delete the reference to a minimum culvert installation depth of 0.3 m. A minimum depth of 20% of the culvert diameter will satisfy fish passage requirements.

207. (5) A non-regulatory method that investigates the restoration of fish passage over historical structures is a crucial part of mitigating the effects of older dams and culverts on fish populations.

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