IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by Meridian Energy Limited for resource consents for the Mokihinui Hydro Project

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STATEMENT OF EVIDENCE OF MARK CHARLES GRACE MABIN ON BEHALF OF MERIDIAN ENERGY LIMITED

ANDERSON LLOYD
LAWYERS
DUNEDIN

Solicitor: Stephen Christensen/
Philippa Jones

Level 10, Otago House
Cnr Moray & Princes Street,
Private Bag 1959,
DUNEDIN 9054
Tel 03 477 3973
Fax 03 477 3184

1. QUALIFICATIONS AND EXPERIENCE

1.1 My full name is Mark Charles Grace Mabin.

1.2 I have the following qualifications:

PhD (Physical Geography, University of Canterbury)

MSc (Geography, University of Canterbury)

BSc (Geography and Geology, University of Canterbury)

In addition I have completed the following university programmes:

Making Good Decisions certification programme for RMA decision makers (University of Auckland)

Advanced Resource Management Law (Lincoln University)

I am a member of the following bodies:

Resource Management Law Association

New Zealand Hydrological Society

New Zealand Geological Society

1.3 I have over 25 years of experience in the discipline of geomorphology and have undertaken research, university teaching and consulting activities in many parts of the world, and have authored or co-authored research papers and reports including 15 papers in internationally refereed scientific publications.

1.4 For the past six years I have been employed in the Christchurch office of URS New Zealand Limited where I am a Senior Associate Environmental Scientist. I have undertaken assessments of effects on the environment for existing and proposed large-scale infrastructure projects such as hydro-electric power schemes (for Meridian Energy, Contact Energy, and Mighty River Power), wind farms (for Meridian Energy), mines (Solid Energy, Xstrata Zinc), municipal wastewater treatment facilities and ocean outfall pipelines (for Ashburton District Council, Waimakariri District Council and Christchurch City Council). I provided evidence to the Resource Consent and Environment Court hearings regarding Meridian Energy's Project West Wind at Wellington, and Project Hayes in Otago.

1.5 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

2.1 I have been involved in the following work in relation to Meridian Energy Limited's (Meridian's) Mokihinui Hydro Project (MHP):

2.1.1 Mabin, M.C.G. (2007) *Geomorphic assessment of the Mokihinui River catchment area*. URS New Zealand Ltd report prepared for Meridian Energy Ltd. 22 p;

and I have prepared my statement of evidence in reliance on this work.

2.2 I have also reviewed reports of other experts giving evidence on behalf of Meridian relevant to my area of expertise, including:

2.2.1 Damwatch (2007) *Mokihinui Hydro Proposal Project Engineering Description*

2.2.2 NIWA (2007) *Mokihinui River Proposed Hydropower Scheme: Sediment Report*

2.2.3 Linetech (2007) *Mokihinui 110kv line: Tee Line from Mokihinui Hydro Generation Scheme Constructability Report*

2.3 I have reviewed the relevant submissions of others namely the submissions of:

2.3.1 M. Mathers on behalf of the Green Party of Aotoeroa/New Zealand Aoraki Province;

2.3.2 Frida Inta; and

2.3.3 Royal Forest and Bird Society Golden Bay Branch.

2.4 In undertaking my assessment I have analysed topographic and geological maps, reviewed scientific papers, analysed stereo aerial photographs and remote sensing imagery, and I undertook field work around the proposed dam site and in the lower parts of the Mokihinui Gorge.

3 SCOPE OF EVIDENCE

3.1 I have been asked by Meridian to prepare evidence in relation to the actual and potential effects of the MHP on the geomorphic environment. This includes:

3.1.1 Discussion of the landscape geomorphology of the northwest part of the South Island, and the Westport – Karamea regions within which the MHP occurs;

3.1.2 Describing the geomorphic environment that will be directly affected by the proposal; and

3.1.3 An assessment of the effects of the proposal on the geomorphic environment.

4 EXECUTIVE SUMMARY

4.1 The area within which the MHP occurs is in the northwest part of the South Island and is centrally located in a 15,000 km^2 region of mountain, basin and range, and hill country that is characteristic of the northwest Nelson and north Westland area. The geological and landform history of the project area has resulted in a landscape that is typical of this large part of the northwest South Island.

4.2 The specific area within which the MHP occurs is the Mokihinui region that comprises the Mokihinui and Ngakawau catchments, and part of the Waimangaroa catchment that together cover about 1,060 km^2. The major elements of this landscape comprise mountains, rugged hills, plateaux, inland basins, coastal plains and river valleys. Minor, but distinctive landscape elements include gorges and lakes. All of these features are typical of the whole northwest South Island region.

4.3 The total MHP footprint can be taken to comprise the dam, construction area and reservoir lake, and transmission line, pylons and access tracks. Altogether these features will have a footprint of some 4.5 km^2. The affected area will extend in a narrow corridor for 14 km along the Mokihinui Gorge to the dam area, and then for about 28 km down the Mokihinui Valley and into the Charming Creek Valley, across the Ngakawau Gorge and across the Stockton Plateau to the upper Waimangaroa River Valley.

4.4 The dam and reservoir lake will be situated in the Mokihinui Gorge and will create an environment analogous to a landslide dammed lake like Lake Perrine, a not uncommon feature in this region. Although some 14 km of the lowest slopes of the Mokihinui Gorge will be flooded, the bulk of the gorge landform will remain. The length of flooded gorge represents 10 % of the total length of gorges in the Westport-Karamea region. The total 4 km^2 footprint of dam and lake represents 0.5 % of the Mokihinui catchment landscape.

4.5 The transmission line will cross valley floors, rugged hills, gorges, and plateaux landscape types. It will run through the middle of about 385 km^2 of parts of the Mokihinui, Ngakawau and Waimangaroa catchments and the total 0.5 km^2 footprint represents about 0.1 % of the Mokihinui region landscape.

4.6 Therefore, the MHP will have a less than minor effect on the landscape geomorphology of the Mokihinui region. The total footprint (4.5 km^2) represents only 0.4 % of the Mokihinui region landscape area. The landform directly affected, the Mokihinui River gorge, is a type well represented in the region. The dam and resulting lake will be features not unlike other landslide dammed lakes that occur in this area.

4 THE PROPOSAL

4.1 I confirm my evidence is based on the project proposal as described in the Assessment of Environmental Effects and summarised in Appendix 1.

5 EXISTING GEOMORPHOLOGY

5.1 My assessment relates to the physical character of the landscape and addresses the Earth Science characteristics of the area in order to develop a geomorphic understanding of the mountains, hills, plateaux, valleys, coastal plain, gorges and lakes that comprise this landscape.

Regional Setting

5.2 In my description of the geomorphic environment I will refer to three broad areas in decreasing order of size:

5.2.1 *Northwest South Island*; which contains within it the

5.2.2 *Westport Karamea Region*; which contains within it the

5.2.3 *Mokihinui Region.*

I show these areas on Figure 1 accompanying my evidence.

5.3 *Northwest South Island.* The broad landscape geomorphology setting of the MHP is in the northwest part of the South Island. This approximately 15,000 km^2 area extends about 240 km from Golden Bay south-southwest to Greymouth, and about 70 km east from the Tasman Sea to the Southern Alps, Lake Rotoiti and Motueka.

5.4 Geologically this west Nelson and north Westland region lies to the west of the great Alpine Fault and thus granitic and sedimentary rocks occur widely. These rocks are different to the schist and greywacke rocks that dominate the bulk of the South Island on the eastern side of the fault.

5.5 This landscape has a characteristic suite of major geomorphic elements that includes mountains, rugged hill country, river valleys and broad basins, plateaux and coastal plains.

5.6 *Westport Karamea Region.* In the central parts of the northwest South Island landscape region, and sharing all of the typical landscape elements found there, I identify a coherent sub-region that I will refer to as the Westport – Karamea Region. This is bounded to the south by the Buller River and the Karamea River to the north, and extends inland from the Tasman Sea to the eastern margin on the Mokihinui catchment. The MHP is situated centrally in this region

5.7 The Westport – Karamea region covers some 2,200 km^2 extending approximately 75 km from the Buller River north to about Karamea, and approximately 35 km east into the Matiri Range in the mountains of southwest Nelson. It exhibits all of the major landscape elements found in the larger northwest South Island region.

5.8 *The Mokihinui Region.* The MHP comprises a dam and power station, reservoir lake, and transmission lines that will lie in parts of the Mokihinui River catchment (749 km^2), the Ngakawau River catchment (246 km^2), and the northern Waimangaroa River catchment (65 km^2). The total catchment areas within which the MHP occurs covers 1,060 km^2, although as I will discuss below, the actual footprint of the project in this landscape is less than 5 km^2. For the purposes of my assessment I will refer to these combined catchment areas as the Mokihinui region.

Geomorphology

5.9 The science of geomorphology is concerned with the landforms on the Earth's surface and the processes that shape them. Landforming processes include tectonic forces that cause the earth's crust to rise and fall, erosion processes that wear down the landscape, transport processes that carry erosion products away, and deposition processes that result in sediment build-up. Landforms can result from all stages of these processes. Associations of many landforms together comprise a landscape, and it is this latter aspect of geomorphology that is the focus of this assessment.

5.10 Geomorphology may be thought of as the 'science of scenery', and as such it provides a link to the broader context of landscape and visual assessment that adds layers of human perception, meaning and cultural value to an interpretation of the natural landscape. These latter assessments will be presented to the hearing by Mr Rough. The material covered in my assessment can therefore be seen as occupying part of a continuum of approaches to understanding the Earth's surface: from the purely scientific constructs such as the 'ground-up' geological view that concentrates on the rocks and tectonic forces; to the 'surface-down' geomorphic view; to the cultural meanings that arise from broader human interpretations of the meaning of the landscape.

Mokihinui Region Landscape Geomorphology

5.11 I will describe the geomorphic landscapes of the MHP region in some detail below, but at this point it is necessary to outline the main landscape elements I will be dealing with as this will provide some context for my discussion of the geological processes and tectonic forces that have contributed to shaping the area.

5.12 In the Mokihinui region the main geomorphic landscape elements are (in order of aereal coverage) set out below and the distribution of these landscape elements is shown in Figure 2 accompanying my evidence.

5.12.1 Mountains rising to over 1,300 m in elevation. These include the Glasgow and Radiant Ranges on either side of the Mokihinui

Gorge, and the Allen, Matiri and Lyell Ranges that make up the high country of the eastern parts of the catchment. I have mapped these on the basis of their distinctive patterns of elevation, steepness, sharp-crested ridges, and clear breaks in slope between the other landscape elements.

5.12.2 Rugged hills occur in the central and western parts of the Mokihinui region. Some rise to around 1,000 m elevation, but most are less than 500 m high. I have mapped these on the basis of their lower topography and more rounded ridge crests.

5.12.3 Plateaux occur in several places in the southern half of the Mokihinui region. High plateaux occupy the tops of the Matiri Range in an area known as the Thousand Acre Plateau. In the southwest is the large Stockton Plateau that is underlain by coal deposits. I have mapped these on the basis of their topographic expression of flat or gently sloping surfaces that are surrounded on most sides by steeper slopes that fall away to much lower elevations below.

5.12.4 An inland basin of low hill country surrounded by mountains occurs in the Mokihinui Valley upstream of the gorge. I have mapped the limits of this area on the basis of the clear break in slope between the more gently sloping basin slopes and the steep mountains and rugged hill country that rise above it on all sides.

5.12.5 Coastal plains form a narrow strip generally less than 3 km wide behind the shoreline in the western part of the region. There is a clear break in slope between these areas and the higher rugged hills or plateaux to the east.

5.12.6 Valley floor occurs where rivers such as the Mokihinui River have cut a relatively broad valley which merges into the coastal plain landscape.

5.12.7 River gorges and lakes are minor but locally distinctive elements of the geomorphic environment.

5.13 It can be seen from Figure 2 that the geomorphic character of the Mokihinui region is typical of the wider Westport Karamea region.

6 GEOLOGICAL SETTING

6.1 I have derived my understanding of the geological setting of the MHP from geological maps and reports, in particular Rattenbury et al (1998), Nathan et al (2003), Bowen (1965), and Grindely (1975). My discussion outlines information relevant to an understanding of the broad features of the landscape within which the MHP will be constructed. Two concepts are important:

6.1.1 Rock type characteristics and the influence these have on landform style, in particular the contrasts between the older basement rocks and younger covering sedimentary strata; and

6.1.2 Tectonics, uplift and landscape history, and the Te Waipounamu Erosion Surface that have left distinctive features in the landscape.

6.2 The basement rocks on which the younger rocks rest belong to the Buller Terrane and include the oldest structural units of the New Zealand landmass (Rattenbury et al, 1998). About half of the Westport-Karamea region and most of the Mokihinui catchment is formed in these rocks. They include sedimentary strata of the Greenland Group formed 490 – 500 million years ago, and two bodies of granite rocks known as the Karamea Batholith that were formed 355 – 400 million years ago and 100 – 140 million years ago. These rocks all occur together as the older sediments have been intruded by the Karamea Batholith granites.

6.3 Basement rocks are resistant to erosion and they therefore form the mountainous parts of the Mokihinui region. The Mokihinui Gorge and the deeper parts of the Chasm Creek, Ngakawau and Waimangaroa Gorges have also been cut into these rock types.

6.4 Overlying the basement rocks are much younger Tertiary age covering marine strata that were laid down between about 5 – 45 million years ago. These sediments consist of coal measures, mudstone, sandstone, and limestone. They are generally soft and easily eroded rocks and much of the hill country of the Mokihinui region is formed in these materials.

6.5 The coal measures are widely exposed in the Stockton Plateau south of Millerton, and occur in the Chasm Creek catchment south of Seddonville. Mudstone occurs in the upper Ngakawau catchment and in the hills to the north of Seddonville. Limestone is seen in the hills north of the Mokihinui River mouth, on the eastern flanks of the Glasgow Range, and extending north into Maori Gully. The most striking limestone outcrop sits atop the Matiri Range forming the Thousand Acres Plateau in the far eastern part of the upper Mokihinui catchment.

6.6 A third group of materials occur in scattered locations around the MHP area. These are geologically very young sediments such as river alluvium, coastal marine deposits, glacial deposits, and landslide debris that are all less than two million years old.

6.7 This northwest part of the South Island has a very long geological history, extending back some 500 million years. It includes phases when the area was associated with Gondwanaland (the basement rocks), when Gondwanaland was breaking up (the Waipounamu Erosion Surface, and early Tertiary sedimentation), when the present plate boundary between the Australian and Pacific Plates was established (later Tertiary sedimentation), and the Kaikoura Orogeny that has resulted in the formation of the broad outline of mountains and basins that makes up the present landscape.

6.8 In this long history two particular phases have left their mark on the present landscape: The Waipounamu Erosion Surface, and the Kaikoura Orogeny.

Waipounamu Erosion Surface

6.9 After the basement rocks had been formed (the Greenland Group sedimentary rocks, and the Karamea Batholith granites) these rocks were uplifted by tectonic forces associated with the break-up of the Gondwanaland supercontinent. A long period of stability ensued between about 80 and 30 million years ago and the landmass was eroded down to a low-relief surface. Originally termed the Late Cretaceous Peneplain, this feature is now known as the Waipounamu Erosion Surface (Le Masurier and Landis, 1996), remnants of which are recognised as occurring in many parts of the South Island, offshore islands and on the continental shelf.

6.10 There are two distinctive remnants of the Waipounamu Erosion surface in the Mokihinui region, although in both cases they are actually still buried under a relatively thin cover of younger sedimentary rocks.

6.11 The Thousand Acres Plateau in the Matiri Range at the southwest corner of the Mokihinui catchment is a dramatically flat high elevation surface at between 1,000 and 1,400 m above sea level. It is composed of limestone that rests on the flat surface of the Waipounamu Erosion Surface.

6.12 The Stockton Plateau south of the Ngakawau River is the other remarkable flat lying surface, although it is somewhat lower at between 600 and 900 m elevation. It is underlain by coal measures that in turn rest upon a remnant of the Waipounamu Erosion Surface.

6.13 Elsewhere in the northwest South Island remnants of the erosion surface are directly exposed where they have been exhumed from beneath their covering of soft Tertiary sedimentary rocks. They are well seen in plateaux like the Gunner Downs, Gouland Downs, and Mackay Downs along the Heaphy Track.

Kaikoura Orogeny

6.14 About 20 million years ago the long phase of mild extensional tectonics that had resulted in the split up of Gondwanaland, formation of the Tasman Sea, the Waipounamu Erosion Surface and sinking of much of the New Zealand landmass was replaced by a compressional regime as the present plate tectonic boundary between the Australian and Pacific Plates was formed. Uplift began and by about 5 million years ago this developed into the rapid phase of the Kaikoura Orogeny mountain building that continues to the present day.

6.15 The compressional tectonic regime has resulted in the development of major faults that have marked out numerous terranes and these have been variously uplifted, some forming mountain blocks, others rising more slowly so that they now form basins surrounded by mountains, and still other blocks rising relatively uniformly so that the underlying Waipounamu Erosion Surface has been uplifted more or less intact still with a thin layer of young Tertiary strata on top.

6.16 While this differential uplift has been occurring, erosion processes have been trying to wear down the new mountainous land and some of the younger sedimentary rock cover has been stripped off to reveal the older basement beneath. As the uplift and faulting has progressed, rivers have been forced to cut down into rising ranges forming gorges, and leaving behind their former floodplains as river terraces.

6.17 Thus it can be seen that the broad outlines of the present landscape owe much to the variety of rock types, geological history, and tectonic forces that have occurred in the northwest South Island over many millions of years.

7 GEOMORPHIC ENVIRONMENT

7.1 In studies of the broad geomorphic landscape an effective assessment unit is the river catchment wherein there is a coherent arrangement of slopes and an organised channel network that carries water and sediment off the landscape.

7.2 My assessment of the effects of the MHP on the geomorphic environment therefore covers the Mokihinui River catchment where the dam, reservoir lake, and some of the transmission line will be located; the Ngakawau River catchment through part of which the transmission line will pass; and the northern part of the Waimangaroa River catchment where the transmission line will connect via a new substation into to the existing grid. The catchment areas and MHP components are shown in Table 1, and I describe the characteristics of the present geomorphic environment in the paragraphs below.

Table 1 Mokihinui area catchment characteristics

	Area	**Hydro Project components**
Mokihinui River	749 km^2	Dam and reservoir lake (4.0 km^2), transmission line (5.5 km)
Ngakawau River	246 km^2	Transmission line (17.7 km)
Waimangaroa River	65 km^2	Transmission line (6.8 km)
Total	*1,060 km^2*	

7.3 The MHP components will occur within a total catchment area of 1,060 km^2. The main geomorphic environments found in these catchments are mapped in Figure 2 and I show the areas covered in Table 2. In common with the wider Westport-Karamea region and the broader northwest South Island landscape, the major elements of the landscape are: mountains, rugged hills, plateaux, inland basin, river valley floors, and coastal plain. Minor, but distinctive landscape elements include river gorges and lakes. These are described below. I have not listed landscape types such as gorges and lakes in Table 2 as although there are a number of Gorges and lakes in the region, these make up only a very small proportion of the whole land area.

Table 2 Landscape types in the Mokihinui region

Landscape Type	Mokihinui catchment	Ngakawau catchment	Waimangaroa catchment	*Totals*
Mountains	566 km^2	33 km^2	2 km^2	*601 km^2*
Hills	98 km^2	158 km^2	24 km^2	*280 km^2*
Plateaux	34 km^2	45 km^2	24 km^2	*103 km^2*
Inland basins	43 km^2	0 km^2	0 km^2	*43 km^2*
Coastal Plain	0 km^2	10 km^2	15 km^2	*25 km^2*
Valleys	8 km^2	0 km^2	0 km^2	*8 km^2*
TOTAL	*749 km^2*	*246* km^2	*65* km^2	*1,060 km^2*
Mountains	53.4 %	3.1 %	0.2 %	*56.7 %*
Hills	9.2 %	14.9 %	2.3 %	*26.4 %*
Plateaux	3.2 %	4.3%	2.2 %	*9.7 %*
Inland basins	4.1 %	0 %	0 %	*4.1 %*
Coastal Plain	0 %	0.9 %	1.4 %	*2.3 %*
Valleys	0.7 %	0 %	0 %	*0.7 %*
TOTAL	*70.6 %*	*23.2 %*	*6.1 %*	*100 %*

7.4 Mountain landscapes cover over 56 % of the total catchments[1] area, and are the dominant element of the Mokihinui catchment (Table 2). A small part of the eastern Ngakawau catchment is mountainous (the western slopes of the Glasgow Range) and there is a very small area of mountain at Mt William in the southern part of the Waimangaroa catchment.

7.5 The main mountain block comprises the Glasgow and Radiant Ranges that form a 12 km wide belt in the central – west part of the Mokihinui catchment, and the river has cut its gorge through here. Valleys cut into the mountains are typically 500 m deep and the ridge crests that separate the valleys are spaced some 2 – 3 km apart.

7.6 The mountain topography is formed in basement rocks that have been uplifted and the overlying Tertiary sediments have been eroded off. The main processes that have formed the mountains have been tectonic uplift and fluvial action with landslide events common on the slopes.

[1] Total catchments area = 1060 km^2 comprising the Mokihinui catchment (749 km^2), Ngakawau catchment (246 km^2), and north Waimangaroa catchment (65 km^2).

7.7 The proposed Mokihinui Hydro dam and reservoir lake will be situated within the area I map as the mountain landscape environment, although more specifically it will be in a gorge landform environment within this mountain area as I discuss below.

7.8 Rugged hills cover 26 % of the catchments area, and in my opinion are a dominant element of the Ngakawau and Waimangaroa catchments (Table 2). The western part of the Mokihinui catchment downstream of the dam site is also predominantly hilly. Most of the hill country is less than 500 m elevation, with valleys typically 100 – 200 m deep, and ridge crests spaced 1 – 2 km apart. The hill country is distinguished from the mountains by being generally lower elevation, and having more closely spaced valleys.

7.9 The hill country has been formed in young generally soft Tertiary sedimentary strata including coal measures, sandstones and siltstones. Uplift has raised these sediments above sea level but erosion processes have not yet stripped these cover sediments away to reveal the underlying basement rocks as has happened in the mountain areas. The main processes that have formed the hills have been tectonic uplift and fluvial action with landslide events common on the slopes.

7.10 The northern 15 km of the transmission line route will cross rugged hill landscape in the Chasm Creek and Charming Creek catchments. These hills are formed in sandstones of the Brunner Coal Measures and mudstones of the Kaiata Formation.

7.11 Plateaux comprise 9.7 % of the catchments area and occur in scattered locations and different elevations across the region.

7.12 In the far east of the Mokihinui catchment areas of plateau occur near the tops of the Matiri Range. The most distinctive is the Thousand Acres Plateau which is at 1,100 to 1,200 m elevation. This area is underlain by Tertiary limestone and mudstone that rests on the Waipounamu Erosion Surface directly beneath. Tectonic uplift during the Kaikoura Orogeny has raised these plateaux more-or-less undisturbed to their present elevation.

7.13 The plateaux areas in the Ngakawau and Waimangaroa catchments are of similar origin, although here they are underlain by older Tertiary sediments of the Brunner Coal Measures (Stockton Plateau) and Kaiata mudstone (Blackburn Creek).

7.14 Only the Stockton Plateau comes within the footprint of the MHP as 11.5 km of the transmission line route will pass over this landscape.

7.15 One inland basin occurs in the Mokihinui region, although these are more common in the wider northwest South Island landscape. The Mokihinui inland basin lies in a depression between the Glasgow and Radiant Ranges on the west and the Matiri Range to the east. The basin is about 17 km long and 3.5 km wide, and represents 4.1 % of the total catchment area. The MHP will not affect this landscape area.

7.16 A narrow coastal plain occurs along the Tasman Sea coastline in the west, and it represents 2.3 % of the total Mokihinui region. Most of the plain is less than 10 m above sea level and has been formed by coastal progradation and river deposition over the last 6,000 years.

7.17 Beach processes are the main landforming agent responsible for the formation of the coastal plain. Some parts of the shoreline close to the main river mouths are continuing to build out, while other parts are eroding. The effect of the MHP on beach processes around the Mokihinui River mouth is discussed in the evidence of Dr Hicks. However, away from this restricted area the MHP will not affect the coastal plain landscape type.

7.18 Valley floor landscapes occur where there is sufficient space between the hills and mountains for floodplains and terraces to develop. Only the Mokihinui River is large enough for these features to have developed in the Mokihinui region. The lower 10 km of the valley downstream of the proposed dam site comprises valley floor landforms, and this represents 0.7 % of the total Mokihinui region landscape. An area of valley floor landforms also occurs in the inland basin landscape described above.

7.19 The present river channel is part of this landscape system, and the potential effects of the hydro proposal on this area are discussed in the evidence of Dr Hicks. The powerhouse and construction area will be on valley floor landforms just downstream of the end of the Mokihinui Gorge.

7.20 In addition, about 3.4 km of the transmission line will pass downvalley from here on the valley floor landscape type.

7.21 From my examination of topographic maps I consider gorges to be a distinctive but minor element of the Westport-Karamea region. In geomorphology the term gorge has both restricted and more general meanings as noted by Thomas and Goudie (2000, p 231):

7.21.1 *A deep and narrow section of a river valley, usually with near vertical rock walls* (Type 1);

7.21.2 *More generally a narrow valley between hills or mountains* (Type 2).

7.22 Both types of gorges occur in the Westport Karamea region, and a list of the gorges in order from north to south longer than 1 km, derived from my interpretation of topographic maps is shown in Table 3.

7.23 The Type 2 generally narrow gorges are cut through both hard basement rocks and the softer Tertiary sedimentary strata. The more spectacular Type 1 gorges are predominantly formed in basement rocks.

Table 3: Gorges in the Westport-Karamea Region

#	River	Length (km)	Type
1	Karamea River	6.0	2
2	Kakapo River	1.5	2
3	Little Wanganui River	2.0	2
4	Glasseye Creek	3.2	2
5	Falls Creek	3.2	2
6	Six Mile Creek	1.5	2
7	Chasm Stream	4.6	1
8	Mokihinui River (from downstream of the Forks)	14.0	2
9	Rough and Tumble Creek	4.7	2
10	Hemphill River	3.6	2
11	Mokihinui River North Branch (upper)	1.5	1
12	Mokihinui River North Branch (lower)	5.7	2
13	Watson Stream	1.4	1
14	Ngakawau River (upper)	5.3	1
15	Ngakawau River (lower)	3.1	1
16	Waimangaroa River	7.0	1
17	Whareatoa Stream	3.8	2
18	Lower Buller Gorge	24.3	2
19	Upper Buller Gorge	38.1	2
	Total length	134.7	

7.24 The Mokihinui Gorge that will be partly inundated by the hydro scheme reservoir is a Type 2 gorge about 16 km long, and cut in basement rocks. It is 800 – 900 m below the nearby peaks of the Radiant and Glasgow Ranges.

7.25 The transmission line will cross two other gorges on Chasm Creek and the Ngakawau River, both of which are Type 1 gorges. Chasm Creek gorge is 4.6 km long and generally about 100 m deep by 300 m wide at the top. It is cut through a relatively thin layer of soft Tertiary Coal Measures at the top and down into the hard basement granite rocks beneath. The upper Ngakawau Gorge is 5.3 km long and typically more than 200 m deep by 300 m wide at the top. It is cut through thin mudstone deposits into basement granite beneath.

7.26 The Mokihinui gorge is not unusual as in the Westport - Karamea region there are 19 gorges totalling nearly 135 km in length. The upper and lower Buller Gorges are longest at 24 km and 38 km respectively.

7.27 There are a number of lakes in the Mokihinui region. Two main types occur, cirque lakes and landslide dammed lakes. Cirque lakes occupy basins in the heads of formerly glaciated valleys in the Glasgow Range and will not be affected by the MHP.

7.28 Landslide dammed lakes are relatively common although in geological terms they are generally temporary features. Many such lakes were formed after the Murchison Earthquake in 1929, including Lake Perrine at the head of the Mokihinui Gorge, although many of these have now largely been filled in by natural river sedimentation processes.

7.29 Other landslide dammed lakes occurring in the Mokihinui region include Lakes Phyllis and Marina in the Hemphill River valley, and Lake Dora near The Forks. Lake Matiri is just east of the Mokihinui region, and similar large lakes are also known from the recent geological past in the northwest South Island region. For example, I have documented a 16 km long lake that existed in the middle Maruia valley (approximately 70 km south southeast of the Mokihinui area) between about 17,000 – 14,000 years ago (Mabin, 1983). Reid (1978) describes a number of similar features in the nearby Mangles and Matakitaki valleys (45 – 55 km to the southeast).

8 ACTUAL AND POTENTIAL EFFECTS

8.1 Effects on the geomorphic environment arise when landforms are significantly altered or destroyed, and when the nature, scale and intensity of landforming process regimes are changed to such an extent that existing landforms are significantly changed or new landforms are created.

8.2 Assessment of the spatial scale of an effect is important, although typically structures tend to be smaller than the landforms they are placed on. In addition, time is also an important factor. The geomorphic environment is not static, as landforms are continually changing albeit mostly at slow or imperceptible rates and over long periods of time. Therefore, assessment of geomorphic effects must be carried out in the context of an understanding of natural rates of change in the geomorphic environment, and how these compare to changes resulting from human activities.

8.3 Effects on the geomorphic environment can thus be seen to involve two issues: does the footprint of an activity significantly alter or perhaps destroy a landform; and are landforming process regimes significantly changed.

8.4 Dealing with landforming process regimes, the MHP will only affect landforming processes in the channel of the Mokihinui River and along the coastline around the river mouth and these effects are described in the evidence of Dr Hicks.

8.5 Turning to the footprint of the project, I estimate that the various elements of the MHP will cover the following areas:

8.5.1 The dam and associated powerhouse and construction area at the downstream end of the Mokihinui Gorge will cover at most about 0.6 ha. The dam will be in the gorge, while the powerhouse and construction area will be on valley floor landforms.

8.5.2 The reservoir impounded behind the dam will extend about 14 km upvalley along the Mokihinui Gorge. This lake will typically be less than about 300 m across and will have a total footprint of about 3.4 km^2.

8.5.3 The transmission line will take power south to join with Transpower's Inangahua – Westport line. It will be about 28 km long, and will run down the Mokihinui Valley (3.4 km), then generally southwest into the Charming Creek Valley (8.2 km), across Ngakawau Gorge and up onto the Stockton Plateau (5.9 km) and south into the upper Waimangaroa River Valley (10.5 km) to join the existing line near Burnett's Face.

8.5.4 It will cross valley, gorge, hill and plateau landscapes. About 159 concrete or steel pole structures will be required, and some 500 m of access tracks may need to be constructed. For my assessment purposes I have assumed the total footprint of the transmission line will entail 159 pylon foundations and the 500 m of access tracks. I estimate this to be no more than 0.5 km^2.

8.5.5 Thus, the total footprint of the MHP will be about 4.5 km^2.

8.6 The dam and reservoir lake will be situated in the Mokihinui Gorge and will create an environment analogous to a landslide dammed lake. As I have discussed above, these types of lakes are found elsewhere in this region.

8.7 Some 14.2 km of the floor of the Mokihinui Gorge will be flooded. From Table 3 it can be seen there are nearly 135 km of gorges in the Westport – Karamea region, and thus the inundated gorge landform represents only 10.5 % of the total length of gorges in the region, and only 5.2 % of the number gorges found here. In addition, I consider that the gorge does not contain any features of geomorphic significance and no important landform or geological sites are identified within the gorge in the New Zealand Geopreservation Inventory.

8.8 The Mokihinui Gorge is several hundred metres deep, with the peaks of the adjacent Glasgow and Radiant Ranges rising to more than 1,000 m, and ridges rising to more than 600 m elevation. The reservoir level will be at 100 m elevation, and for much its length the inundation depth will be less than 50 m. Thus most of the gorge landform will still remain above the reservoir water surface level.

8.9 In total the 4.0 km^2 footprint of dam, powerhouse and lake represents 0.5 % of the Mokihinui catchment landscape (749 km^2).

8.10 The transmission line will cross valley floors, rugged hills, gorges, and plateaux landscape types. It will run through about 385 km^2 of landscape defined by the parts of the Mokihinui, Ngakawau and Waimangaroa catchments that lie west of the Radiant – Glasgow – Mt William Ranges. The total 0.5 km^2 footprint represents about 0.1 % of this landscape.

8.11 I therefore conclude that the footprint of the MHP will have a less than minor effect on landforms of the Mokihinui region.

9 ISSUES RAISED BY SUBMISSIONS

9.1 Submissions on the MHP applications have been made on behalf of various branches of the Green Party of Aotoeroa/New Zealand including a submission by M. Mathers on behalf of the Aoraki Province, and a submission by Frida Inta. These address matters relevant to my geomorphic assessment relating to the Mokihinui Gorge.

9.2 Both submissions incorrectly claim that the Mokihinui Gorge is the second largest in the area, with F. Inta (p 29) citing Table 4-3 in my technical report[2] in support of this claim. The table referred to shows that the Mokihinui Gorge is the third longest in the Westport-Karamea region.

9.3 My assessment of gorges was restricted to the Westport-Karamea region. However, as I have demonstrated above in paragraphs 5.2 to 5.8, the MHP lies within the northwest South Island region and there are several gorges longer than the Mokihinui, including on Big River, on the Heaphy River, and on the Kohaihai River. I therefore consider the size of the Mokihinui Gorge to be unremarkable in either the Westport Karamea region or the northwest South Island region.

9.4 F. Inta also claims that in my report I inconsistently classify the Mokihinui Gorge as both a Type 1 and a Type 2 gorge. This is incorrect. On page 4-4 of my report I identify the Mokihinui Gorge as a Type 2 gorge, and nowhere do I refer to it as a Type 1 gorge.

9.5 F. Inta further suggests that the Mokihinui Gorge should be classified as a Type 1 gorge. As you will see from paragraph 7.21 above, the definition of gorges that I apply holds that Type 1 gorges typically have near vertical rock walls. The Mokihinui Gorge does not have these features and in my opinion a classification as a Type I gorge cannot be sustained.

9.6 Submissions by both M. Mather and F. Inta stress the uniqueness of the Mokihinui Gorge. M. Mather suggests (paragraph 1) that *"its precipitousness, width, and length probably make it unique in the whole of NZ",* and F. Inta uses very similar language in paragraph 6 on p 29 of her submission. No data or authorities are cited to support these claims. At a trivial level one could say these claims are probably true as there are not likely to be any other gorges in New Zealand or indeed the world that have exactly same geomorphic characteristics as the Mokihinui Gorge. However, as the same can be said of every gorge everywhere, in New Zealand or the world, I do not consider such appeals to uniqueness to be helpful.

9.7 From my perspective as a geomorphologist I consider that the Mokihinui Gorge does not contain remarkably precipitous slopes, is not remarkably narrow or wide, and is not unusually long or short.

9.8 The Royal Forest and Bird Society Golden Bay Branch has submitted on the MHP and they state that the Mokihinui is the West Coast's third largest river. They cite no data or authority in support of this claim.

9.9 I have examined river data on the NIWA Water Resources Explorer website (http://wrenz.niwa.co.nz/webmodel/). This gives information on catchment size, mean flow, and many other characteristics for all New Zealand catchments from less than 0.5 km^2 in area and larger. There are many rivers larger than the Mokihinui in the West Coast part of the northwest South Island in terms of catchment area and/or mean flow, including the Buller River, Grey River, Maruia River, Inangahua River, the Matakitaki River, and the Karamea River. This data does not support a claim for the Mokihinui River being the third largest on the West Coast.

9.10 The Green Party of Aotearoa New Zealand in their newsletter *Green Times* of August 2008 has raised a number of issues regarding the MHP. Matters relevant to my assessment are:

9.10.1 MHP will drown the 14 km long Mokihinui Gorge; and

9.10.2 The Mokihinui is one of the few remaining wilderness rivers left in New Zealand.

9.11 I discussed the inundation of the Mokihinui Gorge in paragraph 8.7 above. The inundation level will be at 100 m above sea level while the slopes above rise to over 1,000 m. Thus the MHP will not drown the Mokihinui Gorge.

9.12 I do not address matters relating to wilderness rivers in my evidence. However, the geomorphic perspectives I have outlined above do permit comment on the characteristics of the Mokihinui River in relation to other rivers in this region.

9.13 The Mokihinui River drains from the mountains of the northwest part of the South Island. Other rivers of similar size also drain from these mountains including the Karamea River, the Matiri River, the Owen River, the Aorere River, the Takaka River and the Heaphy River. While they each have distinctive attributes, I consider them to be rivers of the same general geomorphic character as they drain from similar mountain environments, through gorges and rugged hill country, and past high plateaux. For these reasons I consider the Mokihinui River is not one of the few remaining rivers of its type in this region.

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[2] *Geomorphic Assessment of the Mokihinui River Catchment Area.* Appendix 15 to the AEE

10 CONCLUSION

10.1 In summary I consider that the MHP will have a less than minor effect on the landscape geomorphology of the Mokihinui region. The total footprint (4.5 km^2) represents only 0.4 % of the landscape area. The main landform directly affected, the Mokihinui River gorge, is a type well represented in the Westport-Karamea region. The dam and resulting lake will be features not unlike other landslide dammed lakes that are common in this area.

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