BEFORE THE ENVIRONMENT COURT
AT CHRISTCHURCH

ENV-2010-CHC-115, 123, 124 AND 135

IN THE MATTER	**of Appeals pursuant to Section 120 of the Resource Management Act 1991**
BETWEEN	**WEST COAST ENT INC** **Appellant**
AND	**ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC** **Appellant**
AND	**WHITE WATER NEW ZEALAND INC** **Appellant**
AND	**DIRECTOR GENERAL OF CONSERVATION** **Appellant**
AND	**WEST COAST REGIONAL COUNCIL AND BULLER DISTRICT COUNCIL** **Respondents**

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STATEMENT OF EVIDENCE OF
WILLIAM BRUCE SHAW
FOR DIRECTOR-GENERAL OF CONSERVATION
Dated: 16 May 2012

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AND	**MERIDIAN ENERGY LIMITED** **Applicant**
AND	**FRIDA INTA** **Section 274 Party**
AND	**WHANAU PIHAWAI WEST – RICHARD WAYNE BARBER AND IRI MAY BARBER MILNER** **Section 274 Party**
AND	**J MacTAGGART** **Section 274 Party**
AND	**ORION ENERGY NZ LTD, ALPINE ENERGY LTD, MAIN POWER NZ LTD AND ELECTRICITY ASHBURTON LTD** **Section 274 Party**
AND	**NZ RAFTING INC** **Section 274 Party**
AND	**ANN SHERIDAN** **Section 274 Party**
AND	**BULLER ELECTRICITY** **Section 274 Party**

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1. QUALIFICATIONS AND EXPERIENCE

1.1. My name is William Bruce Shaw. I am Principal Ecologist and a Director of Wildland Consultants Ltd, based in Rotorua. I have a Master of Science degree from the University of Canterbury, 1980, and a Bachelor of Science in Earth Sciences and Biology (double major) from the University of Waikato, 1977. My professional memberships include the Royal Society of New Zealand, the New Zealand Ecological Society, the New Zealand Institute of Forestry, the New Zealand Biosecurity Institute, the Ornithological Society of New Zealand, the New Zealand Botanical Society, the New Zealand Association of Resource Managers, and the Resource Management Law Association.

1.2. I am the author of 24 conference papers, 25 scientific or technical publications, 39 published articles, and more than 300 ecological reports.

1.3. I have been a practising ecologist since 1980, and have lectured in ecology and nature conservation at Lincoln College and the Waiariki Institute of Technology. I previously worked for a consulting firm in Christchurch, and have undertaken ecological survey work and related assessments in urban, rural, and remote back country situations over more than 30 years. From 1986-1990 I was employed as a Scientist by the Forest Research Institute, Rotorua, specialising in forest ecology, threatened plants, vegetation mapping, and the ranking and management of natural areas. From 1990 to 1996 I was a Conservancy Advisory Scientist (1990-1994) and then (1994-1996) Protection, Planning and Use Manager for the Department of Conservation.

1.4. Since 1996 I have been Principal Ecologist and Director of Wildland Consultants Ltd. I have particular expertise in ecological management (especially ecological restoration), the evaluation of ecological significance, and the assessment of ecological effects of actual and proposed land uses.

1.5. I have about 30 years of experience with vegetation mapping, having used satellite images and aerial photographs to produce vegetation and land cover maps, at a range of scales, for large and small areas. I was a technical advisor for the Land Cover Database version 2 (LCDB2), a national-level vegetation classification and mapping initiative.

1.6. Ecological evaluation is a discipline in which I have nearly 30 years of experience having, in the 1980s, developed an ecological ranking system that was applied regionally and nationally[1] by the Department of Conservation. I have also developed, for Environment Waikato, a technical guideline for application of natural heritage criteria in their Regional Policy Statement (RPS), been an advisor to the Ministry for the Environment on criteria for the evaluation of Section 6(c) of the Resource Management Act, developed ecological evaluation criteria for the Bay of Plenty RPS (which became operational in January 2008), and developed (with Dr Kelvin Lloyd) ecological criteria for the Canterbury RPS.

1 This was a criteria-based system (Shaw 1994) which has been replaced by more comprehensive systems, as described in the evidence of Dr John Leathwick.

Experience on or relevant to the West Coast

1.7. Since the late 1970s, I have visited many natural areas and back country locations on the West Coast, between South Westland (the Cascade River) and Farewell Spit, in the course of undertaking private and work-related trips.

1.8. In 1980 I led a Lincoln College (now Lincoln University) field-based teaching trip for Nature Conservation and Parks and Recreation students that visited various sites between Buller-North Westland and Franz Josef.

1.9. In the early 1980s I collated all known records of forest disturbance by wind damage in New Zealand's indigenous forests, including the West Coast.

1.10. A ranking system I first developed in the 1980s has been applied to all land administered by the Department of Conservation, including the entire West Coast Conservancy, for priority setting for control of pest animals and pest plants.

1.11. In the mid-1990s I travelled to Hokitika and assisted the West Coast Conservancy of the Department of Conservation with priority-setting for pest animal control across public conservation land in the Conservancy.

1.12. I peer reviewed the Protected Natural Areas Programme survey report[2] for the Ngakawau Ecological District for the Department of Conservation prior to publication of that report in 1998.

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[2] Overmars F.B., Kilvington M.J., Gibson R.S., Newell C.L., Rhodes T.J. 1998: Ngakawau Ecological District: Survey report for the Protected Natural Areas Programme. Department of Conservation, Hokitikia. 178 pp.

1.13. In the late 1990s I travelled to Haast to assess indigenous ecosystems on the Haast Plain, as part of a team working on the national classification of indigenous ecosystems for the Department of Conservation.

1.14. Over the period 2002-2007 Wildland Consultants Ltd staff established more than 120 permanent carbon monitoring sample plots in the northern South Island, including the North-West Nelson - Kahurangi tract.

1.15. Since 1996 I have overseen and peer reviewed various ecological assessments undertaken in Buller and Westland by Wildland Consultants' ecologists.

1.16. I visited the lower Mokihinui catchment on 16 September 2008. During this visit I undertook a helicopter inspection of the lower catchment, upstream of the proposed dam site, including the lower reaches of the North and South Branches, and I also walked into the lower catchment. I had previously visited the Mokihinui catchment in 1979, when I also walked into the lower catchment, upstream of the proposed dam site. I also visited the lower catchment in 2011, in the company of other Department of Conservation witnesses and legal counsel. In this trip I flew up the lower gorge by helicopter, to Andersons Flat, walked across Andersons Flat and then upstream to Mokihinui Forks hut. I then flew around the mid-catchment and downstream through the gorge.

1.17. I have also walked the Charming Creek Walkway, from the Ngakawau River to Charming Creek Road (near Seddonville).

1.18. I have also traversed the route of the proposed transmission line in a helicopter, between the Mokihinui River and the

Stockton Coal Mine, landing at various locations to assess potential effects of proposed pylon locations.

1.19. In February 2012 I spent two days at Waimangaroa Bush, a proposed biodiversity offset site put forward by Meridian in relation to the current proposal.

1.20. I previously presented evidence at the resource consent hearing in 2009, based on evidence presented at that hearing by the following witnesses for the Department of Conservation:

- Dr Richard Allibone: freshwater fisheries;
- Associate Professor Dr Russell Death: invertebrate and periphyton communities;
- Dr David Kelly: freshwater habitats;
- Dr Kelvin Lloyd: terrestrial vegetation and flora;
- Dr Colin O'Donnell: terrestrial avifauna, bats, and lizards;
- Ms Kath Walker: land snails;
- Mr Tim Shaw: whio (blue duck);

1.21. Evidence by these witnesses provided, in my view, particularly relevant and important assessments of the biota and ecological values within and adjacent to the project area. My role in 2009 was to provide an integrated overview of this information, including a wider regional and national level perspectives on the ecological values of the Mokihinui River. I have a similar role at this hearing.

1.22. In preparing my 2009 evidence, I also considered various reports provided in the Assessment of Environmental Effects, including the 'Terrestrial Eclogy Assessment', the

'Native Freshwater Fisheries Report', and the 'Periphytons and Invertebrates Report'. Related evidence by Dr Ruth Bartlett, Mr Edward Norton, Mr Bonnett, and Dr Jellyman was also read. I also considered the officers' reports provided on 'Terrestrial Ecology', 'Avifauna', and 'Aquatic Ecology'.

Other relevant experience

1.23. I have undertaken many ecological assessments for infrastructure projects, including:

- Monitoring of shoreline vegetation at Lake Waikaremoana associated with effects of operation of the hydro-electricity scheme there (the lake is managed within a 3 m operating range[3]);
- Proposed hydro-electricity schemes on the Kaituna River and another North Island river;
- I am the team leader for a major proposed wind farm in the northern Wairarapa, involving 30,000 ha of private properties;
- Major roading projects, including the Central Motorway Junction, Auckland; strategic roading at Tauranga (technical advisor to hearings commissioners for >$300 million of capital works), the Taupo eastern arterial (>$100 million of works), and the Rotorua eastern arterial.
- I was the team leader for the ecological assessment of a major proposed wind farm near Palmerston North and

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[3] Note that the lake levels change relatively slowly within the operating range as compared to the Mokihinui proposal which will involve daily fluctuations, more akin to the 'varial flows' on the upper Waikato River.

have also undertaken other preliminary assessments of proposed wind farm sites;

- Ecological assessments for many subdivisions, a gas pipeline, new regional prisons, lake jetties, coastal structures, landfills, the Ohau Channel diversion structure, and marinas.

- Oversight of ecological assessments for many other infrastructure projects throughout New Zealand.

1.24. I was a technical advisor for the New Zealand Biodiversity Strategy (2000).

1.25. I am the author of the first recovery plan (1993) for a threatened plant species in New Zealand and the lead author of a "mainland island" ecological restoration plan (1996), the second-ever such plan within New Zealand, for the then largest single area of indigenous ecosystems and habitats in New Zealand under active ecological management (50,000 ha in northern Te Urewera National Park).

1.26. I am the author of an ecological restoration plan for a large privately-owned area of indigenous forest in the eastern North Island that includes a steep precipitous mountainous area and rivers with a significant population of whio (blue duck).

1.27. Over a period of 20 or so years I have presented evidence or been involved in mediated settlement of cases involving ecological assessments and assessments of significance at numerous hearings, including the Planning Tribunal/Environment Court and Boards of Inquiry (more than 30 cases), the High Court, the District Court, and the Waitangi Tribunal.

1.28. I have read the Code of Conduct for Expert Witnesses 2006 and have complied with it in the preparation of this statement of evidence. Except where I state that I am relying upon the specified evidence of another person, my evidence in this statement is within my area of expertise. I have not omitted to consider any material facts known to me that might alter or detract from the opinions which I express below.

2. SCOPE OF EVIDENCE

2.1. The purpose of my evidence is to:

- Provide an overview of biodiversity conservation and management in New Zealand relevant to the Meridian Hydroelectricity Project (MHP) proposal;
- Integrate and provide a synthesis of the evidence of:
  - (i) Dr Kelvin Lloyd;
  - (ii) Dr John Leathwick;
  - (iii) Dr Colin O'Donnell;
  - (iv) Ms Kath Walker;
  - (v) Mr Tim Shaw;
  - (vi) Dr Astrid van Meeuwen-Dijkgraaf;
  - (vii) Dr Bill Langford.
- Provide an integrated overview of the ecological effects of the proposed MHP, including the proposed dam, reservoir impoundment, and transmission line.

- Provide commentary on whether all potential adverse effects have been addressed and the adequacy of proposed mitigation.

- Present a conceptual ecological overview, rather than an exhaustive analysis of all matters arising out of my evidence.

3. KEY FACTS AND OPINIONS

3.1. Definitions of biodiversity are provided in the Resource Management Act 1991, the New Zealand Biodiversity Strategy (2000), and the Convention on Biological Diversity (1992), to which New Zealand is a signatory. These definitions all recognise the different levels at which the variety of life is organised, including ecosystems, habitats, and species. It is my opinion that, overall, the evidence provided by witnesses for Meridian, is inadequate and incomplete in terms of addressing biodiversity as defined in the RMA 1991, because it does not comprehensively address the impacts on biodiversity for each of these levels.

3.2. Outstanding ecological terrestrial and aquatic values are present in the Mokihinui gorge and wider catchment.

3.3. The transmission line route crosses ecologically significant coal measures vegetation and habitats, and even one in particular of Meridian's witnesses clearly opposes this aspect of the proposal.

3.4. It is very clear that, in terms of S6(c) of the RMA and ecological evaluation criteria in the Westland RPS and the Buller District Plan, that indigenous vegetation and habitats of indigenous fauna to be affected are ecologically significant.

3.5. When considered in combination, and taking into account the dynamic natural processes that provide key ecological drivers for the riverine ecosystem, the river and adjacent habitats on lower gorge sides and terraces have ecological values that, in my view, clearly rate as being of national significance.

3.6. The proposed MHP (including the transmission line) will result in major adverse effects on a diverse range of significant aquatic and terrestrial ecosystems, habitats, and species, and is likely to have far-reaching effects on mobile fauna.

3.7. Meridian has provided an inadequate and incomplete ecological assessment of the effects of the proposed MHP. This inadequate assessment has then been used in an offset model that has technical deficiecies. Further, not one of the ten Business in Biodiversity Offsets Programme (BBOP) principles has been met by the approach used.

3.8. Most of the mitigation proposed by Meridian is in the upper catchment or immediately adjacent to the coast (Waimangaroa Bush). As such, the mitigation proposed does not directly address most of the diverse suite of ecosystems, ecological processes, habitats, and species to be lost or degraded. As a consequence, the project will result in a major net loss of indigenous biodiversity in the area affected.

3.9. Having regard to my area of expertise, it is my opinion that the particularly large suite and scale of adverse effects, combined with the lack of capability to appropriately address those effects, should require avoidance of this site.

3.10. The MHP will result in perhaps the most severe adverse impacts of hydro development to date on a New Zealand coastal-lowland river ecosystem.

4. BIODIVERSITY CONSERVATION AND MANAGEMENT IN NEW ZEALAND

What is biodiversity?

4.1. This may seem self-evident, but it is important that all parties in this case have a common understanding of what comprises biodiversity and therefore what ecological features are relevant to this proposal.

4.2. A definition of biodiversity is provided in the Resource Management Act (RMA) 1991:

> "**Biological diversity** means the variability among living organisms, and the ecological complexes of which they are a part, including diversity within species, between species, and of ecosystems."

4.3. The term is further defined in the New Zealand Biodiversity Strategy (2000):

> "**BIOLOGICAL BIODIVERSITY (BIODIVERSITY):** The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity). The principal levels of biological organisation in which diversity occurs include:

> ***Genetic Diversity*****:** The variability in the genetic make-up among individuals within a single species. In more technical terms, it is the genetic differences among populations of a single species and those among individuals within a population.
>
> ***Species Diversity*****:** The variety of species - whether wild or domesticated - within a particular geographical area. A species is a group of organisms which have evolved distinct inheritable features and occupy a unique geographic area. Species are usually unable to interbreed naturally with other species due to such factors as genetic divergence, different behaviour and biological needs, and separate geographic location.
>
> ***Ecological*** **(*ecosystem*)** ***Diversity*****:** The variety of ecosystem types (for example, forests, deserts, grasslands, streams, wetlands and oceans) and their biological communities that interact with one another and their non-living environments."

4.4. There is a set of over-arching goals in the New Zealand Biodiversity Strategy (2000), of which Goal 3 is directly relevant to this case:

> **"Goal Three: Halt the decline in New Zealand's indigenous biodiversity**
>
> <u>Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state</u>, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments; and do what else is necessary to
>
> Maintain and restore viable populations of all individual species and subspecies across their natural

range and maintain their genetic diversity." [My emphasis by underlining.]

4.5. The Strategy (P.20) goes on to state: "In Goal Three, "full range" of natural habitats and ecosystems means the same as a "comprehensive and representative range", that is, a range that reflects the known diversity of habitats and ecological communities remaining in New Zealand. "Healthy functioning state" refers to a state in which an ecosystem can support all indigenous species occurring naturally within it.

4.6. Goal Three reflects a focus on natural habitats and ecosystems as a means of conserving species and the diversity within them. This is in keeping with the Convention on Biological Diversity emphasis on conserving biodiversity in its natural surroundings (that is, *in situ* conservation). Maintaining viable populations of indigenous species across their natural ranges should largely be achieved by maintaining a full range of natural habitats and ecosystems. However, within the life of this Strategy, it is likely that the survival of some indigenous species will continue to require an individual species recovery focus beyond just maintaining and restoring the habitats and ecosystems to which these species belong.

4.7. This goal also recognises that most of New Zealand's ecosystems are modified to some extent and made up of mixtures of indigenous and introduced species. Ecosystems in production landscapes and in urban areas are also important for maintaining our indigenous biodiversity.

4.8. <u>Goal Three is the bottom line nationally if we are to prevent further decline in indigenous ecosystems and species</u>. But it is important to note that this does not preclude goals to maintain or restore indigenous biodiversity to ***higher levels*** in some environments (the marine environment, for example) or for particular areas or species. Communities may choose to seek higher targets for particular ecosystems or species within their region, district, or locally. However, unless we at least stabilise our indigenous biodiversity nationally, higher goals will not be an option." [My emphasis by underlining.]

4.9. The Strategy also provides a definition for 'ecosystem':

> "An interacting system of living and non-living parts such as sunlight, air, water, minerals and nutrients. Ecosystems can be small and short-lived, for example, water-filled tree holes or rotting logs on a forest floor, or large and long-lived such as forests or lakes."

and 'natural habitats and ecosystems':

> "Habitats and ecosystems with a dominant or significant indigenous natural character. They do not include modified areas, such as farm or forestry land, where the indigenous vegetation has largely been replaced, although these areas may still provide important habitat for indigenous species."

4.10. New Zealand is also a signatory to the Convention on Biological Diversity:

> "… an international agreement on biological diversity that came into force in December 1993. The objectives of the Convention are: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources (NZ Biodiversity Strategy 2000).

4.11. The New Zealand Biodiversity Strategy (2000) contains ten themes: (1) Biodiversity on land; (2) Freshwater biodiversity; (3) Coastal and marine biodiversity; (4) Conservation and use of genetic resources; (5) Biosecurity and biodiversity; (6) Governance; (7) Māori and biodiversity; (8) Community participation and awareness; (9) Information, knowledge, and capacity: (10) New Zealand's international responsibilities.

4.12. For each of these, the Strategy sets out 'Action Plans', a set of priority actions, and a set of desired outcomes for 2020 (note that the Strategy was released in 2000, 12 years ago, and 2020 is now only eight years away).

4.13. For 'Theme One - Biodiversity on Land', the following is presented (as one of four outcome statements):

> "A net gain has been made in the extent and condition of natural habitats and ecosystems important for indigenous biodiversity. Scarce and fragmented habitats (such as lowland forests and grasslands, wetlands and dunelands) have increased in area and are in better ecological health due to improved connections and the sustainable management of surrounding areas. Some modified habitats are restored." [My emphasis by underlining.]

4.14. For 'Theme Two - Freshwater Biodiversity', the following is presented (as one of four outcome statement):

> "The extent and condition of remaining natural freshwater ecosystems and habitats are maintained. Some degraded or scarce habitats, such as lowland river systems, important wetlands and riparian areas, are restored or increased in area. Intact natural freshwater areas are protected and their natural

> character is maintained." [My emphasis by underlining.]

4.15. The Department of Conservation commissioned an independent review (Green and Clarkson 2006[4]) after the first five years of implementing the Biodiversity Strategy. That review found "grounds for cautious optimism" but indicated many areas where improved performance was recommended. In relation to 'Theme One - Terrestrial biodiversity', the review recommended "That references in the Strategy to 'sympathetic management' be widened to address the need for biodiversity conservation principles to be applied to all aspects of sustainable land management."

4.16. In relation to 'Theme Two - Freshwater Biodiversity', the review recommended:

> "That the protection, restoration, and sustainable management of freshwater ecosystems and indigenous species be accorded higher priority in the next phase of the implementation of the Biodiversity Strategy."

4.17. The state of our biodiversity is an international issue. "Given the wealth and uniqueness of New Zealand's biodiversity, the country is internationally regarded as 'one of the richest and most threatened reservoirs of plant and animal life on earth' (Conservation International 2007)." [Quoted in MfE 2007[5]]

4.18. As noted above, New Zealand is a signatory (along with *c.*190 other countries) to the Convention of Biological

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4 Green W. and Clarkson B. 2006: Review of the New Zealand biodiversity strategy themes. Report to Department of Conservation, pp1-238.

5 MfE 2007: Environment New Zealand 2007. Ministry for the Environment. 456 pp.

Diversity 1992. The Convention recognised for the first time in international law that the conservation of biological diversity is "a common concern of humankind".

4.19. The Convention has three main goals:

- Conservation of biological diversity (or biodiversity);
- Sustainable use of its components; and
- Fair and equitable sharing of benefits arising from genetic resources.

4.20. The Convention has the following definition of biological diversity:

> "*Biological diversity*" means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."

4.21. Two national overviews of the state of our indigenous biodiversity have been produced (Mfe 1997[6] and 2007) and the following extracts are from MfE (1997):

> "Although predation targets only a few species, habitat loss indiscriminately hits all the species in an area. Recent overseas research has shown that the effect of habitat loss on biodiversity increases markedly once a critical threshold is crossed. According to American scientist, David Tilman: "The

[6] MfE 1997: The State of New Zealand's Environment 1997. Ministry for the Environment.

'good news' is that if you destroyed half the Earth, you'd lose only about 10 percent of the species. But the bad news is … as you near 60 percent - 70 percent - 80 percent habitat loss, a very slight increase in destruction leads to a sharp increase in the number of species lost" (Culotta 1994[7]; Tilman *et al*. 1994[8]).

The magnitude of these extinctions is masked by the fact that they do not all happen at once - some species can hang on grimly for decades, or even centuries, before finally succumbing. To date, Earth is just barely on the 'good news' side of the ledger with about 52 percent of its land ecosystems replaced or disturbed by farmland, settlements, logging, mining and roads (World Resources Institute 1994[9]). However, New Zealand is on the 'bad news' side of the habitat balance sheet, with our area of domesticated land now standing at 63 percent and the percentage of significantly disturbed habitat estimated at 73 percent (World Resources Institute 1994[10]). Habitat loss in New Zealand has occurred at three levels:

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[7] Culotta E. 1994: Ecologists gather for mix of policy, science in Nashville. *Science 265*: 1178-1179.

[8] Tilman D., May R.M., Lehman C.L., and Nowak M.A. 1994: Habitat destruction and the extinction debt. *Nature 371*: 65-66.

[9] World Resources Institute 1994: World Resources 1994-95. Oxford University Press.

[10] Note that more recent analysis is available (e.g. Walker S., Price R., Rutledge D., Stephens R.T.T., and Lee W.G. 2006: Recent loss of indigenous cover in New Zealand. *New Zealand Journal of Ecology 30*(2): 169-177), but the fundamental picture is similar.

- wholesale **removal** of ecosystems for conversion to farmland, exotic forests and settlements;

- partial removal or **fragmentation** of ecosystems into 'islands' surrounded by farmland;

- **degradation** of ecosystems through loss of species and disruption of ecological process." (MfE 1997)

"Today, most of New Zealand's surviving, relatively undisturbed habitat is either at high altitudes in the mountains, or in small lowland forest stands, shrunken wetlands and other ecological 'islands'." (MfE 1997)

"By the time Europeans arrived, the forests had been reduced from about 85 percent of the land area to 53 percent, and the tussock grassland had expanded from about 5 percent to almost 30 percent. The new settlers triggered a new wave of deforestation. Within barely 100 years, the forests had been further reduced to 23 percent of the land area while the grassland had expanded to just over 50 percent. Today, New Zealand has ten times more grassland than it once had, and only a quarter of its original forests. The landscape has been changed beyond recognition from a dark green forest cloak fringed by tussock, duneland and wetland to a light patchwork blanket of pasture, exotic forests, crops, roads and settlements." (MfE 1997)

4.22. Particularly significant adverse effects on indigenous biodiversity are a fundamental issue with this proposed development. It is very important, firstly, to be clear about what is to be affected, the scale of the impact, the relative significance of the features to suffer the adverse effect, whether or not mitigation is to be provided, and whether that mitigation addresses the scale of loss.

4.23. It is very important to fully understand and openly declare these matters, including any ‘pluses’ and ‘minuses’ resulting from the types and scale of mitigation proposed.

4.24. The proposed National Policy Statement on Indigenous Biodiversity, in relation to principles to be applied when considering a biodiversity offset, adopts the principle of No Net Loss:

> “A biodiversity offset should be designed and implemented to achieve *in situ*, measurable conservation outcomes which can reasonably be expected to result in no net loss and <u>preferably a net gain of biodiversity</u>: [My emphasis by underlining.]

4.25. My view is that consideration of No Net Loss needs to place particular emphasis on terrestrial and freshwater ecosystems and habitats, and this is consistent with the approach highlighted in the New Zealand Biodiversity Strategy (and the 2006 review of that Strategy) as being of particular concern.

4.26. In light of the above, I suggest that this particular application needs to be addressed at several levels:

- Has biodiversity been addressed adequately?
- Have all of the ecological effects been addressed and has adequate mitigation been provided for each effect?
- At a strategic level, is the destruction of a lowland river ecosystem and associated habitats and species

warranted, in terms of the types and scales of effects, and the mitigation to be provided?

4.27. To address these matters, it is necessary to consider:

- Ecological values, within national and regional contexts, and
- To comprehensively evaluate the full suite of effects, in precise detail, on ecosystems, habitats, and species, and to assess whether mitigation has been provided for each effect identified.

5. DEVELOPMENT WITHIN PROTECTED AREAS - AN OVERVIEW

5.1. There is an assumption, at least by most New Zealand ecologists, that protected areas (i.e. areas subject to formal legal protection that fall under the ambit of the Conservation Act 1987) will not be subject to major loss of ecologically significant habitat [legally protected areas are specifically reported on in MfE 1997 and 2007, with the inference that, at a national level, the extent of area subject to formal legal protection is an indicator of the level of biodiversity protection.] That is not to even vaguely suggest that protected areas are 'sacrosanct' and off-limits to development, or that all development is or should be excluded from them. Even our most iconic national parks contain lodges, parking areas, ski fields, tramping huts, roads, walking and cycling tracks, helicopter landing sites, aircraft flight zones, boating facilities, hotels, camp grounds, telecommunication facilities, park management infrastructure, and other facilities. Some national parks (e.g. Te Urewera and Fiordland[11]) contain energy generation infrastructure.

5.2. Some of this development happened before our national parks were gazetted (e.g. the lowering of Lake Waikaremoana for hydro-electricity generation in 1946) or the development occurred before the full suite of ecological effects was fully understood, or the development has been carefully assessed and sensitively designed and built to minimise potential adverse effects.

5.3. I have first-hand experience with development of new or expansion of facilities within protected areas (e.g. hotels, telecommunication sites, walking and cycling tracks, huts, ski fields), the management of existing facilities, energy generation (e.g. natural lakes used for hydro-electricity generation), and investigation of proposed new developments (e.g. wind farms, transmission lines, gold prospecting).

6. PROTECTED STATUS

Mokihinui Catchment

6.1. Most of the Mokihinui catchment is administered by the Department of Conservation as part of the Lyell Range and Radiant Range Conservation Area. A large area above the Mokihinui Forks is gazetted as the Mokihinui Forks Ecological Area. The catchment is contiguous with Kahurangi National Park, and the formal recognition of that

[11] There is special legislation in place to provide for development and operation of the Manapouri Power Scheme within (and beneath) Fiordland National Park.

national park is described in the evidence of Mr Alan White.

6.2. Is the protected status of the Mokihinui catchment warranted? I have no doubt whatsoever that it is, for the following reasons:

- The catchment is contiguous with and is an integral part of one of the largest natural areas in New Zealand. This larger tract, North-West Nelson, is a recognised biodiversity 'hotspot', at a national level.

- Ecosystems, habitats, and species represented in the Mokihinui catchment, including those within the riverine gorge ecosystem, are ecologically significant and warrant ongoing protection and active management to retain them in good condition.

- Most natural areas (and protected areas) in New Zealand now occur in the uplands due to the heavily modified state of our lowlands, as outlined above. The Mokihinui gorge ecosystem is ecologically significant simply because it contains good quality indigenous vegetation and habitats that extend almost to sea level and the coast. This is now relatively uncommon in New Zealand, with the most notable examples of relatively intact ecological sequences extending from the coast to the mountain tops being present only in Kahurangi North-West Nelson, Paparoa Range, South Westland-Fiordland-Waitutu, the Catlins, and near East Cape. All of these sites, however, have different assemblages of ecosystems, habitats, and species.

6.3. Based on the above analysis, it would be easily warranted for that part of the Mokihinui catchment administered by the Department of Conservation to be added to Kahurangi National Park.

6.4. My view on the ecological quality and status of the Mokihinui catchment has been confirmed by observations made during my field inspections of the catchment and the river gorge, and the ecological evidence of the various witnesses for the Department of Conservation, Meridian, and others.

Transmission Line Route

6.5. The proposed transmission line route traverses the Radcliffe Ecological Area and the Ngakawau Ecological Area. Both of these protected areas were originally recognised by the New Zealand Forest Service[12], and have exceptional ecological values, as described in the evidence of Dr Lloyd, Dr D. Norton, and Ms K. Walker. The values of Ecological Areas are clearly stated by Dr Norton in a recent paper[13]:

> "Ecological areas are on a par with national parks in terms of their ecological values and they warrant the highest level of protection and management".

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[12] Identification and gazettal of Ecological Areas by the New Zealand Forest Service was a process that was only applied to natural areas with very high ecological values. A set of evaluation criteria was applied to candidate areas, and these were then subject to rigorous evaluation by an independent scientific committee, known as the Protected Area Scientific Advisory Committee (PASAC). Proposed areas that made it through this process should be regarded as 'jewels in the crown' of New Zealand protected areas, as they are all either highly representative of land types and biodiversity, and/or contain special features. However, it should also be recognised that many areas of very high biodiversity value administered by the NZ Forest Service were not selected as Ecological Areas due to competing pressures for indigenous logging.

[13] Norton D.A. and Overmars F.B. 2012: Ecological areas - premier protected natural areas. *New Zealand Journal of Ecology 36*(1): 108-120.

7. LARGE TRACTS OF INDIGENOUS ECOSYSTEMS AND HABITATS

7.1. The section of the Mokihinui River under consideration is part of a relatively large catchment, with *c.* 68,000 ha upstream of the proposed impoundment. The Mokihinui catchment is part of an extensive area of indigenous vegetation that includes Kahurangi National Park, the Mokihinui Forks Ecological Area, and Conservation Area.

7.2. The broad forest class pattern of North-West Nelson, including Kahurangi and the Mokihinui (as mapped by Franklin and Nicholls 1989[14]), includes a lower altitude band of mixed rimu and beeches. On the western side of the tract, below 450 m, hard beech is predominant, with red beech and silver beech further inland and at higher altitudes. Northern rata also occurs along the western side of the tract. Pure beech forest is dominant at higher altitude, with montane shrubland tussock grassland, and herbfield on the higher ridge systems.

7.3. North-West Nelson and Kahurangi, including the Mokihinui catchment, is a nationally significant tract of indigenous vegetation and habitats, supporting a very diverse range of ecological gradients, vegetation types, indigenous plants, and indigenous fauna, including many threatened species, some of which are regional endemics.

7.4. In the North Island, the largest unit of natural landscape now remaining is the Urewera-Raukumara tract (which covers more than 500,000 ha).

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[14] Franklin D.A. and Nicholls J.C. 1989: Tasman Forest Class Map. *Mapping Series 6, Sheet 15*. Ministry of Forestry.

7.5. These large tracts contain some of the best remaining examples of nationally rare vegetation types, including local examples of podocarp-dominant forest, most of which has otherwise been lost to land clearance and logging. Although modified to some extent by various pest animals that occur widely on the New Zealand mainland, these largely natural tracts are also our last remaining examples of largely natural ecological processes that are still functioning at a landscape scale.

7.6. Large tracts also contain intact major catchments, such as the Mokihinui. Rivers in these large tracts have the best quality and longest upstream and downstream connectivity, with high quality habitats from the coast to small headwater streams.

7.7. These large tracts - because of their size and inherent diversity of ecological processes, habitats, and species - are nationally significant. This in itself is a very strong reason to continue to apply a very high level of protection to these places and to not lose key components or linkages in a piecemeal cumulative fashion.

8. 'HISTORICAL' RECOGNITION OF ECOLOGICAL VALUES OF VEGETATION

8.1. Ecological values of some of the vegetation in the Mokihinui Gorge have been recognised for at least 30 years. Park and Walls (1978)[15] produced an "Inventory

[15] Park G.N and Walls G.Y. 1978: Inventory of tall forest stands on lowland plains and terraces in Nelson and Marlborough land districts, New Zealand. Unpublished report, Botany Division, DSIR.

of Tall Forest Stands on Lowland Plains and Terraces in Nelson and Marlborough Land District, New Zealand." This ground-breaking work, for New Zealand, identified the rimu-dominant stand at Andersons Flat as being of ecological significance. Recognition of this site pre-dates our current level of knowledge of ecological processes and the importance of key ecological components in many of our landscapes.

8.2. The rimu-dominant forest at Andersons Flat possesses key elements identified by Park and Walls in 1978:

- It is contiguous with extensive areas of hill forest;
- It is relatively unmodified;
- Key ecological processes are still in place, allowing continued evolution of the ecosystem.

8.3. Analysis undertaken by Park and Walls (1978) showed that:

- It was one of only two stands of this type in the entire North-West Nelson sector of Nelson Land District.
- It was one of only six similar stands within protected areas in their entire study area which covered all of the Nelson and Marlborough land districts.

8.4. It is notable that Park and Walls (1978) estimated the size of the Andersons Flat stand as 5-10 ha, whereas the detailed mapping and GIS analysis of Dr Lloyd shows that the stand comprises 25 ha of rimu-dominant forest. The larger size (25 ha) of the stand means that it is of greater ecological significance than was thought when Park and Walls undertook their analysis, and it is likely that they would have assigned it an even higher ranking in 1978.

8.5. New Zealand ecologists now also have a much greater understanding of the key ecological roles and national rarity of dense podocarp stands than we did in the 1970s, and dense podocarp stands, such as the stand at Andersons Flat, are now recognised as being particularly rare and significant.

9. WHAT IS THE MOKIHINUI RIVER GORGE ECOSYSTEM?

9.1. The gorge is a dynamic and wild natural environment and this has important implications for both its vegetation and aquatic communities. It experiences large floods and these floods periodically sweep the lower gorge sides 'clear' of taller vegetation and also deposit fine silts as the floodwaters recede. At least two large earthquakes have affected the gorge within recent times and these have resulted in:

- Numerous landslide scars;
- Numerous patches of secondary early successional vegetation.

9.2. A recent severe wind storm has left an imprint of locally-severe blowdown scattered throughout, in a pattern typical of such events.

9.3. The forest pattern reflects climate, landforms, soil pattern and disturbance history. The gorge environment and its general environs are generally steep to very steep, with thin soils. Slopes have been subject to reasonably large-scale mass movement associated with at least two large earthquakes and, as a result, the forest cover is a somewhat patchy mosaic of hard beech-dominant forest with many patches of low stature early successional vegetation on landslide scars. Abundant podocarps are present on more stable terrain, such as Andersons Flat.

9.4. Disturbance events such as windthrow and landslides are typical drivers of ecological succession in New Zealand forests, especially for light-demanding species such as hard beech, northern rata, matai, and rimu, the main tree species in the Mokihinui Gorge and adjacent area.

9.5. The river gorge ecosystem includes many discrete and inter-connected abiotic and biotic elements, and it is useful to provide an overview of what that ecosystem comprises, as set out below:

Abiotic Elements

- A large upper catchment discharging through a “confined” lower gorge, resulting in high flood levels on the gorge walls.
- Gorge structure that has developed as a result of geological uplift and down-cutting through various rock types (greywacke, limestone, and granite) by the river.
- Rock types and geological structures on the gorge walls and in the riverbed that reflect the underlying catchment geology.
- Rapids and river reaches that reflect gradient, geology, and water flow levels.
- Landslides on gorge walls.
- Suspended bed load being moved downstream by flood flows.
- Erosive forces, driven by normal and flood-related river levels.

- Riverine element of the hydrological cycle, whereby rain falling in the catchment is returned to the sea.

- Overall, the river gorge is a key element of a major ecosystem process[16] that underpins the functioning of many aspects of the wider catchment.

Biotic Elements

- Riparian turf community.

- Riparian shrubland community.

- Terrestrial forest vegetation on alluvial and colluvial terraces of varying sizes, the largest of which is Andersons Flat.

- Riparian seeps:

  - Aquatic invertebrates;

  - Aquatic bryophytes.

- Largely unmodified riverine habitat.

  - Indigenous fish;

  - Aquatic invertebrates;

  - Periphyton.

- Terrestrial forest vegetation on lower hillslopes.

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[16] Ecosystems are characterised by processes that move energy and materials.

  - Forest on greywacke;

  - Forest on granite;

  - Forest on limestone.

- Lowland hillslope forest with a major northern rata element.

- Lowland forest bird habitats, including stands of northern rata and podocarps that provide important seasonal food sources for mobile fauna species.

- A significant whio (blue duck) population in a dynamic river gorge habitat (and significant habitat for other water birds).

- Significant lowland habitat for four subspecies of *Powelliphanta* land snail, including snail populations on different basal geologies.

- Flood-driven genetic interchange between the *Powelliphanta* subspecies, which has resulted in a diversity of speciation and evolutionary development not evident at any other site in New Zealand.

- Significant populations of terrestrial birds, long-tailed bats, and lizards.

- Diverse representation of terrestrial indigenous invertebrates other than snails.

9.6. I am not aware of this combination of ecological features in another river gorge environment in New Zealand.

9.7. To sum up, the Mokihinui gorge ecosystem represents a combination of geology, landforms, riverine habitat, vegetation and biota, and related ecological processes and functions that is not represented elsewhere. It is the combination of natural features and processes that gives this particular system its distinctive qualities and values.

10. SIGNIFICANCE OF THE RIVERINE ECOSYSTEM

10.1. The evidence of Dr John Leathwick shows clearly that the Mokihinui is ranked in the top 14 rivers in New Zealand. Further analysis by Dr Leathwick shows that, of these 14 rivers, seven are subject to glacial influence and four are different river environments. So, of rivers directly comparable, the Mokihinui ranks third. On this basis, the Mokihinui is clearly significant at national and regional levels.

Significance of other habitats in the riverine gorge

10.2. Dr Leathwick's rankings of relative significance do not take into account other features that are significant at national and/or regional levels, and which are additional to the riverine values assessed by Dr Leathwick, including the following:

- Riparian plant community;
- Riparian land snail populations;
- Whio (blue duck) population;
- Soil and litter habitat (and related biota);
- Terrestrial vegetation[17];
- Lizards;

[17] Dr Leathwick's analysis takes account of catchment cover, but not the specific vegetation composition within the gorge system.

- Indigenous terrestrial bird habitat;
- Bat habitat;
- Aquatic invertebrates;
- Aquatic bryophytes.

10.3. I briefly discuss each of these below:

Riparian Plant Community

10.4. The evidence of Dr Kelvin Lloyd clearly indicates that the riparian turf community is of regional significance, and is likely to be of national significance.

10.5. There will also be complete loss of an outstanding example of nationally important - extensive, diverse, and intact - riparian turf vegetation and the loss of high quality habitat for *Olearia cheesemannii* (ranked nationally as Chronically Threatened-Gradual Decline), including 95% of the population in the gorge.

Riparian Land Snail Populations

10.6. The evidence of Ms Kath Walker demonstrates that there are four subspecies of *Powelliphanta* present in the gorge ecosystem, with very significant evolutionary development driven by river floods and resultant genetic interchange.

10.7. This is the only place where this situation exists, and is clearly significant at a national level.

Whio (Blue Duck)

10.8. The evidence of Mr Tim Shaw shows that a significant proportion of the entire whio population of the Mokihinui catchment and the wider Kahurangi region is represented in the gorge. More importantly, 22.9 km of river and stream habitat (including known whio habitat) is to be permanently destroyed. This habitat is clearly regionally significant.

Soil and Litter Habitat

10.9. No evidence has been provided by the applicant on the soil and litter habitat to be affected, and the assemblages of species to be affected that utilise this habitat other than *Powelliphanta* land snails. Based on the 'footprint' of terrestrial vegetation to be affected, up to 300 ha of this habitat type will be lost permanently.

Terrestrial Vegetation

10.10. The evidence of Dr Kelvin Lloyd shows that a diverse array of vegetation types will be destroyed, involving 16 vegetation types (including 100% loss of riparian shrubland and turf, as already discussed above).

10.11. The excellent condition of the vegetation, as indicated by healthy northern rata canopies and abundant regeneration of this and other browse-vulnerable species on landslide scars, indicates that the current level of management (including monitoring) is sufficient to ensure long-term viability of the vegetation. Healthy northern rata stands are now an uncommon feature nationally, due to the massive impacts of possum browsing on this species, and many stands have suffered near total destruction (e.g. Orongorongo catchment, Mamaku Plateau, Ruahine Range) due to heavy selective browsing pressure. There are now active programmes to protect remaining stands and research is currently underway on regeneration techniques to enable restoration in places where virtually total loss has occurred.

10.12. Dr Lloyd also provides a detailed analysis of each criterion for the evaluation of ecological significance in the Buller District Plan and the West Coast Regional Policy Statement. The vegetation and habitats evaluated are clearly very significant in terms of criteria provided in the District Plan and the Regional Policy Statement. It follows that the vegetation and habitats are also significant in terms of Section 6(c) of the RMA.

10.13. Some of the types to be lost are certainly regionally significant in their own right, such as rimu-northern rata-[matai]/broadleaved forest and rimu-[kahikatea]/toro-kamahi forest.

10.14. Representation of the various types on different basal geologies and landforms, is also regionally (and possibly nationally) significant.

Lizards

10.15. The evidence of Dr Colin O'Donnell indicates that the Mokihinui gorge is part of an area known to be a 'hotspot of regional reptile diversity', with six species known within 10 km of the site.

Indigenous Terrestrial Bird Habitat

10.16. Dr O'Donnell has rated the forest and shrubland habitats to be affected as containing excellent examples of bird faunas characteristic of these vegetation types.

10.17. In terms of the West Coast RPS he concludes that the MHP stands out because the collective significance of the site is very high, which clearly makes it of at least regional significance.

Bat Habitat

10.18. Dr O'Donnell also concludes that the long-tailed bat population is likely to be a regional hotspot for this species. Dr O'Donnell and Dr Brian Lloyd agree that the long-tailed bat population in the Mokihinui catchment is regionally and nationally significant. There is uncertainty, however, over the use of the MHP site by long-tailed bats, but there are numerous large trees within the proposed impoundment footprint that could potentially provide roost habitat for bats.

Aquatic Habitat for Invertebrates and Bryophytes

10.19. Based on Dr Suren's evidence, it is clear that the impoundment will affect the following significant features:

- Aquatic habitat connectivity for invertebrates;
- Habitat for riverine aquatic invertebrates;
- Aquatic invertebrates;
- Seepage wetlands;
- Aquatic invertebrates that inhabit seeps;
- Aquatic bryophyte habitat;
- Aquatic bryophyte communities;
- A rare aquatic bryophyte.

10.20. Dr Death's evidence indicates that the aquatic invertebrates and periphyton in the main stem and larger tributaries of the Mokihinui River are characteristic of unmodified flood-prone rivers. As such, he considers that they represent a decreasingly common ecological type in New Zealand. He also considers that the seeps and tributaries have a unique and rare biota.

10.21. Dr Suren, at Paragraph 5.40 of his evidence, records the presence of a threatened liverwort *Phaeoceros delicates* in a small stream at Andersons Flat.

10.22. I note that in Paragraph 4.16 of his evidence, Mr Toft records the notable presence of a stilleto fly, *Anabarhynchus spitzeri*, along the length of the Mokihinui River from a few hundreds of metres below the highway bridge to Lake Perrine. This species was also recorded from the Karamea Gorge but was previously known only from two sites at Makarora (Paragraph 5.9 of Mr Toft's evidence).

10.23. At Paragraph 4.17 of his evidence, Mr Toft notes that an additional stiletto fly, *A. ostentatus*, was recorded in the Mokihinui Gorge and in the vicinity of Lake Perrine, but is mostly confined to the North Island. This species was also recorded in the Karamea River.

10.24. These two stilleto flies can be regarded as distinctive species in the Wangapeka Ecological District on the basis of their unusual occurrences and possibly disjunct distributions.

10.25. Two undescribed taxa of *Nerofeonea* beetles were recorded in the Mokihinui Gorge and are currently known only from the vicinity of the Mokihinui River (Paragraph 5.3 of Mr Toft's evidence), and these were not present in comparative samples obtained from the Karamea River. These beetles may well be endemic to the Wangapeka Ecological District, if not the Mokihinui catchment.

10.26. In Paragraph 5.14 of his evidence, Mr Toft notes that the *Nerofeonea* beetles are examples of taxa that either do not disperse well across geographical barriers, or have highly specific habitats or food requirements that are not shared between areas. In this context, it would not be surprising to find other differences in invertebrate composition between the Mokihinui and Karamea gorges due to the different geological conditions, vegetation types, and habitats that occur in these gorges.

10.27. Dr Suren, in Paragraph 5.24 of his evidence, reports that an indigenous caddis fly (*Xenobiosella motueka*) recorded in the Mokihinui Gorge is at its southern distributional limit.

10.28. Dr Suren also reports (in Paragraph 5.31) a high bryophyte richness from seepages and small tributaries in the Mokihinui Gorge, relative to other rivers in the region.

10.29. The gorge supports terrestrial invertebrate assemblages that are distinctive in terms of unique assocations, rare species, and species at their distribution limits.

10.30. Seepage wetlands in the Mokihinui Gorge provide important habitat for invertebrate fauna, as described in the evidence of Dr Suren.

10.31. Dr Suren identifies several important bryological and invertebrate values of seepage wetlands and small tributaries, but does not assess the significance of these according to the planning criteria, as Dr K. Lloyd has done. Similarly, Mr Toft does not make an assessment of terrestrial invertebrate values against the planning criteria, as Dr Lloyd has done.

10.32. Mr Toft notes (Paragraph 6.1 of his evidence) that the primary effect of the hydro-electric development on terrestrial invertebrates (other than snails) will be loss of habitat, particularly for those species of open riparian habitat. Dr Suren also notes the distinctiveness of invertebrate and bryophyte assemblages in seepage wetlands within the Mokihinui Gorge riparian zone.

10.33. At Paragraph 7.3 of his evidence Mr Toft notes that lowland forest habitats with highly diverse invertebrate communities will be lost due to the hydro-electric development. He notes that the affected forest is likely to include a number of terrestrial invertebrates with limited dispersal abilities, but does not consider that the loss of habitat due to the hydro-electric development would threaten the ongoing survival of these species. In my opinion, the risk of global extinction is too high a threshold for assessing whether potential adverse effects are significant.

10.34. Mr Toft does not explicitly assess the significance of effects on terrestrial invertebrates other than snails, but based on the information on invertebrates in his evidence, I would assess the potential adverse effects of the hydro-electric development on terrestrial invertebrates as being significant, due to the large area and range of habitats to be destroyed. Ms Walker’s evidence discusses adverse effects on *Powelliphanta* snails.

10.35. As demonstrated by Dr Suren's evidence, seepage wetlands in the Mokihinui Gorge are habitat for regionally distinctive assemblages of invertebrates and for a rich bryophyte flora. They are very likely to be regionally uncommon wetlands. Seepages are also historically rare wetland types on a national scale (Williams *et al*. 2007[18]).

10.36. Seepage wetlands in the West Coast Region have been estimated to cover a greater area currently than they would have historically (Ausseil *et al.* 1998[19]), but an accuracy assessment for Otago reported by the same authors shows that the current extent of seepages was strongly over-estimated (only 11% of those classified as such were actually seepage wetlands).

10.37. Seepage wetlands in the Mokihinui Gorge form intact sequences from river level through bryophyte-dominated turf, herbaceous turf, and shrubland to non-forest. They support at least one wetland species, the caddis fly *Xenobiosella motueka,* that is at its distribution limit and dependent on the seepage wetland habitat (Paragraph 5.24 of Dr Suren's evidence). Seepage wetlands are of at least regional importance in providing habitat for very high densities of invertebrates, and high taxonomic richness and taxonomic distinctiveness, in addition to providing habitat for a relatively rich flora of bryophytes (Paragraphs 5.21, 5.22, and 5.31 of Dr Suren's evidence).

10.38. Dr Death’s view that the seeps and tributaries to be destroyed are unique is based on the presence of diverse ecosystems with at least five invertebrate species and five

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[18] Williams P.A., Wiser S., Clarkson B., and Stanley M.C. 2007: New Zealand’s historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31*(2): 119-128.

[19] Ausseil A., Gerbeaux P., Chadderton L.W., Stephens T., Brown D., and Leathwick J. 2008: Wetland ecosystems of national importance for biodiversity: Criteria, methods, and candidate list of nationally important inland wetlands. *Landcare Research Contract Report LC0708/158*. 162 pp.

periphyton taxa new to science, and the "convincing evidence" of Dr Suren that these assemblages are different from other seepage faunas within the wider Mokihinui catchment, the Karamea River catchment, and elsewhere on the West Coast.

11. OVERVIEW OF RELATIVE ECOLOGICAL SIGNIFICANCE OF ELEMENTS OF THE RIVER GORGE ECOSYSTEM

11.1. A summary of levels of relative ecological significance for key elements of the Mokihinui gorge system is set out in Table 1:

Table 1: Levels of relative ecological significance of ecosystems, habitats, and species present in the Mokihinui River gorge.

Feature	Level of Relative Significance	
	National	Regional
Riverine ecosystem	✓	✓
Riparian plant community	✓	✓
Seepage wetlands	✓	
Land snails	✓	✓
Whio (blue duck) population		✓
Terrestrial vegetation		✓
Lizards		✓
Long-tailed bat population	✓	✓
Aquatic bryophyte community		✓
Threatened aquatic bryophyte	✓	✓
Aquatic invertebrates		✓

11.2. Overall, the site is clearly of national and regional significance for a range of factors (note that the above analysis does not take into account the diverse inter-connectedness of various ecological processes and functions, which I will now discuss for the river gorge ecosystem.

12. WHAT WILL BE AFFECTED BY THE DAM AND IMPOUNDMENT?

12.1. Determination of exactly what effects will result from the proposed development is a fundamental information requirement. Documentation of these effects must be done in a comprehensive manner, to enable full accounting of effects, identify mitigation and outstanding effects that become an environmental cost of the project.

12.2. Lists of effects are set out below, starting with an assessment of effects on key ecological processes, the significance of those processes, and the degree of potential adverse effect. Note that the assessment of 'degree of adverse effect' in Tables 2-5 takes no account of potential mitigation, which is addressed in Tables 6-9.

12.3. Ecological processes in the Mokihinui Gorge to be affected by the project are set out below in Table 2. This is not an exhaustive list, but is an attempt to represent key processes.

12.4. A rating (Low, Moderate, or Major) has been provided for the degree of each potential adverse effect:

- Low - Minor effect, involving relatively small areas and no uncommon or threatened ecosystems, habitats, or species.
- Moderate - More than minor effects on ecologically significant ecosystems, habitats, or species.
- Major - Large area(s) to be affected and/or significant adverse effects on ecologically significant ecosystems, habitats, or species.

12.5. Assignment of these ratings is based on the evidence of relevant witnesses for the Department of Conservation and/or Meridian.

Table 2: Ecological processes, relative ecological significance, and degree of potential adverse effects resulting from flooding of the Mokihinui Gorge by the proposed Hydro-electricity Project.

Ecological Process	**Relative Ecological Significance***	**Degree of Adverse Effect**
Loss of ecological connectivity for aquatic invertebrates.	Regional	Major
Loss of migratory pathway for indigenous fish.	Regional	Major
Loss of riverine processes that have created and maintain habitat for: - Indigenous fish; - Avifauna; - Invertebrates.	 National Regional National	 Major Major Major
Loss of riverine flood-driven processes that have formed and govern the riparian zone: - turf community - Rare plants - Seeps	 Regional (possibly National) Regional National	 Major (total loss) Major Major
Flood-driven genetic interchange between *Powelliphanta* populations on different sides of the river.	National	Major (total loss)
Carbon sequestration: - Soils; - Vegetation.	 Regional Regional	 Major (300 ha) Major (300 ha)
Seasonal use, by mobile fliers, of key habitats on alluvial terraces to be flooded.	Regional	Major (total loss)
Upstream migratory use of river gorge by indigenous fish.	National	Major (total loss)
Downstream migratory use of river gorge by indigenous fish.	National	Major disruption

12.6. A list of effects on specific ecological features in the Mokihinui Gorge is set out in Table 3:

Table 3: Ecological features, relative ecological significance, and degree of potential adverse effects resulting from flooding of the Mokihinui Gorge by the proposed Hydro-electricity Project.

Ecological Feature	Relative Ecological Significance*	Degree of Adverse Effect
Soil and litter habitat (for arthropods, molluscs, worms, fungi).	Regional	Major (>280 ha)
Riparian zone - turfs - rare plants - seepage wetlands	 Regional (possibly National) Regional Regional	 Major (total loss) Major Major
Terrestrial Vegetation		
1. Rimu-nothern rata-[matai]/ broadleaved forest	Regional	Major (69.3 ha)
2. Rimu-[kahikatea]/toro-kamahi forest	Regional	Major (22.5 ha)
3. Kahikatea-rimu-matai-silver beech forest	Regional	Major (5.8 ha)
4. Rimu-hard beech-[silver beech] forest	Regional	Major (27.0 ha)
5. [Rimu-matai-miro]/hard beech forest	Regional	Major (6.4 ha)
6. [Rimu]/hard beech/kamahi forest	Regional	Major (107.3 ha)
7. Strongly modified rimu-northern rata-matai/broadleaved forest	Regional	Major (21.4 ha)
8. Kamahi/broadleaved forest	Regional	Moderate (1.7 ha)
9. Regenerating rimu/broadleaved forest	Local	Moderate (3.0 ha)
10. Regenerating [kahikatea]/broadleaved forest	Local	Moderate (4.6 ha)
11. Regenerating broadleaved forest	Local	Moderate (5.2 ha)
12. Tutu scrub	Local	Minor (2.1 ha)
13. Recent landslide vegetation	Local	Minor (5.6 ha)
14. [Toro]/hard rush/browntop grassland	Local	Minor (0.1 ha)
15. [Kahikatea]/*Coprosma tayloriae*-rohutu/ bracken fernland	Local	Minor (0.2 ha)
16. Tall oat grass grassland	Local	Minor (1.1 ha)
Avifauna		
Forest birds	National	Major
Gorge habitat for grey duck	Regional	Major
Whio - four pairs (and single)	Regional	Major
Gorge habitat for whio (blue duck)	Regional	Major

Gorge habitat for black shag	Local	Local
Bats		
Long-tailed bat habitat	National	Major
Lizards		
Lizard habitat	National	Major
Land Snails		
Powelliphanta lignaria unicolorota	National	Major (274 ha)
Powelliphanta lignaria lusca	National	Moderate (21.4 ha)
Powelliphanta lignaria	National	Moderate (14.2 ha)
Powelliphanta ruforadiata	National	Moderate (10 ha)
Other Terrestrial Invertebrates	Regional	Major (>280 ha)
Aquatic Habitat		
Invertebrates	Regional	Major
Indigenous fish	Regional/National	Major

* Of features to be affected.

Note: Potential effects on habitats and species downstream of the proposed dam site are not included above.

12.7. Ecological processes to be affected by the transmission line are set out below in Table 4:

Table 4: Ecological processes, relative ecological significance, and degree of potential adverse effects associated with the transmission line for the proposed Mokihinui Hydroelectricity Project.

Ecological Process	**Relative Ecological Significance***	**Degree of Adverse Effect**
Creation of canopy gaps, 'resetting' of successional sequences and providing sites for weed establishment.	National	Major
Edge effects in indigenous forest.	National	Moderate
Edge effects in indigenous shrubland.	National	Minor
Fragmentation of *Powelliphanta patrickensis* habitat	National	Moderate (local)
Fragmentation of *Powelliphanta lignaria johnstoni* habitat	National	Moderate (local)
Fragmentation of *Powelliphanta lignaria rotella* habitat	National	Moderate (local)
Predator use of foot and vehicle tracks.	National	Moderate?

* Of features to be affected.

12.8. A list of effects on specific ecological features to be affected by the transmission line is set out in Table 5 below:

Table 5: Ecological features to be affected, relative ecological significance, and degree of potential ecological effects associated with the transmission line for the proposed Mokihinui Hydroelectricity Project.

Ecological Feature	**Relative Ecological Significance***	**Degree of Adverse Effect**
Coal measures forest	National	Major
Coal measures scrub	National	Major
Coal measures pakihi	National	Major
Great spotted kiwi	National	Minor
Fernbird	Regional	Minor
Weka	Regional	Minor
New Zealand pipit	Regional	Minor
Lizards	Regional	Minor
Powelliphanta patrickensis	National	Major**
Powelliphanta lignaria rotella	National	Major**
Powelliphanta lignaria johnstoni	National	Major**

* Of features to be affected.

** Incremental habitat degradation is a significant effect for these species.

13. OTHER EFFECTS OF THE PRPOSED IMPOUNDMENT ON VEGETATION

13.1. Direct effects on vegetation as a result of inundation have been addressed in the evidence of Dr Kelvin Lloyd. These effects include the drowning of approximately 300 ha of lowland indigenous forest and the complete loss of the riverine riparian turf zone.

13.2. I have monitored lake margin turf zones (e.g. Lake Waikaremoana) over many years but these lake-based systems are very different (with different species assemblages) than the riverine riparian turfs in the Mokihinui, being governed by different ecological processes.

13.3. Based on the evidence of Mr Cliff Tipler, the applicant is proposing to leave much of the drowned indigenous forest in-situ (the proposal is to clear c. 84 ha of the c. 210 ha between RL 67m and RL 105, the latter being the highest level, it is suggested, at which trees could be affected by floods. Mr Tipler's figure at Paragraph 9.10 shows that all trees protruding above the minimum operating level of 97m RL will be felled, with further clearance down to 92m RL. Mr Tipler's text, however, also refers to dead trees that will protrude through the lake surface, so it is not clear what will actually remain. Mr Tipler's evidence, however, also contains a map (Figure 6) showing that trees will be cleared from most of the shoreline. The evidence of Mr Peter Rough (Paragraphs 10.25 to 10.41) places considerable emphasis on the supposedly natural appearance of drowned forest on lake margins. My experience at Lake Waikaremoana, where a natural landslide formed the lake and drowned existing indigenous forest more than 2000 years ago, is that tree trunks will remain standing and in place for the life of the impoundment (2000 year-old tree trunks were felled in large numbers at Waikaremoana to remove the navigational hazard they comprised). It is not clear, in my view, from the evidence of Mr Tipler and Mr Rough, exactly what will be left standing on the lake margins.

13.4. Another example of the length of time for which plant material will persist is Lake Monowai. This is a large lake in the southern part of Fiordland in the southern part of Fiordland National Park, which was raised *c.*2 m in 1925. Stumps from dead trees drowned when the lake was formed are still present on the lake margins, 87 years after the lake was raised.

14. CLIMATE CHANGE

14.1. In achieving the purpose of the RMA, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to, among other matters, the effects of climate change.

14.2. Climate change effects on natural ecosystems and habitats are uncertain, including rates of change and effects on specific biota and biotic assemblages. In a recent review of potential effects of climate change on New Zealand's biodiversity, Lundquist *et al*. (2011)[20] concluded:

> "While other threats are responsible for historical impacts on biodiversity, future climate change is

[20] Lundquist C.J., Ramsay D., Bell R., Swales A., and Kerr S. 2011: Predicted impacts of climate change on New Zealand's biodiversity. *Pacific Conservation Biology 17*: 179-191.

> predicted to act synergistically with existing threats. As such, minimizing other impacts may allow ecosystems to be more resilient, in the face of an uncertain future due to changes in climate."

and

> "We do not understand enough about most species to predict changes in species abundances and distributions; the timing of species life cycles; interactions among species; extinction rates; the structure and composition of communities; and ecosystem function. Further research is needed to develop general principles to predict changes to New Zealand's terrestrial and aquatic biodiversity to guide decision-making."

and

> "Climate change policies should address emissions reductions, as well as adaptation to predicted change. New Zealand's Emissions Trading Scheme is contributing to the reduction of emissions, while also reducing biodiversity loss by making deforestation less cost-effective (Karpas and Kerr 2011). <u>Reduction of other human impacts</u> (Kingsford *et al*. 2009) <u>will be a good strategy, as pristine systems are more resilient to climate change impacts</u> (Watson *et al*., in press)." [My emphasis in underlining.]

14.3. Uncertainty about the effects of climate change on natural systems and biota is, in my view, sufficient justification to take a cautious approach to indigenous deforestation, biodiversity loss, and modification of intact natural ecosystems, all of which are effects of the MHP, and which should, therefore, be avoided.

15. ADEQUACY OF MITIGATION

15.1. It is essential to comprehensively and objectively assess whether all potential effects have been addressed, which I have summarised using the lists of effects in Tables 2-4. The tables below provide the same lists of ecological processes and ecological features to be affected as presented above in Tables 2-4.

15.2. For each ecological process and feature to be affected, an assessment is provided as to whether mitigation of that specific process or feature is to be provided and, on that basis, an assessment is provided as to whether a net gain or loss is likely for that factor.

15.3. Assessment of whether a net gain or loss is likely to be achieved is based on evaluation of the mitigation package proposed by the applicant, as described in the evidence of Dr John Parkes, Mr Fred Overmars, Dr Graham Ussher, and Dr David Norton. Direct comparisons were made of each ecological process and feature.

15.4. My comparisons are based on an assessment of like-for-like. For example, where loss of lowland forest is to occur, is replacement of that forest with similar forest type proposed, on similar landform and soils, and within the same bioclimatic zone. Adequacy of mitigation should be evaluated (and delivered) on a like-for-like basis, otherwise diversity will be lost and biodiversity that is more difficult to conserve becomes replaced by diversity that is commonplace and easy to conserve, and the full range of biodiversity will become even more eroded.

15.5. Ecological processes in the Mokihinui Gorge to be affected by the project are set out in Table 6:

Table 6: Ecological processes to be affected in the Mokihinui Gorge, the degree of potential adverse effect, whether mitigation is to be provided (to address each specific effect), and an assessment of whether a net gain or loss will be achieved for each process.

Ecological Process	**Degree of Adverse Effect**	**Mitigation Provided**	**Net Gain or Loss**
Loss of riverine processes that have created and maintain habitat for: - Indigenous fish; - Avifauna; - Invertebrates.	 Major Major Major	 None None None	 Loss Loss Loss
Loss of flood-driven processes that have formed and govern the riparian zone.	Major (total loss)	None	Loss
Flood-driven genetic interchange between *Powelliphanta* populations on different sides of the river.	Major (total loss)	None	Loss
Carbon sequestration: - Soil; - Vegetation.	 Major Major	 None None	 Loss Loss
Seasonal use, by mobile fauna, of key habitats on alluvial terraces to be flooded.	Major (total loss)	None	Loss
Upstream migratory use of river gorge by indigenous fish.	Major (total loss)	Trap and transfer	Loss
Downstream migratory use of river gorge by indigenous fish.	Major disruption	None	Loss

15.6. A list of effects on specific ecological features in the Mokihinui Gorge is set out in Table 7:

Table 7: Ecological features to be affected in the Mokihinui Gorge, degree of potential adverse effect, whether mitigation is to be provided (to address each specific effect), and an assessment of whether a net gain or loss will be achieved for each feature.

Ecological Feature	Degree of Adverse Effect	Mitigation Provided	Net Gain or Loss
Soil and litter habitat	Major	None	Loss
Riparian zone (turf, shrubland, seepage wetlands)	Major (total loss)	None	Loss
Terrestrial Vegetation			
1. Rimu-nothern rata-[matai]/ broadleaved forest	Major	None	Loss
2. Rimu-[kahikatea]/toro-kamahi forest	Major	None	Loss
3. Kahikatea-rimu-matai-silver beech forest	Major	None	Loss
4. Rimu-hard beech-[silver beech] forest	Major	None	Loss
5. [Rimu-matai-miro]/hard beech forest	Major	None	Loss
6. [Rimu]/hard beech/kamahi forest	Major	None	Loss
7. Strongly modified rimu-northern rata-matai/broadleaved forest	Moderate	None	Loss
8. Kamahi/broadleaved forest	Moderate	None	Loss
9. Regenerating rimu/broadleaved forest	Minor	None	Loss
10. Regenerating [kahikatea]/broadleaved forest	Moderate	None	Loss
11. Regenerating broadleaved forest	Moderate	None	
12. Tutu scrub	Minor	None	Loss
13. Recent landslide vegetation	Moderate	None	Loss
14. [Toro]/hard rush/browntop grassland	Minor	None	Loss
15. [Kahikatea]/*Coprosma tayloriae*-rohutu/ bracken fernland	Minor	None	Loss
16. Tall oat grass grassland	Minor	None	Not relevant
Avifauna			
Forest birds	Major	Yes	Gain[21]/

[21] Based on the evidence of Dr Ussher.

[22] Based on the evidence of Dr O’Donnell.

			Loss[22]
Gorge habitat for grey duck	Major		Loss
Whio, including four pairs (and single)	Major	Yes	Loss[23]
Gorge habitat for whio (blue duck)	Major	No	Loss
Gorge habitat for black shag	Local	No	Loss
Bats			
Long-tailed bat habitat	Major	No	Loss
Lizards			
Lizard habitat	Major	No	Loss
Land Snails			
Powelliphanta lignaria unicolorota	Major	Yes	Loss
Powelliphanta lignaria lusca	Moderate	Yes	Loss
Powelliphanta lignaria	Moderate	Yes	Loss
Powelliphanta ruforadiata	Moderate	Yes	Gain
Other Terrestrial Invertebrates	Major (loss of 300 ha of habitat)	No	Loss
Aquatic Habitat			
Invertebrates (124 taxa)	Major	None	Loss
Indigenous fish (13 taxa)	Major	None	Loss

Note: Potential effects on habitats and species downstream of the proposed dam site are not included above.

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[23] Based on the evidence of Dr O'Donnell.

15.7. Ecological processes to be affected by the transmission line are set out in Table 8:

Table 8: Ecological processes to be affected by the transmission line for the Mokihinui Hydroelectricity Project, The degree of potential adverse effect, whether mitigation is to be provided (to address each specific effect), and an assessment of whether a net gain or loss will be achieved for each process.

Ecological Process	Degree of Adverse Effect	Mitigation Provided	Net Gain or Loss
Creation of canopy gaps, 'resetting' of successional sequences and providing sites for weed establishment.	Local	None	Loss
Edge effects in indigenous forest.	Local	None	Loss
Edge effects in indigenous shrubland.	Local	None	Loss
Fragmentation of *Powelliphanta patrickensis* habitat.	Moderate	None	Loss
Fragmentation of *Powelliphanta lignaria johnstoni* habitat.	Moderate	None	Loss
Fragmentation of *Powelliphanta lignaria rotella* habitat.	Moderate	None	Loss
Predator use of foot and vehicle tracks.	Local	None	N/A

15.8. A list of effects on specific ecological features to be affected by the transmission line is set out in Table 9:

Table 9: Ecological features to be affected by the transmission line for the Mokihinui hydroelectricity project, the degree of potential adverse effect, whether mitigation is to be provided (to address each specific effect), and an assessment of whether a net gain or loss will be achieved for each feature.

Ecological Feature	Degree of Adverse Effect	Mitigation Provided	Net Gain or Loss
Coal measures forest	Major	None	Loss
Coal measures scrub	Major	None	Loss
Coal measures pakihi	Major	None	Loss
Great spotted kiwi	Minor		Loss (of habitat)
Fernbird	Minor		Loss (of habitat)
Weka	Minor		Loss (of habitat)
New Zealand pipit	Minor		Loss (of habitat)
Lizards	Minor		Loss (of habitat)
Powelliphanta patrickensis	Major	None	Loss
Powelliphanta lignaria johnstoni	Major	None	Loss
Powelliphanta lignaria rotella	Major	None	Loss

15.9. A summary of the numbers of ecological processes and features to be affected is set out below:

Table 10: Summary of indicative scale of ecological processes and features to be affected by the proposed Mokihinui Dam, reservoir, and transmission line, and an assessment of whether like-for-like mitigation is to be provided.

	Mokihinui Gorge		**Transmission Line**	
	Loss	**Gain**	**Loss**	**Gain**
Ecological Processes	7	-	7	-
Ecological Features	28	2	11	-

15.10. The exact numbers presented in Table 10 are not important as, for example, this summary does not recognise the number of aquatic invertebrate taxa to be affected, the number of fish species, the numbers of vascular and non-vascular plants, or the number of soil biota. This assessment also does not include potential effects on ecosystems, habitats, and species downstream of the proposed dam site. There is also debate over whether effects on forest birds will result in a net gain, as set out in the evidence of Dr Colin O'Donnell.

16. OVERVIEW OF EFFECTS AND MITIGATION

16.1. The mitigation package put forward by Meridian clearly does not address all of the adverse effects, with no mitigation offered at all for the complete destruction and loss of the high value aquatic components of the river gorge ecosystem. This is a particularly major deficiency.

16.2. For the ecological processes identified in Tables 6 and 8 above, my assessment is that there will be a net loss of nearly all of them (one is not relevant in terms of net loss).

16.3. For the numerous specific ecological features identified in Tables 3 and 5 above, my assessment is that there will be a net loss of most of these.

16.4. There are some fundamental reasons why the degree of net loss is so marked:

- No mitigation at all is provided for the particularly significant loss of aquatic habitats and riverine-related ecological processes.

- Much of the focus of the mitigation is habitats upstream of the Mokihinui Forks. While having some ecological merit, this package of works, largely related to cyclical aerial application of 1080, does not directly address the particular features to be lost within the impoundment footprint.

- The proposal to protect and enhance Waimangaroa Bush, while having some merit in ecological terms, is a different ecological system, on sand dunes, and provides no additionality. It does not address the permanent destruction of a very large area of high quality lowland forest in the river gorge.

16.5. There is obviously a considerable disjunct between the views of the Department's witnesses and those for Meridian in relation to the types of effects and whether effects are adequately mitigated by the proposed BEA. I suggest that this is because Meridian has provided an incomplete assessment of environmental effects, and that its deficiencies are reflected in the evaluation and design of the proposed mitigation, leading to an overall failure to either properly mitigate the full range of impacts on biodiversity or, alternatively, to recognise effects that would become an environmental cost of the project.

16.6. I find the evidence of Dr Bill Lee to be particularly illuminating. Dr Lee, in his consideration of the biodiversity to be affected, in my view, has attempted to address key concepts such as ecosystems and ecological processes, although his assessment is also underpinned by an inadequate assessment of environmental effects and inadequate data describing biodiversity to be affected.

16.7. My conclusion in relation to the inability to provide mitigation for the proposal is supported by the evidence of

Dr Lee, who recognised the following residual 'direct' impacts:

- Reduction of population size of threatened species;
- Reduction of area of ecosystems or habitats;
- Change in key processes.
- New disturbances/resources to sustain pest animal species.
- New conduits for pest animal invasion;
- Increased risks for pest plant invasion.

16.8. Dr Lee's assessment found "substantial residual biodiversity impacts" that required offsetting at different levels of biodiversity, such as river system, habitat, species, and populations.

16.9. His conclusion was that "several management actions required to offset the residual impacts appeared to be unattainable, reflecting the **biodiversity values** of the impacted area, the **absence of comparable riverine systems** that could be restored, and the **uncertainty and time involved in the protection of these values elsewhere**."

16.10. Dr Lee has made three key points in his statement (as I have emphasised in bold above), all of which I agree with. It is clear from the evidence presented for the Department of Conservation and other parties, including Meridian, that the site has extremely high biodiversity values.

16.11. I am not aware of a comparable river system that could be restored to address adverse impacts on the Mokihinui, and a witness for Meridian also acknowledges that this is the case.

16.12. My view in relation to Dr Lee's third point about "protection of these values elsewhere" is that the mitigation package put forward by Meridian does not address protection of the same values elsewhere, and is therefore not like-for-like offsetting, as discussed in the evidence of Dr van Meeuwen-Dijkgraaf. I share the concerns identified by Dr Lee in relation to residual impacts, as these effects are very considerable and are a major 'cost' to biodiversity. Analysis by Dr van Meeuwen-Dijkgraaf of the offsetting approach used by Meridian has shown that not one of the ten Business in Biodiversity Offsets Programme (BBOP) has been met.

16.13. My concerns about the adequacy of the mitigation package have been added to by the analysis of Dr Langford who has demonstrated, for key elements of the offset model of Dr Ussher, that uncertainty exists as to whether Dr Ussher has produced a soundly-based model.

17. COMMENTS ON THE EVIDENCE OF DR DAVID NORTON AND DR USSHER

17.1. At Paragraph 2.4.6 Dr Norton states that he has used the following definition of 'biodiversity' in his evidence: "those species that are indigenous to New Zealand, including both endemic and non-endemic indigenous species". Dr Norton's definition contrasts markedly with the definition in the RMA[24], which encompasses 'species', 'ecological complexes', and

[24] And the definition in the Convention on Biological Diversity.

‘ecosystems’, and is consistent with the definition in the New Zealand Biodiversity Strategy (2000). By contrast, Dr Norton’s definition is solely species-based and species-focused, which, in my view, is a very simplistic and deficient view of what comprises biodiversity.

17.2. At Paragraphs 5.17a,b, and c, Dr Norton states that only four “biodiversity impacts of the MHP on terrestrial indigenous biodiversity can be regarded as significant”:

- Coal measures ecosystem;
- Grey duck;
- Riparian communities (including seeps);
- Snails, specifically *Powelliphanta lignaria unicolorata*.

17.3. I provide the following comments on Dr Norton’s assessment of ‘significant’ effects:

Coal Measures Ecosystem

- I agree with his evaluation of the significant adverse effects on coal measures vegetation, and agree with his statement that the area to be affected is “the best remaining example of this naturally uncommon ecosystem which is highly threatened nationally”. I note that, at Paragraph 6.21, Dr Norton states strongly that his preference is that the transmission line does not cross this area, and he sets out sound reasons for his views, which I agree with. It is particularly notable that Dr Norton considers this area to have “naturally significant natural values,” sufficient to warrant avoidance of incremental adverse effects associated with the proposed transmission line.

Grey Duck

- Grey duck is a **water bird** that utilises lakes, ponds, coastal lagoons, rivers, and streams, including remote rivers and headwater streams. I am therefore somewhat surprised that Dr Norton has included grey duck within his assessment as an effect on **terrestrial** indigenous biodiversity. In his view, the "significant" impacts on grey duck only relate to the likely future use of the impoundment by mallard duck, leading to even more hybridisation between grey duck and mallard duck. He does not mention the loss of the 22.9 km of river and stream **habitat** as a significant adverse effect on grey duck (or blue duck, or black shag, or other shag species).

Riparian Communities (including Seeps)

- I agree with Dr Norton's assessment that impacts on riparian communities will be "significant". I also note that he includes seeps within his considerations of riparian communities, which I consider to be wetlands rather than terrestrial systems, the term he uses for these systems, as already noted. Dr Suren also refers to the significance of the seeps in his evidence, as already discussed.

Snails - Powelliphanta lignaria unicolorata

- Dr Norton considers that impacts on *Powelliphanta lignaria unicolorata* will be "significant" on the basis that "this taxon appears to be rapidly declining in abundance". Ms Walker addresses this matter in her evidence but I find it surprising that Dr Norton has not considered the *Powelliphanta* population in relation to ecological processes, rather taking only a species-based view of significance.

17.4. Overall, in his summary of significant effects, I am surprised that Dr Norton makes no mention of the permanent loss of nearly 300 ha of lowland forest (and soil habitat) as being a significant adverse effect.

17.5. Likewise, he makes no mention of the significant adverse effects associated with:

- Loss of podocarp forest on alluvial terraces, or lowland forest with a significant element of northern rata.
- the permanent loss of 14 km of riverine gorge ecosystem.

17.6. With the exception of his assessment of significant effects on the “coal measures ecosystem” and “riparian communities (including seeps)”, Dr Norton’s assessment of significant impacts is limited to only two species. Even for those species, he does not mention significant loss of habitat (grey duck) or loss of ecological processes (*Powelliphanta*). As such, it is my view that Dr Norton has not adequately considered and taken account of effects on biodiversity as defined in the RMA.

17.7. Dr Norton’s conclusion appears to contradict his own assessment at Paragraph 3.1:

> “The MHP impact area contains significant indigenous vegetation and significant habitats of indigenous fauna in terms of the criteria listed in the West Coast Regional Policy Statement and the Buller District Plan.”

17.8. I agree with this statement, as do other witnesses for Meridian, the Department of Conservation, and other parties.

17.9. I note that Dr Ussher has used the same approach as Dr Norton and my view is that he has also provided an incomplete and inadequate assessment of biodiversity in relation to the RMA. Dr Norton provides a lengthy treatise (Paragraphs 6.1-6.45) on his approach to biodiversity offsetting. At Paragraph 6.33 he highlights three biodiversity offset principles that he considers to be particularly relevant to the MHP:

- Additionality;
- Like-for-like;
- Time and uncertainty guarantees.

17.10. In Paragraph 6.34, he goes on to state that, based on the evidence of Dr Ussher in relation to the biodiversity offset model, that "it is clear that the BES represents a like-for-like offset for most of the values that are impacted by the MHP". He goes on to state that he and Dr Ussher both consider that the biodiversity gain from the BES is "considerably greater than the loss associated with the MHP", with only two effects not able to be offset: grey duck and riparian communities. As already stated above, my view is that both Dr Norton and Dr Ussher have applied an incomplete, and inadequate analysis of what will amount to very significant adverse effects on biodiversity, and aquatic-related components in particular. Their inadequate analysis appears to have enabled them to conclude that the BES addresses like-for-like, and that biodiversity gains exceed losses, neither of which is correct.

17.11. Overall, Dr Norton's views are contrary to the definition of biodiversity in the Resource Management Act 1991 (and the NZ Biodiversity Strategy 2000), and this is shown by the definition of biodiversity that he has used.

17.12. In the above section (Tables 6-9) I show that quite a number of biodiversity elements are not addressed by the mitigation proposed and, as a result, will suffer a net loss.

17.13. As a result, application of Dr Norton's and Dr Ussher's approach to effects on biodiversity will result in a substantial net loss of biodiversity, and Dr Norton's concluding statement at Paragraph 7.2 ("the BES will result in substantial improvements in indigenous biodiversity at a local, regional, and national scale") is seriously flawed.

17.14. At Paragraph 6.32 Dr Norton states that: "The scale and scope of animal pest control proposed here is perhaps unprecedented on the New Zealand mainland". At Paragraph 3.6, he states that "Without the BES, indigenous biodiversity will continue to decline within the Mokihinui catchment, including both the impact and biodiversity enhancement areas, and will eventually result in the **extinction of a number of key species from this area**". [My emphasis in bold.] The existence of relatively large control operations is relatively well-known amongst pest control experts and ecologists who work frequently in the pest control area, although few such people probably know the specifics of many operations due to the considerable number and scale of initiatives now in place. These operations are undertaken by the Department of Conservation, Regional Councils, and the Animal Health Board, sometimes jointly. Large private landowners are also starting to undertake reasonably large operations, sometimes to complement wider-scale operations undertaken by the agencies mentioned above.

17.15. In the North Island, the now long-standing Northern Te Urewera Ecosystem Restoration Project (in Te Urewera National Park) encompasses 50,000 ha. A tabulated summary of other examples of reasonably large scale pest animal control operations is set out below:

Operation Name	Location	Area (ha)
Hauhungaroa	Hauhungaroa Ranges	51,977
Kia Wharite-Mangapurua	Whanganui National Park and surrounds	180,000
Project Kaka	Tararua Forest Park	29,365
Waitutu possum control	Waitutu forest, Southland	25,000
Coromandel Peninsula: Moehau, Whenuakite	Coromandel Peninsula	41,000
Tongariro kiwi sanctuary/whio security site	Tongariro Forest	20,000
Milford Area	Fiordland National Park	65,000
Dart-Caples	Fiordland National Park	70,000

17.16. The evidence of Mr Terry Farrell shows that the Department of Conservation, and other parties, are currently undertaking the following pest animal control on the West Coast:

- Mokihinui catchment:
  - South Branch (entire sub-catchment) - aerial and ground-based goat control (DOC) - 28,000 ha;
  - North Branch (entire sub-catchment) - aerial and ground-based goat and deer control (Solid Energy NZ) - 28,700 ha;
  - Māori Gully - ground and aerial possum and rat control (DOC) - 1,100 ha;
  - South Mokihinui ground or aerial possum control (DOC) - 1,865 ha.
- Buller area:

- Feral goat control (DOC) - 59,366 ha;
- Possum and rat control (DOC) - 45,845 ha;
- Possum and rat control (Animal Health Board) - 162,858 ha;
- Possum, rat, and stoat control (Solid Energy NZ) - 585 ha;
- Stoat control (DOC) - 112 km of trap lines.

▪ Other West Coast pest control:

- Goats (DOC) - 92,607 ha;
- Possums and rats (DOC) - 249,349 ha;
- Possums (AHB on DOC land) - 418,201 ha;
- Stoats (DOC) - 21,000 ha.

▪ Total extent of pest control:

- Goats - 208,673 ha;
- Possums and rats - 877,938 ha;
- Stoats - 30,000-40,000 ha.

17.17. Mr Farrell's evidence demonstrates that in the vicinity of one million hectares of West Coast conservation land is currently under active management to control pest animals[25].

17.18. Dr Norton's comments appear to indicate that he is out of touch with the operational scale of pest animal control

[25] Including recognition that there is an overlap of *c.*100,000 ha between possum and goat control operations (Mr T. Farrell, Department of Conservation, pers. comm.).

being undertaken in Buller, on the wider West Coast, and elsewhere in New Zealand.

17.19. At Paragraph 7.1, Dr Norton states:

> "It is important to acknowledge that without the BES, indigenous biodiversity will continue to decline across the *ca.* 35,300 ha of the proposed offset area, as well as in the MHP impact area, which will result in a net-loss of biodiversity locally, regionally and nationally."

17.20. Dr Norton does not appear to acknowledge that 56,700 ha of the Mokihinui catchment is already under active management to control feral goats and/or deer, with *c.*3,000 ha under active intensive management to control possums and rats to protect large land snails and other biodiversity. This is a very significant level of active management, equivalent to intensive management of a reasonable-size core (3,000 ha) 'mainland island' site, with control of large pest browsers across nearly 60,000 ha.

17.21. When considered within the context of existing pest control within the Mokihinui catchment, and more widely on the West Coast, Dr Norton's very strongly-presented conclusion that "without the BES" biodiversity will continue to decline and will result in a net loss at local, regional, and national scales is without foundation. His concerns about the need to avoid biodiversity loss are noted, but his suggested approach will, if implemented, result in the destruction of an outstanding example of the very biodiversity that he states that he is concerned about. With such management already in place, there is no evidence to support Dr Norton's claim (in his Paragraph 3.6) of the impending extinctions of key species in the catchment.

17.22. As noted by Dr Leathwick, it is also very likely that the Mokihinui catchment will also receive increased investment in biodiversity enhancement from the Department of Conservation.

18. COMMENTS ON THE EVIDENCE OF DR PAYTON AND DR USSHER

18.1. At Paragraph 5.11, Dr Ussher states: “For all of these reasons, I regard that [sic] the NZFS maps provide a greater degree of confidence in the classification of forest classes for the MHP for my purposes” [my emphasis by underlining]. It may suit Dr Ussher’s purposes to use that mapping system (i.e. Franklin and Nicholls 1989) but his reasons for doing so are flawed, for the following reasons:

- Franklin and Nicholls (1989) is only a very broad representation of the vegetation within the project area, at a scale of 1:250,000.

- Dr Ussher obviously does not understand how this map will have been compiled. In Franklin and Nicholls (1989) it is stated:

> “The accompanying map is one of a series showing the broad classes of indigenous forest in New Zealand. Each map covers a more or less distinct ecological region.
>
> This illustration of the forest pattern is based on sampling and reconnaissance records of the New Zealand Forest Service volumetric survey (Thomson, 1946; Masters *et al*., 1957) and ecological survey (New Zealand Forest Service, 1957; Nicholls, 1977a), plus some recourse to publications by Druce *et al*. (1987),

Esler (1962), Park and Walls (1978), Rose (1985) and Wardle (1970)."

18.2. My experience with this mapping series[26] is that this map will have been compiled entirely by aerial photograph interpretation, utilising the above information sources where relevant.

18.3. My view is supported by the fact that there are no New Zealand Forest Service National Forest Survey or Eco-Survey plots within the area to be affected by the dam and the impoundment.

18.4. Dr Ruth Bartlett, for the resource consent application, obviously considered that a more detailed classification and map was required, and produced a vegetation map at a scale of 1:22,000 (i.e. 10 times the level of resolution of Franklin and Nicholls 1989).

18.5. Also for the consent hearing, Dr Kelvin Lloyd produced an even more detailed classification and map at a scale of 1:50,000, but which had been mapped using aerial photographs at a scale of 1:5,000, supported by extensive ground-truthing. This map has 50 times the level of resolution of Franklin and Nicholls (1989).

18.6. It is notable that Franklin and Nicholls (1989) show only one broad forest class (rimu-general-hardwoods-beeches) covering almost all of the area to be inundated, with only one minor additional area of general hardwoods-beeches (which Dr Lloyd shows has been mapped incorrectly). This illustrates the very broad nature of this level of forest

[26] While employed as the scientist responsible for the series at the Forest Research Institute in the 1980s,

mapping, as, for example, not even the abundant podocarps on alluvial terraces are shown, nor the abundant northern rata in the lower gorge.

18.7. I find it very difficult to understand why Dr Ussher has rejected the classifications and mapping undertaken at a scale of 1:5,000 in favour of a very broad representation of forest pattern at a scale of 1:250,000.

18.8. In Paragraph 5.11, Dr Ussher states: "The classification applied by Dr Payton provides a systematic, plot-based method for discriminating between plot information, but is not able to define types spatially to give areas occupied by each type within a given footprint (which is an essential requirement of the Habitat Hectares modelling method)." Dr Ussher doesn't appear to understand that, for Dr Payton to have produced a spatial vegetation map, using his plot data, to "give areas occupied by each type within a given footprint" then he would have to have used either good quality aerial photographs or satellite images to apply his data within a spatial context. It is also likely that he would also have needed to ground-truth any such map, in addition to the interpretation of any plot data used for mapping purposes.

18.9. Franklin and Nicholls (1989) clearly state that their map shows "the broad classes of indigenous forest in New Zealand" and that "each map covers a more or less distinct ecological region." They also state that their broad forest classes "are groups of forest cover types with one or more important features in common." Forest mapping in New Zealand, as undertaken by the New Zealand Forest Service was based on a hierarchy of classification, with broad **forest classes** mapped at 1:250,000 (e.g. Franklin and Nicholls 1989) and **forest types** mapped at 1:63,360. The statements above ("are groups of …. forest cover types") clearly indicates that there would be more detailed units encompassed within the broad forest classes. My view is that a good forest ecologist with experience in mapping would be able to delineate those more detailed types within the project area. The absence of such mapping from Dr Ussher's analysis is a serious flaw.

18.10. I note that Dr Lloyd has now updated and further refined his vegetation mapping and also extended it to include the upper catchment, including the BEA. This type and scale of mapping is essential and should have been provided by Meridian, as a minimum requirement to underpin an objective assessment of effects for a project of this type.

19. SCALE OF ECOLOGICAL EFFECTS OF OTHER HYDRO DEVELOPMENT

19.1. Major river-based hydro-electricity developments built in the South Island include the Clyde Dam (432MW, 1992) and upper Waitaki (Ohau A: 264 MW, 1980; Ohau B: 212 MW, 1984; Ohau C: 212 MW, 1985) schemes. These schemes had major adverse effects on riverine ecosystems.

19.2. In the North Island, the Waikato River system has been developed throughout its middle and upper reaches, and there is even a small dam (6 MW, 1952-1982) on the Hinemaiaia tributary of Lake Taupo. Generation capacity for the Waikato catchment (including the Tongariro Power Scheme), overall, is more than 1400 MW.

19.3. The Rangipo component (120 MW) of the Tongariro Power Scheme was commissioned in 1983, while the Tokaanu component (240 MW) was commissioned in 1973. The Tongariro scheme takes water from tributaries of the Rangitikei (Moawhango), Whangaehu, Whanganui, Whakapapa, and Tongariro Rivers, resulting in significant dewatering of upper catchments and loss of fish passage and ecological connectivity, but did not create a river impoundments and drowning of terrestrial ecosystems was largely avoided (one impoundment was created - Lake Otamangakau - but that was not a river-based impoundment).

19.4. River gorges on the middle reaches of the Waikato River have a series of eight dams - Arapuni, Aratiatia, Atiamuri, Karapiro, Maraetai, Ohakuri, Waipapa, and Whakamaru - with a combined output more than 1000 MW, that were built between 1929 and 1970, resulting in the significant loss of riverine gorges, terrestrial forest, geothermal ecosystems, and major loss of ecological connectivity and fish passage.

19.5. Many smaller individual schemes, in terms of relative generation capacity, have also been developed on various other rivers throughout New Zealand.

19.6. None of the developments outlined above are located in such a sensitive lowland forested environment comparable with the Mokihinui project, or is embedded within the ‘heart’ of a protected natural area.

19.7. Schemes within such otherwise largely intact natural areas, including Manapouri (850 MW, 1971) and Lake Waikaremoana (138 MW, 1929 - 1948), are older schemes, built at a time of lesser ecological awareness, but even they resulted in less ecological effects than what is proposed for the Mokihinui.

19.8. The Patea scheme (30 MW, 1984), between Wanganui and New Plymouth is located in a matrix of indigenous vegetation and farmland. This dam is 82 metres tall, the fourth highest in New Zealand. The dam impounds Lake Rotorangi, the longest constructed lake in New Zealand (43 km), and will have resulted in significant effects on fish passage. The same applies to the Rangitaiki River, which has two dams.

19.9. To develop a better understanding of the scale and type of effects of hydro schemes built to date, the Freshwater Environments of New Zealand (FENZ) database was analysed to evaluate the distances of existing dams from the coast, as set out in Table 11 below.

Table 11: Distances of existing New Zealand Hydro-electricity Schemes from the coast.

Hydro Scheme	Distance from Coast (km)
Patea	44
Mokau - no impoundment	88
Wanganui h/waters	300
Tongariro upper	420
McLarens Falls	12, 25, 28
Rangitaiki - Matahina	35
Rangitaiki - Aniwhenua	62
Waikaremoana	78
Waikato - Aratiatia	320
Waikato - Karapiro	150
Moawhango	206
Wairau (Marlborough)	87
Waihopai	60
Coleridge	98
Rangitata	62
Waitaki	71
Clutha - Clyde	172
Clutha - Roxborough	131
Wairau (Southland)	95
Kapitea (Kumara)	14
Arnold	34

19.10. Only two of the existing hydro schemes listed above, McLarens Falls and Kapitea (Kumara), are within 20 km of the coast, and these are both small schemes on small waterways with limited ecological values. By comparison, the proposed Mokihinui dam site is only 12 km from the coast, and the proposed reservoir will extend a further 14 km inland. It is readily evident, from Table 11, that all other large river impacts resulting from hydro dams are much further inland. This is an important consideration in terms of potential impacts on migratory fish species as, for example, eight out of 15 species have preferred optimal habitat that is within 20 km of the coast (Leathwick *et al*. 2009[27]).

19.11. Only a further two schemes, Rangitaiki and Patea, are within 50 km of the coast. Both of these schemes have had major effects on fish passage, but they did not affect a suite of other ecological values comparable in type or scale to Mokihinui.

19.12. The proposed location of the Mokihinui dam, 12 km from the coast will, potentially, be the most damaging hydro-electricity dam ever constructed in New Zealand in terms of effects on migratory fish species.

19.13. The FENZ database was also analysed to search for other major dams or structures associated with water supply, irrigation, and/or water abstraction. Significant examples are set out in Table 12:

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[27] Leathwick J.R., Elith J., Rowe D., and Julian K. 2009: Robust planning for restoring diadronous fish species in New Zealand's lowland rivers and streams. *New Zealand Journal of Marine and Freshwater Research 43*: 659-671.

Table 12: Examples of New Zealand water supply dams and distances from the coast.

Location	Distance from Coast (km)
Wellington	
- Kaitoke	43
- Orongorongo	22
- Wainuiomata	28
Palmerston North	
- Mangahao	85, 180
Auckland	
- Hunua	25, 25, 75, 83
- Waitakere	6.5, 6.6, 15
Opuha	65

19.14. Although some of these are close to the coast, they are located on relatively small waterways, which lack the values of the Mokihinui.

19.15. At least 12 other hydro proposals have already been consented or are currently under consideration, with a combined potential output of more than 400 MW.

19.16. With the exception of the hydro development on the Waikato river system, to my knowledge, none of the above projects involve a scale of overall adverse ecological effects equivalent to the Mokihinui project. Some projects have resulted in very significant adverse effects on riverine ecosystems (e.g. Waitaki, Clutha, Waiau), others have raised or lowered existing lakes (e.g. Monowai, Waikaremoana, Pukaki, Tekapo), but none have affected a suite of riverine and terrestrial ecosystems, habitats, and threatened species on the scale of the Mokihinui proposal.

19.17. Based on the above analysis, the very considerable adverse ecological effects of the Mokihinui proposal appear disproportionate to its modest electricity output (100 MW maximum capacity). The scale of adverse effects also needs to take other factors into account, such as the loss of carbon sequestration, which have not been addressed.

20. ECOLOGICAL EFFECTS OF OTHER (NON-HYDRO) LARGE SCALE ENERGY DEVELOPMENT

20.1. I note that other large scale energy developments are being proposed and consented in New Zealand, and development undertaken to date demonstrates, in my opinion, that it is not necessary to incur major adverse ecological effects when such developments are undertaken.

20.2. There are at least 11 operational geothermal power stations in New Zealand, which a combined output potential of 750 MW, and a further two are under construction with a potential combined output of 248 MW.

20.3. There are at least 14 operational wind farms, commissioned since 1993, with a combined output of more than 600 MW. Two wind farms are either being built or expanded, to add a further 17 MW. A further 10 wind farms are already consented, with a combined potential output of 850 MW.

20.4. Several other wind farms are proposed, with a potential combined output of more than 1000 MW. The proposed Castle Hill wind farm alone, in the northern Wairarapa, has a potential output of 600-800 MW. I have undertaken an ecological assessment of that project, for the applicant, and the ecological effects are very much less that the Mokihinui proposal and all potential adverse effects can be mitigated to result in no net loss of indigenous biodiversity (unlike the Mokihinui proposal). In fact the types and scale of mitigation to be provided for that project will result in a net gain for indigenous biodiversity[28].

21. OVERALL APPROACH BY MERIDIAN

21.1. My view is that the assessment framework used by Meridian to evaluate the merits of this particular project is seriously flawed. The work done is problematic at various levels:

- Lack of adequate recognition of the multi-level nature of biodiversity (e.g. ecosystems, habitats, and species).
- Lack of adequate recognition of particular ecological components (e.g. vegetation, land snails).
- A biodiversity offset model was constructed based on flawed accounting, incomplete ecological data and inadequate uncertainty analysis.
- Having regard to the evidence of Dr Langford, the offset model is technically deficient.

21.2. These flaws have ‘compounded’ through the evaluation process, with Meridian persisting with an application on the basis that most adverse effects are able to be mitigated.

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[28] The Castle Hill Wind Farm project could, in a worst case scenario, result in the clearance of *c*.66 ha of indigenous vegetation, mostly comprising secondary communities dominated by manuka and kanuka. No primary forest would be cleared. The mitigation package includes formal legal protection and intensive pest control across more than 500 ha, in addition to intensive monitoring, steam protection, and a range of other measures.

21.3. My view, and the views of other witnesses in this case (including some Meridian witnesses), is that most adverse effects are not able to be mitigated. Net ecological effects will result in a significant loss of biodiversity. This has been known by Meridian since at least 2007 (as shown by the evidence of Dr Lee).

21.4. A fundamental question remains - what should Meridian do based on the advice now before this hearing? My view is that it is not possible to produce a mitigation package for this particular proposal that will result in an acceptable level of impact, and that, as a result, the types and scales of adverse impact will be particularly severe.

22. CONCLUSIONS

22.1. I have considered the types and scales of ecological effects in relation to other hydroelectricity developments in New Zealand and have come to the conclusion that, with the exception of the Waikato Hydroelectricity System, no other development to date in New Zealand has involved the scale of combined loss of indigenous ecosystems and habitats now proposed for the Mokihinui. Based on its location, only 12 km from the coast and within a largely unmodified catchment, the Mokihinui is likely to result in a scale of adverse ecological effects on coastal and lowland environments beyond any other scheme built in New Zealand.

22.2. The proposed development is not a minor or cumulative impact on ecological features and values of low or moderate value. What is proposed is the permanent destruction of recognised key ecological features and fundamentally important ecological processes within formally protected natural areas, some of which has been under active management to protect and enhance key values for many years.

22.3. I am not aware of another single proposed development within, say, the last 30 years, that involves the scale and range of adverse ecological effects involved in the Mokihinui project that has been consented for a protected area, regardless of its status (i.e. type and level of formal protection).

22.4. Consideration of the types and scales of effects and mitigation proposed has led me to conclude that this proposal will result in major adverse ecological effects which will not be mitigated, and that the effects will result in a permanent and irreversible net loss of biodiversity.