Prepared for

Ministry of Economic Development

Waters of National Importance –

Identification of Potential Hydroelectric Resources

By

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January 2004
East Harbour Project # EH 107
Document Status: Final Draft

Executive Summary

The thrust of this report is to identify those hydro electricity opportunities where there is a possibility that they may be considered for development within the next 20 years. Some are actively being investigated, appraised, considered or in the consent process, while the bulk of opportunities are not being actively investigated, or are considered unachievable under current investment criteria. While the authors have included a large number of those not being currently actively investigated, opportunities they consider could be investigated at some stage in the future have been included. Opportunities they consider unachievable have not been included.

The report provides information on the hydro potential in each region. Specific publicly known opportunities with a high/medium level of confidence of their proceeding are indicated for major catchments. Commentary is included on other catchments within each region where the authors consider there are opportunities that should not be lost sight of.

The opportunities covered by the report range from the large mainstem river options with potential outputs of over 100 MW (mostly in the South Island), to the very small 5 MW (or below) possibilities.

The report indicates that the publicly known hydro potential for New Zealand is around 2,500 MW and 12,000 GWh p.a. In addition there are possibly a significant number of other opportunities that are not publicly identified. These are noted in the report where appropriate.

Table 1 High and Medium Confidence Hydropower Opportunities by Catchment.

Catchment Number & Name	MW	GWh (p.a.)	Number of Projects	% of GWh p.a.
#3 Waitaki	590	3200	4	27.4%
#1 Clutha	410	1950	5	16.7%
#14 Grey	350	1550	7	13.2%
#23 Waiau (Canterbury)	235	1030	4	8.8%
#21 Ngaruroro	135	585	5	5.0%
#5 Whanganui	110	475	5	4.1%
#18 Wairau	105	525	2	4.5%
#31 Hurunui	80	350	2	3.0%
#34 Mohaka	75	330	1	2.8%
#4 Waiau (Southland)	65	350	1	3.0%
#9 Taieri	40	175	4	1.5%
#29 Rangitaiki	40	195	2	1.6%
#53 Waiapu	35	165	3	1.4%
#339 Raukokore	35	145	2	1.2%
#2 Waikato	25	115	4	1.0%
#86 Patea	20	80	1	0.7%
#126 Waimea	15	70	1	0.6%
#22 Ruamahanga	15	55	2	0.5%
#54 Awatere	10	50	1	0.4%
#16 Wairoa (Hawkes Bay)	10	45	1	0.4%
#7 Manawatu	10	40	1	0.4%
#15 Rangitikei	9	40	1	0.4%
#33 Tukituki	9	40	1	0.3%
#48 Whakatane	9	40	1	0.3%
#106 Pelorus	7	30	1	0.3%
#51 Ashburton	7	30	1	0.3%
#116 Tarawera	6	25	1	0.2%
#19 Wairoa (Northland)	3	15	1	0.1%
GRAND TOTAL	**2460**	**11700**	**65**	**100%**

The information in this report will provide a basis for consideration of the interests and values associated with the use of those particular stretches of water.

Contents

1 Introduction

This report provides information on future hydro-electricity opportunities in New Zealand. The opportunities have been identified from publicly available information and organised on a regional basis.

The project brief required only opportunities to be included where there is a high to medium confidence level of their proceeding. As a result the report does not provide a fully comprehensive list of all the opportunities available. However to provide a context for the report the authors have included comment on other catchments where they consider there may be economic opportunities not yet identified, where previous investigations have been constrained by specific assumptions, or where alternative designs of identified but currently considered uneconomic schemes may be possible.

The report expands on the national viewpoint covered in a 2002 report prepared by East Harbour Management Services (East Harbour) for the Ministry of Economic Development, 'Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat'.

The purpose of this report is to provide information on the resource that might be developed for electricity generation in the 20 year timeframe so that material national interest decisions can be addressed by government. The information will be included in a project being convened by the Ministry of Economic Development on Waters of National Importance.

2 Summary

The following Table identifies, on a Regional basis, opportunities for hydroelectric development over the next 20 years with high and medium confidence levels.

Table 2 High to Medium Confidence Hydropower Opportunities by Region.

Region	MW	GWh p.a.	Number of Projects
Canterbury	910	4619	11
Otago	452	2124	9
West Coast	351	1546	7
Hawkes Bay	228	1001	8
Nelson-Marlborough	141	678	5
Wanganui – Manawatu	129	558	7
Bay of Plenty	86	402	6
Southland	65	350	1
Gisborne	37	163	3
Waikato	26	115	4
Taranaki	18	79	1
Wellington (including Wairarapa)	13	55	2
Northland	3	13	1
GRAND TOTAL	**2460**	**11700**	**65**

Table 3 High to Medium Confidence Hydropower Opportunities by Catchment.

Catchment Number & Name	MW	GWh (p.a.)	Number of Projects	% of GWh p.a.
#3 Waitaki	588	3,208	4	27.4%
#1 Clutha	412	1,950	5	16.7%
#14 Grey	351	1,546	7	13.2%
#23 Waiau (Canterbury)	236	1,030	4	8.8%
#21 Ngaruroro	134	585	5	5.0%
#5 Whanganui	110	476	5	4.1%
#18 Wairau	106	526	2	4.5%
#31 Hurunui	79	350	2	3.0%
#34 Mohaka	75	330	1	2.8%
#4 Waiau (Southland)	65	350	1	3.0%
#9 Taieri	40	174	4	1.5%
#29 Rangitaiki	38	193	2	1.6%
#53 Waiapu	37	163	3	1.4%
#339 Raukokore	33	143	2	1.2%
#2 Waikato	26	115	4	1.0%
#86 Patea	18	79	1	0.7%
#126 Waimea	16	70	1	0.6%
#22 Ruamahanga	13	55	2	0.5%
#54 Awatere	12	50	1	0.4%
#16 Wairoa (Hawkes Bay)	11	47	1	0.4%
#7 Manawatu	10	41	1	0.4%
#15 Rangitikei	9	41	1	0.4%
#33 Tukituki	9	39	1	0.3%
#48 Whakatane	9	39	1	0.3%
#106 Pelorus	7	32	1	0.3%
#51 Ashburton	7	31	1	0.3%
#116 Tarawera	6	27	1	0.2%
#19 Wairoa (Northland)	3	13	1	0.1%
GRAND TOTAL	**2,460**	**11,700**	**65 Proposals**	100%

3 Methodology

The report[1] 'Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat' included analysis of the availability and cost of all publicly known hydro opportunities. The costs were updated to 2002 values and the authors used their judgement to establish the level of confidence of each opportunity proceeding. The data was aggregated to provide information on confidence levels and costs at both regional and national level. Information on specific projects or catchments was not included.

The opportunities in the 2002 report having high or medium confidence levels of proceeding in the next 20 years have been reanalysed for this report. The historically based information has been updated and adjusted to take account of the community's current attitudes and aspirations that could be a determining factor when resource consent applications are received.

Other opportunities considered of possible future interest that were not included in the 2002 high/medium categories have been re-evaluated and included in this report where appropriate. It should be noted that this is very subjective and dependant on, among other things, the authors' assessment of future community attitudes towards hydro projects.

The catchment numbers (e.g. Catchment #2, Waikato) are taken from project maps (one North Island, one South Island) supplied by the Ministry of Economic Development for this purpose. In a few cases where catchments are very small, and similar to adjacent catchments the number selected may be that of an adjacent or nearby catchment.

A basis of the authors' assessment is that future hydro projects will:

- Tend to not involve river impoundment but will be out of river modular canal type designs,
- Be smaller than traditional hydro projects in NZ,
- Involve shared use of extracted water for irrigation or community water supply,
- Have residual river flows as a determining factor for the level of generation, and
- Be integrated into the needs of other water users.

Hydro electricity projects which involve a degree of impoundment are in the future likely to be used more for peak electricity generation and be linked to wind energy projects where the water storage acts as a form of battery for the wind energy. The two energy forms having their operation integrated.

The report is constrained in that there are a number of opportunities being progressed by interested parties (usually developers or potential developers etc) that the authors are not aware of. Also some information is confidential to specific developers and as it is not in the pubic arena has not been able to be included in this report. While not a large number, nor significant in the overall context of the total MW / GWh figures, they nevertheless represent a significant proportion of likely near-term developments simply because they are the current focus of potential developer activity.

In addition a number of previously identified opportunities were discarded at an early stage of investigation as they were not perceived to be economic, or that there were environmental issues that were perceived as difficult to resolve, or provide too much risk. There is generally little information in the public arena on these projects. The authors have included appropriate ones under "Other Opportunities" for each region.

There is also the issue of access. It is known that some opportunities exist but the asking price for access to the resource is too "high" in that there are other competing land or water uses.

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[1] EHMS 2002 (See Appendix C).

In addition most of the publicly available information is from projects and investigations that are now several decades old. The investigations were undertaken based on assumptions that may no longer be applicable. Where the assumptions are known by the authors adjustments to the information have been made. There will however be a number of projects where critical assumptions can no longer be identified. In general, such projects have been included "as is".

In recent years there has been little investigation of hydro opportunities because;

- There has been strong anti-hydro community attitudes.
- Hydro investigations are very expensive, and take a long time to complete, with little confidence that resource consents will be able to be obtained.
- Hydro projects potentially can affect large numbers of landowners and nearby communities all of whom require extensive and expensive consultation.
- Water impoundment can involve a large land use change.
- To prepare properly for resource consent applications is very costly.

As a result some of the data available for this report are very dated which will affect the confidence of the information. The date of information sources for each of the projects is listed.

The hydro potential in catchments is affected by topography, soil geology, river flows, and other interests associated with a particular water body e.g. fishing, canoeing. Some rivers are very 'flashy' with the result that either storage is ideal, or extensive construction features are required for rare flash events.

Information on flow is one of the significant uncertainties facing a developer. A good long-term (a large number of years) record of flow data is essential if the resource is to be well understood. This information has been and is continuing to be collected but is not necessarily freely or readily available to the public in a form that can provide the appropriate information.

Variations in flow, particularly if they are consistently below the assumed mean flow will have an adverse effect on the return an investor/developer will receive for the project. That, along with civil engineering uncertainties for foundations are two of the most significant factors that must be assessed and understood before construction is committed to.

To take account of these issues the authors have included commentary on the potential opportunities in each region that should not be lost sight of just because there is little information currently available. Indications of potential are based on the principle that where there is flow and "head"[2] there is an opportunity. Changes in technology, conceptual design thinking and relative economics over the next 20 years will result in some currently uninvestigated opportunities becoming relevant for investment.

Opportunities excluded from consideration are those in National Parks. Where a Water Conservation Order covers a river with hydro potential these opportunities are included for consideration as there is a mechanism whereby Water Conservation Orders (as Regulations) can be modified. Similarly for those regional rules that superseded Local Conservation notices. The particular effects of these on specific projects has not been fully assessed as this is outside the scope of this study. Opportunities impinging on the Conservation Estate have been included where there is a possibility that the opportunity could proceed. Many opportunities in the Conservation Estate have been excluded because of the high potential adverse effects.

The Chatham Islands and Stewart Islands have not been included in the scope of this investigation as they are isolated from the grid at either the national grid or local network level.

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[2] "Head" refers to the difference in elevation between the intake water level and the outlet water level for the hydro scheme.

4 Northland Region[3]

4.1 Catchment #19[4]: Wairoa (Northland)

This catchment is the sixth largest in the North Island and has:

- an existing hydro-electric power station (Wairua Falls),
- no controlled lake storage.

Table 4 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Purua Rapids	3	13	T&T 1978

4.1.1 Purua Rapids (16/2)

The Purua Rapids are located about 15 km north-west of Whangarei. In the vicinity of the outfall of the Hikurangi Swamp the Wairua River drops over a series of rapids and low falls between the Purua Bridge and the Wairua Bridge on the Road. The greatest drop occurs 5 km downstream from Purua Bridge, being a waterfall some 8.5 m in height. The 20.5 m^3/s mean flow of the Wairua River, relatively large for Northland from a catchment of 567 km^2 suggests hydroelectric potential of an order proportionate to that developed at the one existing hydroelectric power station in Northland, at Wairua Falls.

The hydroelectric potential of the site could most readily be developed by construction of a concrete barrage-type control structure on the rock sill at the top of the waterfall, diverting water by means of a short canal and penstock to a power station below the falls. A 3 MW generator would give approximately 13 GWh p.a. (50% plant factor[5]).

4.2 Other Opportunities in this Region

4.2.1 Prohibited

There are no known prohibited opportunities.

4.2.2 Undefined

#19 Wairoa Catchment

Mangakahia – 5 MW

[3] Regions generally follow Regional Council definitions, but not in every case.

[4] Catchment reference numbers are taken from maps identifying catchments supplied by the Ministry of Economic Development

[5] For an explanation of plant factor see Appendix B.

Manganui (18/1) – 9 MW[6]

Whatoro (18/2) – 4.2 MW[6]

The general shortage of water supply in Northland may result in storage reservoirs being built for community or irrigation requirements. These may also provide an opportunity for electricity generation.

5 Waikato Region

5.1 Catchment #2: Waikato

This catchment has:

- The largest catchment area of the North Island, including:
  - Lake Taupo and its catchment
  - Waikato River below Lake Taupo outlet
  - Waipa River
- numerous existing hydro-electric power stations (grid or network connected) (also used for cooling Huntly Power Station),
- controlled lake storage (e.g. Lake Taupo, and Lake Moawhango (on the Rangitikei)).

Table 5 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Wairehu Canal	9	40	SKM 2004
Waipapa River	5	21	T&T 1982-1
Waipa River C/2A	10	44	T&T 1982-1
Waipa River C/2B	2	11	T&T 1982-1

5.1.1 Wairehu Canal

This canal is used to transfer water from the Whanganui catchment to the Taupo / Waikato catchment as part of the Tongariro Power Scheme and has a 37 m head differential. The surplus head is dissipated at drop structures along the Wairehu canal between Lakes Otamangakau and Rotoaira and has always been recognised as potential for hydro development.

The proposed scheme configuration is likely to be:

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[6] T&T 1978.

- An intake located between the existing drum screens and the Wairehu canal control gate at the outlet to Lake Otamangakau
- A canal or pipeline running alongside the existing canal to a headpond downstream from the State Highway 47 road crossing
- Penstocks, power station etc towards the Lake Rotoaira end of the canal,

A recent estimate is for a 9 MW power station yielding approximately 40 GWh p.a. (50% plant factor).

Possible Interest – Genesis (Owner of Wairehu Canal)

5.1.2 Waipapa River (B/5A)

The Waipapa River and its tributaries rise in the steep afforested Rangitoto Range west of Whakamaru and flow in a predominantly north easterly direction to reach the Waikato River a short distance from the Waipapa hydro dam. In its middle reaches west of Mangakino, both the river and its adjacent main tributary exhibit favourable combinations of flow and channel gradients for run-of-river diversion type hydro schemes.

A possible development option is a 2 km long canal on the left bank[7], crossing a tableland west of the road, where a headpond could be provided, to discharge into an unnamed stream; a small power station may be economic at the drop into the stream . The combined flows of the diversion and the unnamed stream would then be picked up at the 350 m level and carried by a canal, pipeline and penstock to a power station close to the confluence with the Waipapa River.

The mean flow from the 26 km^2 catchment is estimated to be 1 m^3/s. With an installed capacity of 4.8 MW, 21 GWh p.a. would be available (50% plant factor).

5.1.3 Waipa River (C/2A & C/2B)

The Waipa River, and one of its upper tributaries the Tunawaea Stream, rise in the steep afforested Rangitoto Range between Te Kuiti and Mangakino. Near their confluence in the Waipa Valley both rivers fall steeply over rapids along narrow gorges and afford potential for substantially run-of-river diversion type hydro schemes.

The C/2A scheme headworks would be located 100 m downstream of Okahura Stream confluence and 1 km upstream from the Owiwi Rapids with a tunnel and pipe, into a power station located 0.5 km above Tunawaea Stream confluence. The catchment area of 147 km^2, and a mean flow rate of 7 m^3/s and head of 102 m, with a 10 MW generator would give approximately 44 GWh p.a. (50% plant factor).

The C/2B scheme headworks would be located at 380 m contour on the Waipa River, with a natural channel down to a power station at the Okahura confluence. The 93 km^2 catchment area, with a mean flow rate of 3.5 m^3/s, head of 39 m, and a 2 MW generator would give approximately 11 GWh p.a. (50% plant factor).

5.2 Other Opportunities in this Region

5.2.1 Prohibited

#224 Marakopa River Falls – 6.7 MW (Scenic Reserve)

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[7] The left hand side of the river when viewed facing downstream.

5.2.2 Undefined

#2 Waikato catchment

Lake Taupo Gates

Tauranga Taupo River Headwaters – 5 MW

Waihaha River West Taupo – 10 MW ([MOC 1990], Blue Duck, river of national importance)

Waikato River at Huka Falls – 5 MW

Tongariro Power Scheme enhancements

Waihohonu stream and nearby rivers and streams upstream of the Tongariro Power Scheme

There are several locations adjacent to the Waikato River which could be developed for out-of-river storage. These could be in the form of pumped schemes or utilised for flood storage.

#59 Mokau catchment

Although having two existing power stations totalling 6.5 MW, further opportunities in the catchment have generally not been investigated because of perceived economic, distance from transmission and other infrastructure, and possible environmental issues.

Mokau – 50 MW

6 Bay of Plenty Region

Seven main river systems dominate the hydrology of the Bay of Plenty region. These main river systems are (from east to west) the Motu, the Waioeka, the Whakatane, the Rangitaiki, the Tarawera, the Kaituna, and the Wairoa. Along the coast between the Tarawera and Kaituna river mouths and again north of the Wairoa river mouth, there are a number of minor streams. These streams extend a short distance into the coastal foothills.

6.1 Catchment #116: Tarawera

The Tarawera River drains Lake Tarawera to the Bay of Plenty. The Tarawera has a catchment area of approximately 900 km^2. The river falls approximately 300 m in the 59 km from Lake Tarawera to the sea.

Over its lower reaches, from Kawerau to the sea, the Tarawera River is generally of a flat gradient. However, in the upper regions there are a number of rapids and a waterfall.

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 6 **Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.**

Name	MW	Average Energy Production (GWh pa)	Public Reference
Tarawera - Fenton's Mill	6	27	MWD 1982-1

6.1.1 Tarawera - Fenton's Mill

This scheme proposes to take water from downstream of the Tarawera Falls by way of a diversion. The water would be channelled downstream approximately 4 km by a concrete lined canal to a penstock on the right bank of the river. Approximately 55 m of head could be developed by this scheme. This scheme, with a 6 MW generator, would generate approximately 27 GWh p.a. (50% plant factor).

6.2 Catchment #29: Rangitaiki

This catchment has:

- existing hydro-electric power stations (e.g. Matahina, Aniwhenua, Wheao)
- controlled lake storage (e.g. Matahina, Aniwhenua).

Table 7 **Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.**

Name	MW	Average Energy Production (GWh pa)	Public Reference
Kioreweku	13	83	MOC 1990, BOPE 1994
Whirinaki (B3)	25	110	MWD 1982-1

6.2.1 Kioreweku

An option at Mangamako would develop the head which remains between the existing Matahina and Aniwhenua schemes. The form of the development is similar to that of the Aniwhenua scheme with a low dam and diversion, but in this case creating a new 'waterfall' and 'gorge' by means of river deepening downstream of the power station. This scheme would involve a dam with powerhouse below, and would be run-of-river with an installed capacity of some 13 MW (giving approximately 83 GWh p.a. at 50% plant factor).

This reach of the river was the focus of an unsuccessful application in 1994 by Bay of Plenty Electricity for resource consents for its proposed Kioreweku power station using a canal diversion scheme.

6.2.2 Whirinaki (B3)

A scheme involving a dam on the Whirinaki River was proposed in 1962. This envisaged an earth fill dam situated approximately 17 km downstream of the Minginui confluence. From the dam a 4 km long, 3 m diameter tunnel would lead to a power station on the left bank of the Whirinaki River.

The dam would be approximately 70 m in height and the total head of the scheme would be approximately 140 m.

A mean annual flow rate of 13.0 m^3/s and a nett head of 140 m would, with an installed capacity of 25 MW produce approximately 110 GWh p.a. (50% plant factor).

6.3 Catchment #48: Whakatane

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 8 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Waimana - Matahi	9	39	MWD 1982-1

6.3.1 Waimana - Matahi (A2C)

A scheme located near the settlement of Matahi envisages a diversion structure adjacent to Matahi, a 3.4 km concrete lined canal along the right bank to the penstocks and a 9 MW power station. The head would be 55 m, and this would give approximately 39 GWh p.a. (50% plant factor).

6.4 Catchment #339: Ruakokore

The Raukokore River with a catchment of 352 km^2 rises at an elevation of over 1200 m on the rugged north western slopes of the Raukumara Range near Mt. Honokawa.

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 9 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Raukokore 12/2	14	61	T&T 1978
Raukokore 12/4	19	82	T&T 1978

6.4.1 Raukorore 12/2

Some 8 km from its mouth the Raukokore River follows around a sharp loop with localised steeply rising afforested banks at its downstream end. The mean annual flow rate of 21.1 m^3/s and nett head of 51 m combined with a 14 MW generator would give approximately 60 GWh p.a. (50% plant factor).

6.4.2 Raukorore 12/4

Two km downstream of the Waikura River confluence the Raukokore River turns to flow north between locally steep banks which form a suitable dam site for a 'conventional' hydro scheme. This scheme comprises a reservoir with an area of 7.4 km^2 extending 13 km upstream, with a power station at the front of the dam. The mean annual flow rate of 19.5 m^3/s, combined with nett head of 68 m, with a 19 MW generator would deliver approximately 82 GWh p.a. (50% plant factor).

6.5 Other Opportunities in this Region

6.5.1 Prohibited

#243 Torere catchment

Torere - Takaputahi Diversion – 36 MW (Diverts water from a part of a tributary affected by the National Water Conservation (Motu River) Order, 1984)

Torere – 7MW (Downstream of power station on Torere-Takaputahi Diversion. Relies on diverted water and not economic in its own right)

6.5.2 Undefined

#29 Rangitaiki – 8 MW

#72 Kaituna at Mangorewa – 6 MW

#112 Waioeka – 21 MW

#116 Tarawera – Tarawera at Falls – 7 MW (Mutually exclusive to Fenton's Mill (5.1.1) scheme, uses the head from the falls, would need compensating water over the falls [MOC 1990]

7 Gisborne Region

7.1 Catchment #53: Waiapu

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 10 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Mata	15	67	T&T 1978
Waingakia Diversion	15	65	T&T 1978
Waitahaia	7	31	T&T 1978

7.1.1 Mata (16/2)

A short distance downstream of its confluences with the Waitahaia River the Mata River is joined on its left bank by the Mangaohiroa Stream. At this point the river channel narrows to be flanked by steeply rising banks with rock outcrops, forming a suitable site for a dam. The scheme comprises a 40 m high dam with pipelines extending to penstocks feeding water to a power station with an estimated generating capacity of 15 MW giving approximately 67 GWh p.a. (50% plant factor).

7.1.2 Waingakia Diversion (16/9)

Waingakia Stream affords potential for a 'diversion' type hydro scheme making use of the substantial fall able to be gained by diverting flows through to the Mata River. With a catchment area of 49.6 km^2, Waingakia Stream has an estimated long term mean flow in the reach of interest of 6 m^3/s, and by utilising head of up to 260 m, an annual generation output of up to 65 GWh would be achieved from a 15 MW generator (50% plant factor).

7.1.3 Waitahaia (16/14)

The considerable natural fall in the upper reaches of the Waitahaia River affords potential for a 'diversion' type hydro scheme very similar in concept to that previously outlined for the Waingakia Stream. Although the flow in the Waitahaia River at a convenient diversion site exceeds that of the Waingakia Stream, the economically developable head is less than half as much, with the result that the Waitahaia Scheme is estimated to have a generating capacity of about 7 MW, giving approximately 31 GWh p.a. (50% plant factor).

7.2 Other Opportunities in this Region

7.2.1 Prohibited

There are no known prohibited opportunities.

7.2.2 Undefined

With the isolation of some parts of the region and the stringy electricity distribution lines in the region there are areas where micro hydro electric generation is likely to be attractive in the future. Such distributed generation would avoid the need to upgrade old or undersized distribution lines where there are few electricity users.

8 Hawkes Bay Region

8.1 Catchment #16: Wairoa (Hawkes Bay)

This catchment, the fifth in size in the North Island, has:

- existing hydro-electric power stations (e.g. Tuai, Kaitawa, Piripaua, Waihi)
- lake storage (Lake Waikaremoana).

Table 11 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Wairoa - Mangapoike	11	47	BA 1981

8.1.1 Wairoa - Mangapoike

The Mangapoike Valley rises in elevated country to the north-west of Mahia Peninsula, and the River itself flows largely parallel to the Hawke's Bay shoreline, in a westerly direction to join the Wairoa River at its downstream limit.

A small part of the headwaters of this river is diverted for the Gisborne Water Supply and it is notable, considering the matter of road access to the river, that the upper reaches of the river are reached by road from the Gisborne direction while road access to the lower reaches of the river from Frasertown near Wairoa. No through road exists.

Two options have been proposed, one with a high dam which would result in a 23 MW generating capacity, or a lower output one, approximately 11MW, which would significantly reduce the area of land inundated. The lower output option would deliver approximately 47 GWh p.a. (plant factor 50%).

8.2 Catchment #34: Mohaka

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 12 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Mohaka (Raupunga)	75	330	ECNZ 1992, W20/92

8.2.1 Mohaka (Raupunga) (M15)

From its source in the Kaweka Ranges, the Mohaka River travels 172 km into the mouth at Mohaka in Hawkes' Bay. The catchment is steep and rugged, and at 2430 km^2, is eleventh in size in the North Island. A suitable site for a dam is in the lower reaches of the river near Raupunga about 15 km upstream from the mouth.

In evidence given by B. E. Cox for Electricorp regarding the application for a Water Conservation Order for the Mohaka River system in 1991, two dam configurations were considered as possible development schemes at the Raupunga site. A lower one with an 80m head and a higher one at 100m with installed capacities of 85MW and 105 MW respectively.

The 1992 Planning Tribunal report and recommendations on the Mohaka River Water Conservation Order regarding electricity generation identifies that a 70m dam at Raupunga can be accommodated without endangering the outstanding qualities of the river. This idea appears to be reflected in the amended draft water conservation order where development may be allowed below Willowflat.

The level of the lake formed and the height of the dam formed would need to meet the requirements of a Mohaka River Water Conservation Order (currently in draft form).

A 70m dam with an installed capacity of 75MW with a 50% plant factor would result in an annual average of 330 GWh per year of electricity being generated.

8.3 Catchment #21: Ngaruroro

This catchment is the seventh in size in the North Island and has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 13 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Ngaruroro (Below Taruarau) 6/3	21	92	T&T 1981-3
Ngaruroro (Above Taruarau) 6/7	24	103	T&T 1981-3
Ngaruroro (Whanawhana Scheme) 6/21A	30	131	T&T 1981-3
Ngaruroro (Above Whanawhana) 6/1	22	95	T&T 1981-3
Upper Ngaruroro - 6/10	37	164	T&T 1981-3

8.3.1 Ngaruroro (Below Taruarau) (6/3)

This scheme would consist of a 50 m high earth / rock dam with an adjacent powerhouse.

A catchment area of 978 km^2 gives a mean annual flow rate of 33.2 m^3/s, and with a 100 ha intake reservoir, a nett head of 43 m and a 21 MW generator would give approximately 92 GWh p.a. (50% plant factor).

8.3.2 Ngaruroro (Above Taruarau) (6/7)

This scheme would consist of a 41 m high concrete dam and a 0.5 km long tunnel to a powerhouse.

A catchment area of 463 km^2 gives a mean annual flow rate of 19.8 m^3/s, and with a 21 ha intake reservoir, a nett head of 85 m and a 24 MW generator would give approximately 103 GWh p.a. (50% plant factor).

8.3.3 Ngaruroro (Whanawhana Scheme) (6/21A)

The downstream end of the Ngaruroro River gorge at Whanawhana offers a reasonable damsite, provided problems of spillway capacity and shingle movement can be accommodated.

A catchment area of 1100 km^2 gives a mean annual flow rate of 36.5 m^3/s, and with a 380 ha intake reservoir, nett head of 55 m and a 30 MW generator would give approximately 131 GWh p.a. (50% plant factor).

8.3.4 Ngaruroro (Above Whanawhana) (6/1)

This scheme would consist of a 52 m high concrete dam and an adjacent powerhouse.

A catchment area of 1104 km^2 gives a mean annual flow rate of 36.4 m^3/s, and with a 260 ha intake reservoir, a nett head of 39 m and a 21.6 MW generator would give approximately 95 GWh p.a. (50% plant factor).

8.3.5 Upper Ngaruroro (6/10)

A catchment area of 365 km^2 gives a mean annual flow rate of 16.9 m^3/s, and with a 50 ha intake reservoir, a nett head of 153 m and a 37.4 MW generator would give approximately 164 GWh p.a. (50% plant factor).

8.4 Catchment #33: Tukituki

This catchment, the tenth largest in size in the North Island, has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 14 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Tukituki	9	39	TBA

8.4.1 Tukituki

The Tukituki River flows from its headwaters in the Ruahine Range to its mouth at Haumoana in Hawkes Bay. An opportunity being investigated jointly by Centralines Ltd and Meridian Energy Ltd for a combined hydro/irrigation scheme would use a 12 km canal running from just downstream of Waipawa past Otane and rejoining the river about 5 km downstream of Patangata. An installed capacity of 9 MW could be realised, which would give approximately 39 GWh p.a. assuming plant factor of 50%.

Potential Interest – Centralines / Meridian Energy (Current Investigations)

8.5 Other Opportunities in this Region

8.5.1 Prohibited

There are no known prohibited opportunities.

8.5.2 Undefined

#33 Tukituki – Makaroro above Wakarara – 4 MW

9 Taranaki Region

9.1 Catchment #86: Patea

This catchment has:

- an existing hydro-electric power station (Patea)
- controlled lake storage (Lake Rotorangi).

Table 15 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Patea - Diversion into Mangaehu	18	79	BECA 1985

9.1.1 Patea - Diversion into Mangaehu

The Patea River originates on the eastern side of Mt Taranaki and flows down through Stratford and into the inland hill country where it is joined by a major tributary, the Mangaehu Stream.

The upper reaches of the Patea River are not as deeply incised as the middle reaches, upstream of Lake Rotorangi behind the Patea dam. However, approximately 1.7 km upstream of the Mangamingi Bridge there is a site suitable for a storage dam with an overall height up to 64 m. The river channel itself is about 30 m deep.

A reservoir area of 3.9 km^2 at an impoundment height of 50 m with an installed capacity of 18 MW would generate approximately 79 GWh p.a. (50% plant factor).

9.2 Other Opportunities in this Region

9.2.1 Prohibited

There are no known prohibited opportunities

9.2.2 Undefined

#78 Waitara and other North Taranaki rivers

The North Taranaki rivers and in particular the Waitara have reasonably steady flow because of high Taranaki rainfall. There have been few investigations undertaken of these opportunities yet many are in steep sided valleys where dams could be built. Many would be possibly uneconomic because of the distance of power station sites from transmission lines. The inland Taranaki dam sites may also be difficult and thus expensive because of the soil conditions.

#377 Waiwhakaiho, and Mt Taranaki ring plain rivers

The rivers coming off Mt Taranaki have a reasonably high flow because of the high rainfall in the area. The rivers are steep and many run directly to the sea and have no storage capacity. The topography lends itself to the concept of installing storage reservoirs along the river length so as to make use of the water potential. Some investigations have been undertaken into storage opportunities for community water schemes. Combining community water supply and electricity generation would improve the economics of opportunities.

10 Wanganui-Manawatu Region

10.1 Catchment #5: Whanganui

This catchment has:

- diversion of headwaters to Tongariro Power Scheme / Waikato catchment,
- existing hydro-electric power station (Piriaka),
- no controlled lake storage.

Table 16 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Mangawhero to Wanganui Diversion	60	260	MOC 1990
Waimiha Stream	6	27	T&T 1985
Waimarino Stream	6	24	T&T 1985
Waikoura/ Mangakahu Diversion	8	35	MWD 1986
Tokiahuru	30	130	MOC 1990

10.1.1 Mangawhero to Wanganui Diversion

The Mangawhero River, a tributary of the Whangaehu, also has its headwaters on Mt Ruapehu, but does not receive any of the acidic water from the Crater Lake.

A possibility of a hydroelectric scheme exists downstream utilising the height difference between the Mangawhero and the neighbouring Whanganui River. A dam on the Mangawhero in the vicinity of Orore, and tunnel to a powerhouse on the Whanganui River would develop a head of some 300 m and with an installed capacity of 60 MW, would produce approximately 260 GWh p.a. (50% load factor).

10.1.2 Waimiha Stream (A/6/6)

The Waimiha Stream falls some 130 m as it crosses the Ohura fault north-east of Waimiha settlement, and this gives potential for a 15 m dam with a canal and pipeline configuration supplying a power station on Waimiha Stream. A mean flow of 3.6 m^3/s gives an installed capacity of 6 MW, which would produce approximately 27 GWh p.a. (50% plant factor).

10.1.3 Waimarino Stream (A/9/4)

This scheme utilises the steep section of the Waimarino Stream between the Erua Swamp and the Makatote River confluence. This fall would be enhanced by a 25 m high earthfill dam which would flood the swamp creating a reservoir providing significant storage. A 2-3 km lined canal would feed into a power station located on the right bank of the Makatote River just upstream of the confluence. A mean flow of 4.2 m^3/s with an installed capacity of 6 MW, would give approximately 24 GWh p.a. (50% plant factor).

10.1.4 Waikoura / Mangakahu Diversion

The Waikoura scheme is based on a dam in the high level Waikoura Valley feeding a power station in the Mangakahu Valley with a head of about 350 m. It appears possible to divert a string of catchments into the Waikoura, and the initial assessment rated the scheme at 66 MW. Several reassessments have drastically reduced this output to 8 MW and the scheme need no longer be considered in the “large” class.

The dam in the Waikoura Valley would probably be earth of about 150,000 m^3, and about 20 m high with a spillway chute on one side.

Catchment area of 15.2 km^2 with a mean annual flow of 0.3 m^3/s and 316 m nett head would, with an installed capacity of 8 MW give approximately 35 GWh p.a. (plant factor 50%).

10.1.5 Tokiahuru

The Whangaehu River has its headwaters on Mt Ruapehu and flows to the Tasman Sea south of Wanganui. The waters received from Crater Lake periodically give the river a relatively high acidity, conditions not favourable to fish and wildlife. The acidity would also require the use of special materials in generation machinery and structures. Some water from freshwater tributaries e.g. Wahianoa River, are diverted to the Taupo/Waikato catchment for use in the Tongariro Power Scheme / Waikato River power stations.

There are possible hydro-electric schemes which have been identified on the Whangaehu River. In the upper catchment there is an opportunity to develop a scheme which diverts the Tokiahuru Stream tributary via a 2 km long canal and then on to a 10 MW power station on the Whangaehu River via a 2km canal/pipeline.

Just downstream of the powerhouse for the above scheme is a possible scheme which bypasses a U-shaped section of the Whangaehu River with a 2.5 km long tunnel to a 20 MW power station.

When combined, this 30 MW scheme would deliver approximately 130 GWh p.a. (50% load factor).

10.2 Catchment #15: Rangitikei

This catchment has:

- diversion of headwaters (Moawhango) to Tongariro Power Scheme / Waikato catchment,
- no existing hydro-electric power stations,
- no controlled lake storage (Lake Moawhango excepted).

Table 17 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Hautapu	9	41	T&T 1985

10.2.1 Hautapu (C/1/1)

The Hautapu River flows past Taihape to join the Rangitikei River near Utiku. It offers worthwhile hydro potential downstream of the Turangarere where the river falls 240 m in 22 km.

Studies have identified some 9 MW potential (approximately 41 GWh p.a. with 50% plant factor) which could be developed by a diversion type scheme with a combination of canal, tunnel, pipeline and a power station near Ngawaka Road deviation.

10.3 Catchment #7: Manawatu

This catchment has:

- existing hydro-electric power station (Mangahao),
- controlled lake storage (Mangahao Reservoirs).

Table 18 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Pohangina	10	41	T&T 1985

Note: A 3 MW power station at Mangahao No. 1 dam (previously included in assessments of potential hydro) is presently being constructed / commissioned (January 2004).

10.3.1 Pohangina (D/3/1A)

As the Pohangina River flows out from the Ruahine Ranges it falls steeply from above elevation 1000 m to elevation 300 m and this fall affords the potential for two schemes.

One scheme involves an intake structure with a 4 km concrete pipeline and a 750 m penstock to the powerhouse. An installed capacity of 10 MW would generate approximately 40 GWh p.a. (50% load factor).

10.4 Other Opportunities in this Region

10.4.1 Prohibited

#5 Manganui a te Ao / Mangaturuturu – 8 MW (National Water Conservation (Manganuioteao River) Order 1989)

10.4.2 Undefined

#5 Whanganui catchment

Whakapapanui I Makahikatoa – 5 MW

Waimarino – 6 MW

#44 Whangaehu catchment

Makotuku – 10 MW (Diversion weirs on Makotuku and Mangawhero, just south of Raetihi)

Tokiahuru / Mangaturuturu – 10 MW

#231 Otaki – 10 MW

11 Wellington (Including Wairarapa) Region

11.1 Catchment #22: Ruamahanga

This catchment has:

- an existing hydro-electric power station (e.g. Kourarau south-east of Masterton),
- no controlled lake storage.

Table 19 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Waiohine - Devils Creek	6	26	T&T 1981-1
Waingawa - Kaituna	7	30	T&T 1981-1

11.1.1 Waiohine - Devils Creek (1A)

The Waiohine River exits the Tararua Ranges just north-east of Greytown. The concept of this scheme endeavours to combine the best features of a dam in a narrow gorge with a canal running along the highest terrace of the east bank of the Waiohine River.

There is a narrow constriction in the gorge which could be suitable for a concrete arch dam of height about 23 m. The dam would form a relatively small reservoir contained almost exclusively within the river gorge.

A canal would run some 1900 metres, crossing Devils Creek on a culverted embankment, until constrained by the steep valley side and thence to a power station.

A catchment area of 173 km^2 gives a mean flow of 17.3 m^3/s and, with a nett head of 28.0 m, and a 6 MW plant would deliver approximately 26 GWh p.a. (plant factor 50%).

11.1.2 Waingawa - Kaituna (4/2A & 4/2B)

The Kaituna area is just west of Masterton. In this area a short distance downstream of the confluence of the Atiwhakatu stream, the Waingawa River emerges from its gorge in the Tararua Ranges and flows in a wide alluvial flood plain. The two schemes envisage a shallow diversion weir diverting flows up to about 1½ times mean annual flow into an unlined canal running on the east bank of the river and climbing progressively up onto the terraces. At a point about 1.5 km downstream of the intake, water could be returned to the river through a 3.3 MW power station (Scheme 4/2B) or a diversion could be continued to the east, crossing the Plains road and feeding a storage head pond in a shallow eastern tributary valley. From this head pond would run a concrete pipeline and short steel penstock feeding a 7 MW power station (Scheme 4/2A) from which water would return to the river by way of a tailrace channel, giving approximately 30 GWh p.a. (50% plant factor).

Wairarapa Electricity carried out investigations and consultation for a scheme based on the use of this resource. The scheme was opposed by a group called "Wairarapa Electricity Shareholders and Consumers Association" (WESCA). The scheme was put aside by Wairarapa Electricity and WESCA was disbanded in 1997.

11.2 Other Opportunities in this Region

11.2.1 Prohibited

Water Conservation (Rangitikei River) Order 1993 may affect opportunities [MOC 1990].

11.2.2 Undefined

#22 – Ruamahanga River – Reef Hill / Stoney Flat – 10 MW

#147 Hutt River – Pakuratahi / Kaitoke Saddle – 7 MW

12 Nelson-Marlborough Region

12.1 Catchment #106: Pelorus

This catchment has:

- no existing hydro-electric power stations (excluding network connected stations),

- no controlled lake storage.

Table 20 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Pelorus	7	32	RSML 1981-2

12.1.1 Pelorus River

A site was found where the topography seemed favourable for the construction of a rock fill dam. The proposed dam site, at Rainy River, is 6.5 km downstream of Pelorus Bridge on State Highway 6. It was proposed that the dam would be constructed some 120 m upstream of the Pelorus and Rainy river confluence. At this point, the gorge is approximately 40 m deep and the river bed some 15 m wide. Therefore it is assumed that an average annual flow of 17 m^3/s at the dam site could be expected. The 40 m head and an installed capacity of 7 MW would deliver approximately 32 GWh p.a. (50% plant factor).

12.2 Catchment #18: Wairau

This catchment has:

- existing hydro-electric power stations, (e.g. Branch, Waihopai)
- no significant controlled lake storage.

Table 21 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Wairau	100	500	TPL 2003-1
Waihopai	6	26	RSML 1981-2

12.2.1 Wairau

The proposed scheme is an extension of TrustPower’s Branch hydroelectric scheme. Under the project, part of the Wairau River flow would be diverted into the existing Branch scheme and the water conveyed through interconnecting canals and penstocks to new power stations, with the tailrace of the last station at the end of the Wairau Valley, about 25 km south west of Blenheim.

With a proposed additional installed capacity of approximately 100 MW, the scheme would generate about an additional 500 GWh of electrical energy annually.

TrustPower are currently carrying out an environmental feasibility assessment and have indicated that, subject to project feasibility, they expect to apply for resource consents in April this year.

Possible Interest – TrustPower (owns existing power stations, investigating the opportunity)

12.2.2 Waihopai

The Waihopai River has its source in the mountains east of the Leatham and Branch Rivers. It flows north-east to join the Wairau upstream of Renwick. Desk studies indicated a possible scheme on the lower Waihopai River with an intake upstream of the bridge adjacent to the 150 m contour for 9 km along the base of the left bank foothills. As the river is entrenched in rock for 3-4 m, a large concrete weir structure would be required to abstract water at the terrace level.

This scheme would also have an irrigation potential of some 1600 ha of prime farmland.

From an installed flow of 25 m^3/s, and with a head of 30 m, an installed capacity 6 MW would give approximately 26 GWh at 50% plant factor.

12.3 Catchment #54: Awatere

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 22 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Middle Awatere	12	50	RSML 1981-2

12.3.1 Middle Awatere

The section of river from Gladstone Bridge to the Medway River confluence is referred to in this report as the Middle Awatere. There are several dam sites in the gorge and the best one was considered to be some 4 km upstream of the Jordan River confluence (about 35 km up the Awatere Valley from Seddon).

The mean annual flow recorded is 20.94 m^3/s. A 49 m high earth dam could be constructed in the gorge with nett head of 46 m which, with an installed capacity of 12 MW, would deliver approximately 50 GWh p.a. (50% plant factor).

12.4 Catchment #126: Waimea

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 23 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Wairoa Gorge	16	70	NZERDC 1979

12.4.1 Wairoa Gorge

At the point at which the Wairoa River emerges from steep hilly country on the Waimea Plains near Wakefield (south-west of Nelson), it has a gauged mean flow of over 16 m^3/s. About 2 km upstream from this point the river forks with approximately half the total flow coming from each of the Wairoa to the west and the combined Lee and Roding catchments to the east.

The proposal involves the damming of the Wairoa immediately downstream of the Lee River confluence to create a head of 90 m with the purpose of creating benefits from flood mitigation, irrigation, town water supply, recreation, and electricity generation. If it can be shown that the economic benefits of such a scheme justify its construction then it could provide useful power for the area, with a proposed peak output of 16 MW, delivering approximately 70 GWh p.a. (50% plant factor).

12.5 Other Opportunities in this Region

12.5.1 Prohibited

#18 Waihopai River – 6 MW

12.5.2 Undefined

#41 Motueka – 39 MW

#54 Upper Awatere River – 4 MW

#109 Takaka

Cobb Scheme Supplement – 5 MW

Anatoki River – 13 MW

#222 Aorere – Finney Creek – 30 MW

13 West Coast Region

13.1 Catchment #14: Grey

This catchment has:

- an existing hydro-electric power station (Arnold),
- no controlled lake storage.

Table 24 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Rough River	11	49	RSML 1985-2
Upper Grey (a)	7	31	RSML 1985-2
Upper Grey (b)	10	44	RSML 1985-2
Upper Grey (c)	35	153	RSML 1985-2
Upper Grey (d)	18	79	RSML 1985-2
Lower Grey	210	920	NHRA 7
Dobson	60	270	TPL 2003-2

13.1.1 Rough River

The 30 km long Rough River lies on the eastern side of the Paparoa Ranges joining the Grey River about 3 km below Ikamatua. Its long narrow valley was shaped by glacial action but is now clad in bush up to 1000m.

A small hydro scheme could be constructed with an intake immediately below Mirfin Creek and 10 km above the Atarau Road bridge. A race would run approximately 8 km from here through outwash gravels on the true right to gain 65m head above a powerhouse site on the river flats 2 km above the bridge. The first section of race is an easy sidle onto a wide terrace where some short term storage could be provided.

The mean flow from the 124 km^2 catchment is estimated to be 15.8 m^3/s. This would lead to an installed capacity 11 MW, giving approximately 49 GWh p.a. (50% plant factor).

13.1.2 The Upper Grey

The schemes on the Upper Grey include three river intake and race sites and a dam site.

The first intake site lies 2 km below the confluence of the Blue Grey and the Upper Grey about 20 km south-west of Springs Junction.

From the intake site a race about 6 km long would follow the contour on the true left bank to a point above the Grey where it swings north-west.

The estimated mean flow at the intake is 12.9 m^3/s from the 192 km^2 catchment. The mean flow is 17m^3/s. The installed capacity would be 7 MW, giving approximately 31 GWh p.a. (50% plant factor).

The second intake site would be on the section of the Grey between the Tass River and the Gentle Annie Gorge.

This scheme is similar to the first scheme with a race running about 6 km along the toe of the hill on the true right to a point just short of Snow Creek where 30 m head is obtainable.

The estimated mean flow at the intake site is 28.9 m^3/s from the 402 km^2 catchment. The installed capacity would be 10 MW, giving approximately 44 GWh p.a. (50% plant factor).

The third site on the Grey lies at the lower end of the Waipuna Gorge where the high granite walls would enable a dam of around 75m height to be constructed creating a reservoir back through the gorge and over the lower end of the river flats above to approximately the 250 m level.

The estimated mean flow at the dam site is 38.3 m^3/s from the 540 km^2 catchment. An installed capacity of 35MW would give approximately 153 GWh p.a. (50% plant factor).

The fourth and lower of the schemes on the Upper Grey is a further river intake site in a small granite outcrop through which the river passes about 6 km downstream of the Waipuna Gorge. From here a race would follow the 150 m contour 9 km along the terraces and terrace faces on the true left to gain 30m head at the confluence of the Grey and Waipuna Rivers just south of the Ikamatua.

The mean flow at the intake site is estimated to be 48.6 m^3/s from the 642 km^2 catchment. The installed capacity would be 18MW, giving approximately 79 GWh p.a. (50% plant factor).

13.1.3 Lower Grey

A large scale scheme of around 210 MW (approximately 920 GWh p.a. at plant factor of 50%) appears feasible at the head of the Brunner Gorge near the settlement of Stillwater. This scheme could consist of a large dam impounding water to a height of 50 m. This opportunity has been recognised for many years although no significant investigations have been undertaken. Such a dam would have significant flood mitigation effects[8]. The output of this allows for diversion of the Arnold as proposed by the Dobson scheme.

For this scheme, a dam would be located upstream of Brunner connected to a powerhouse on the left bank near Dobson by a short length of forebay canal and penstocks.

13.1.4 Dobson

Flow from the Arnold River would be diverted at the existing Arnold Dam through a canal to a storage lake in the Stillwater Creek catchment of the Kaiata Range behind Dobson. Water will be conveyed from the storage lake through the Kaiata Range via a tunnel and penstocks to a new power station at Dobson.

The estimated 60 MW peaking station would generate about 270 GWh electricity annually (plant factor about 50%). It would not only give the West Coast self-reliance in electricity but also allow the export of surplus power to Nelson and Marlborough.

Possible Interest – TrustPower (owner of Arnold Power Station)

13.2 Other Opportunities in this Region

From a hydro-electric perspective, with a high rainfall and hilly terrain with little coastal plain, the West Coast has flows and head suitable for electricity generation.

However, catchments are very "flashy" meaning that the ability to gain a high level of reliable generation is likely to be very expensive and there is limited opportunity for storage.

At least two of the existing power stations utilise the storage available in lakes in the area. They are the Arnold, on the Arnold River that flows from Lake Brunner (Moana) and Dillmans that uses the flow from Lake Kaniere.

[8] Evidence presented by D.G. Goring (for ECNZ) “Grey River Water Conservation Order Hearing” – Dec. 1988.

Along with other opportunities that are restricted by the Buller River Water Conservation Order (WCO) (but not so in the case of the Grey River WCO) there are a significant number of catchments where opportunities have been identified, but the uptake is limited because of the cost etc of building transmission lines to connect them to the grid. Some of those opportunities are more suited to local community supply but are listed here for information.

However, there is also the issue of the limited transmission capacity from the Canterbury and Nelson regions to the West Coast. Transpower has identified this as a key issue [AMP 2000/01] and identified that one option is to increase the generation in the area.

13.2.1 Prohibited

#6 Buller catchment (Water Conservation (Buller River) Order 2001)

Upper Buller

Nardoo Creek – 5 MW

Fyfe River – 6 MW

Lake Matiri / Matiri – 20 MW

Stony River – 7 MW

Gowan River – 15 MW

The National Water Conservation (Grey River) Order 1991 is not considered to affect opportunities.

13.2.2 Undefined

#64 Haast - Zeilian Creek – 9 MW

#145 – Moeraki – Moeraki River – 9 MW

#155 – Wanganui – Amethyst River – 8 MW

#168 – Waitoto – Te Naihi River – 9 MW

#261 Taramakau – Taipo – 33 MW

#320 Matatahi River – 9 MW

#671 Lake Rochfort – 6 MW

#261 Waiho / Tartare River – 6 MW

#552 Waimangaroa – 22 MW

With the high flow in Westland rivers there are opportunities for micro hydros in many locations. This is a tradition of the area that could be re-established through the use of modern control technologies.

14 Canterbury Region

14.1 Catchment #23: Waiau

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 25 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Clarence to Waiau Diversion	70	300	NHRA 8
Upper Waiau	56	240	NHRA 8
Mid Waiau	60	270	NHRA 8
Lower Waiau	50	220	NHRA 8

14.1.1 Clarence to Waiau Diversion

The arrangement investigated for this opportunity diverts water from the Clarence catchment into the Waiau catchment near Hanmer Springs. A concrete dam/spillway would be located on the Clarence approximately 1500m downstream of the Jollies Pass road where the river is flowing predominately northwards. The dam would raise the water level 30 m and divert it through a 3500 m tunnel to a surge chamber and powerhouse near Hanmer Springs. A six kilometre tailrace canal would then discharge water into the Hanmer River about six kilometres from its confluence with the Waiau. An installed capacity of 70 MW would give approximately 300 GWh p.a. (50% plant factor)

14.1.2 Upper Waiau (W97)

This scheme is based on damming the Waiau midway between the Hope confluence and Hanmer Plain, where the river is flowing predominantly eastward. The dam/spillway would raise the water level 46 m and generate power in an adjacent powerhouse. An installed capacity of 56 MW would give an annual output of approximately 240 GWh p.a. (50% plant factor).

14.1.3 Mid Waiau (W81)

This scheme has been assumed to be integrated with the Clarence C171 scheme.

The scheme would be located in a gorge in the Waiau downstream from Hanmer Springs, at a locality known as “Hells Gate Corner”, some 81 km from the mouth. The river at this point abruptly changes course from flowing predominantly eastward to flowing predominantly southward on leaving Hanmer Plain. The scheme consists of a dam/spillway raising the water level some 40 m, with an associated powerhouse. An installed capacity of 60 MW would give an annual output of approximately 270 GWh p.a. (50% plant factor).

14.1.4 Lower Waiau (W2)

The scheme studied would involve damming the Waiau two kilometres from the mouth of the river where the river is flowing predominantly south-eastward. The dam/spillway would raise the water level 25 m and pass it to a powerhouse sited on more gentle slopes about 300m below the dam. An installed capacity of 50 MW would give approximately 220 GWh p.a. (50% plant factor).

14.2 Catchment #31: Hurunui

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 26 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Hurunui (H24)	36	160	NHRA 8
Hurunui (H36)	43	190	NHRA 8

14.2.1 Hurunui (H24)

Two possible dam sites on the lower Hurunui where the river is entrenched in the Lowry Peaks Range were suggested.

The proposed dam site would be upstream of the State Highway 1 bridge. The mean annual flow at this point is estimated (from earlier work) to be 58 m^3/s. The river is still entrenched in the Lowry Peaks Range at this point.

The available flow and 45 m head at this site, with a 36 MW generator, would give approximately 160 GWh p.a. (50% plant factor).

14.2.2 Hurunui (H36)

This envisages a dam sited just below the Pahau River confluence and would raise the water by about 48 m. The power station, with an installed capacity of 43 MW, would give approximately 190 GWh p.a. (50% plant factor).

14.3 Catchment #51: Ashburton

This catchment has:

- no existing hydro-electric power stations,
- no controlled lake storage.

Table 27 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Blowing Point	7	31	CPWN #2

14.3.1 Blowing Point

An irrigation water enhancement scheme pre-feasibility study for the Ashburton Community Water Trust identifies opportunities that would draw water at times of higher flows from high country tributaries in the Rangitata, Ashburton and Rakaia catchments. This water would be channelled into one or more storage reservoirs, with potential sites identified in the Stour River valley and at Blowing Point in the Ashburton gorge. There is a possibility of a 7 to 8 MW power station being incorporated into a Blowing Point Dam, giving approximately 31 GWh p.a. (50% plant factor).

14.4 Catchment #3: Waitaki

This catchment has:

- the largest storage capacity of New Zealand lakes for hydro-electric use
- existing hydro-electric power stations (e.g. Benmore, Waitaki),
- controlled lake storage (Tekapo, Pukaki, Ohau)

Table 28 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Project Aqua	524	3000	MEL 2004
Pukaki Canal Intake	44	120	SKM 2003
Hopkins River	9	37	RSML 1982-2
Waiareka-Kakanui Irrigation Scheme	11	51	RSML 1982-2

14.4.1 Project Aqua

Project Aqua is a proposed hydro-electric scheme that would run along a 60km canal on the south side of the lower Waitaki River. It would comprise six individual generation units in series, with a combined total capacity of around 524 MW. It is expected to generate around 3,000GWh in a mean hydro year, and around 2,000 GWh in a 1-in-20 dry-year. (Note: Generation statistics from MEL)

14.4.2 Pukaki Canal Intake

The difference in head between Lake Pukaki and the Pukaki – Ohau A Canal that conveys the lake water to Ohau A power station can be utilised for generation.

A recent review study identified, among a number of opportunities, building a new low station at Pukaki dam canal intake. This station would have an output of about 40 MW when the lake was full. As the head for this station will change significantly with normal operational changes in the level of Lake Pukaki, the amount of energy generated (indicatively 120 GWh p.a.[9]) will be very dependant on the management of Lake Pukaki storage.

14.4.3 Hopkins River

Desk studies have indicated a possible small hydro scheme on the Hopkins River. The scheme would divert the river at the 580 m contour, the narrowest point, with a 5,500 m headrace on the right bank, to a headpond. From here water would be conveyed by twin penstocks to a powerhouse at river bed level. The race would cross five small side streams.

This scheme would have an estimated mean annual flow at intake 24.5 m^3/s. A 30 m head and an installed capacity of 9 MW would give approximately 37 GWh p.a. (50% plant factor).

As a concrete stream bed intake structure would not be practical in this river because of size and cost, a system similar to the Wilberforce River diversion into Lake Coleridge could be feasible.

14.4.4 Waiareka–Kakanui Irrigation Scheme

The Ministry of Works and Development had proposals to irrigate the Waiareka-Kakanui district. With an irrigation scheme that would abstract 22 m^3/s from the Waitaki River near the 150 m contour with a 24 km race to a tunnel portal near the Awamoko Stream. A 3 km tunnel would then convey water to the Waiareka-Kakanui valley for distribution in the irrigation race network, with some 60 m head available from the irrigation race at the Awamoko Stream to the Waitaki River.

The irrigation flow would be shut off at the tunnel portal and a power station or stations totalling 11 MW built to use this head. A headpond would be incorporated in the main race. The tailrace would then connect into the Awamoko Stream.

The forecast energy output (of 51 GWh p.a.) has been based on an 85 % plant factor for 7 months of the year.

This ability to take up opportunity will be dependent on the outcome of decisions on Project Aqua and irrigation proposals in this area.

14.5 Other Opportunities in this Region

There are a number of rivers in Canterbury where other opportunities have been identified. This is the region most likely to have further hydro-electric development associated with irrigation (Highbank and Montalto are existing power stations associated with the Rangitata Diversion Race).

[9] SKM – Jan 2004.

14.5.1 Prohibited

Restrictions in the Canterbury Region include National Water Conservation (Ahuriri River) Order 1990 and National Water Conservation (Rakaia River) Order 1988.

#3 Ahuriri – Avon Burn (1 & 2) – 6 MW

#30 Rakaia – 35 MW

14.5.2 Undefined

#17 Waimakariri – 100 MW

#24 Lower Clarence

#23 Waiau – Kakapo Brook – 5 MW

#77 Ashley catchment

Ashley River – 5 MW

Ashley Gorge dam – 8 MW

#472 Rangitata – 50 MW

15 Otago Region

15.1 Catchment #1: Clutha

This catchment has:

- the largest catchment area of New Zealand rivers.
- the highest mean flow
- existing hydro-electric power stations (e.g. Roxburgh, Clyde),
- controlled lake storage (Hawea)

Table 29 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Manuherikia River	7	23	RSML 1982-1
Luggate	90	435	MWD 1982-2
Queensberry Hills	180	860	MWD 1982-2
Hawea	90	435	SKM 2003
Nevis	45	197	OCEPB 1984

15.1.1 Manuherikia River

The Manuherikia River has its source in the Hawkdun, Wether, Ewe and St. Bathans Ranges from where it flows south to the Falls Dam reservoir. From here the river flows south-west through Omakau to the Clutha at Alexandra.

The study area covers the section of the Manuherikia River above the Dunstan Creek confluence.

The Falls Dam was constructed to store some winter flows, for release in the summer for irrigation schemes downstream. However, the demand for irrigation water has increased and the present storage cannot cope with the demand. The Ministry of Works and Development had proposals to construct a new dam downstream of the existing dam. The proposed dam would be 25 m higher than the existing dam with a storage capacity of 100 million cubic metres. The storage capacity would be ten times the existing scheme.

The proposed irrigation scheme would use an average of 60 million cubic metres of water out of storage each season from September to April. The additional 40 million cubic metres is reserve storage for consecutive dry winters.

The mean annual flow at the dam is 6.15 m^3/s.

The irrigation peak demand period is from December to February with an expected maximum irrigation flow of 8 m^3/s. A minimum residual flow of 1 m^3/s is expected to be required in the Manuherikia River downstream of the dam. Therefore, the maximum flow from the storage reservoir would be 9 m^3/s.

There is potential for a combined small hydro / irrigation development at this site although most of the generation would be outside the peak power demand period.

Mechanical plant for such a scheme may be expensive as the scheme would operate under variable head and flow.

Below the dam the river is confined to a narrow steep sided gorge for 3 km. The proposed powerhouse would be constructed adjacent to the river near the 520 m contour level. As the river is confined by 10 m high rock walls the powerhouse site would have to be cut into rock. A single penstock would convey water from the dam to the powerhouse, a distance of 900 m.

The outlet from the bottom of the dam would be a combined power and irrigation pipe conduit with a bypass at the powerhouse. The maximum head available would be approximately 90 m and assuming a maximum flow of 9 m^3/s the installed capacity would be 7 MW. The residual flow of 1 m^3/s in the winter months downstream of the powerhouse would have an output of 580 kW from an average head of 70 m.

The energy output from this scheme would be approximately 23 GWh p.a. (50% load factor). This is based on a total average annual flow of 140 million cubic metres passing through the turbines at an average head of 70 m.

In 2003 Pioneer Generation Ltd commissioned a 1.2 MW power station at Falls Dam. As this uses a part of the available head it (adversely) alters the economics of this Manuherikia option.

15.1.2 Luggate and Queensberry

The upper Clutha has a mean flow of about 260 m^3/s, and a fall of about 83 m from Lake Wanaka to the head of Lake Dunstan, which means that there is potentially a large hydro-electric resource available. The gorge within the river flats provides sites for dams which would retain water to levels which inundate only small areas of cultivated and farmed river flats.

The most appropriate combination of dams, diversion structures, spillways, powerhouses and canals relates closely to the topography. It has been found that an arrangement with one or two dams and one or two powerhouses is significantly more economical than one with three dams or powerhouses. The actual positioning of structures has required detailed study and is, in part, affected by the geology.

Luggate and Queensberry are two specific proposals for hydro development of the Clutha River upstream of Clyde Power Station / Lake Dunstan. It is preferable to consider them jointly, as they use the available head between the downstream limit of the Lake Wanaka Preservation Act (Clutha / Cardrona confluence) and Lake Dunstan.

It is possible that further investigation may result in other options with different capacities to utilise this available head and associated flows to best effect.

Possible Interest – Contact Energy (Owner of Clutha River based power stations etc, landowner in the Luggate, Queensberry area.)

15.1.3 Hawea

There are two schemes (30 MW and 60 MW) identified. The 30 MW scheme at Hawea consists of replacing the existing works used to control the discharge from the lake with a 30 MW hydropower scheme. The 60 MW scheme diverts water downstream of the 30 MW scheme and conveys it by canal across country where it would finally enter a 60 MW power station on the Clutha River. Approximately 435 GWh p.a. could be produced from these two stations (plant factor of 50%).

Possible Interest – Contact Energy (Owner of Clutha River based power station etc, landowner in the Luggate . Queensberry area.)

15.1.4 Nevis

The Nevis River rises in the Remarkables and the Hector Mountains to the west and in the Garvie Mountains to the east.

The Nevis River is a tributary of the Kawarau and their confluence is at the upstream end of the Kawarau Gorge, between Queenstown and Cromwell / Lake Dunstan. This scheme consists of two dams on the Nevis River storing and diverting water to a powerhouse further down the Nevis. The upper dam would be located at Nevis Crossing and would provide water storage for the scheme. The lower dam would be some 2km further downstream and would divert the water into a 6.5 km tunnel.

A large volume storage lake would be obtained in the lower valley by an arch dam constructed just downstream of the Nevis bridge. An intake dam also of concrete arch construction would be erected at the mouth of the gorge about 2 km downstream and would include the additional flow of the Nevis Burn stream. The average flow here is 10.5 m^3/s and the area drained is 510 km^2. At this point a concrete lined tunnel would be driven 8km parallel to the river to a point above the power station and a steel penstock installed to carry the water to it. The head developed would be 300 m and with 45 MW, would give approximately 197 GWh p.a. (50% plant factor). The elevation of the power station is 300m.

Possible Interest – Pioneer Generation (publicity about investigations).

15.2 Catchment #9: Taieri

This catchment has:

- existing hydro-electric power stations (e.g. Waipori, Paerau),
- associated controlled lake storage (Mahinerangi)

Table 30 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Taieri Falls	8	35	RSML 1982-1
Lower Taieri	18	79	RSML 1982-1
Taieri - Deep Stream	7	30	RSML 1982-1
Taieri - Lee Stream	7	31	RSML 1982-1

15.2.1 Taieri Falls

In 1977 a scheme to use the head from the Taieri Falls to Canadian Flat was investigated by the Otago Electric Power Board's Consulting Engineers.

The proposed Taieri Falls scheme would require a 40 m high earth/rockfill dam above Taieri Falls. The original proposal was for a 2.25 m diameter 900 m long tunnel, to divert water from the dam to emerge on the hillside above Canadian Flat at a surge chamber. From the surge chamber penstocks would carry the water to a powerhouse on Canadian Flat.

However, subsequent high tunnelling costs in a nearby scheme indicate that a pipe conduit benched into the side of the hill may be more economic. The other scheme details would remain the same.

With an installed flow of 4.8 m^3/s giving a 50% plant factor and with a head of 201 m, the installed capacity would be 8 MW, giving approximately 35 GWh p.a. (50% plant factor).

15.2.2 Lower Taieri

The second possible site for a dam storage scheme on the Taieri is just upstream of Hindon, where the river loops around through 180º. The river is confined in rock for a considerable distance upstream and downstream of the proposed site and therefore the storage would be limited to the river channel.

A 45 m high earth or rockfill dam could be constructed at this site with the storage lake extending some 5 km upstream.

The gauged mean annual flow at Hindon is 34.5 m^3/s and an installed flow of 55 m^3/s giving a 50% plant factor, seems reasonable. At this installed flow and with a head of 40 m, the installed capacity would be 18 MW, giving approximately 79 GWh p.a.

15.2.3 Taieri - Deep Stream

Deep Stream drops quite rapidly over its final 5 km, but a scheme on this section of the river would have to abstract water at the 300 m contour level to achieve a practical race alignment. This requires an intake 90 m higher and a further 13 km upstream to where the 300 m contour crosses the river. This intake would be approximately 26 km downstream of the diversion into Lake Mahinerangi. Part of the headworks system would be in pipe conduit but the majority would be in open race with a total length of 23 km. The proposed penstock route and powerhouse site is in Deep Stream near its confluence with the Taieri River. Some storage may be available along the race alignment.

The mean annual flow available is 3.9 m^3/s after subtracting present and future water commitments (1982). With an installed flow of 4.2 m^3/s giving a 50% plant factor, the installed capacity would be 7 MW from the 194 m head, giving approximately 30 GWh p.a.

15.2.4 Taieri - Lee Stream

Lee Stream rises in the hill country to the north of Lake Mahinerangi and to the south-east of the Lammermoor Range from where it flows generally south-eastwards to join the Taieri River about 5 km upstream of Outram. The river drops rapidly over its last 4 km and it is this section of river that affords potential for small hydro development.

A tunnel diversion scheme was proposed for Lee Stream at the beginning of the 1900's. The proposed tunnel had a 2.13 m diameter and was some 2150 m in length. The construction of the tunnel was started from both ends and some 610 m of tunnel had been excavated before the contractor went bankrupt, and the project was abandoned around 1903.

The Dunedin City Electricity Department had extensively investigated scheme options, using the 1903 part tunnel but they have all been uneconomic.

An alternative to the above scheme would be to sidle around the hillside with a conduit following the contours using the same head as the 1900 tunnel proposal.

The estimated mean flow is 2.9 m^3/s from the 284 km^2. With an installed flow of 4.2 m^3/s giving a 50% plant factor and a head of 200 m, the installed capacity would be 7 MW, giving approximately 31 GWh p.a.

15.3 Other Opportunities in this Region

While there are a number of power stations on the two main river systems (Clutha and Taieri, including its main tributary, the Waipori) as well as specific opportunities (e.g. Luggate, Queensberry) being identified, these rivers also contain almost all of the other opportunities in the region. In large part the continuing interest in the Clutha especially is a result of it having the largest flow of all New Zealand rivers, some suitable locations to use the available head and a predominately lake-fed system.

15.3.1 Prohibited

Relevant Restrictions in this region include:

Water Conservation (Kawarau River) Order 1997

Pomahaka River – ex Local Conservation Notice

#1 Pomahaka River – 6 MW

15.3.2 Undefined

#1 Clutha catchment

Lower Clutha – 350 MW

Dumbarton Rock – 110 MW

Manuherikia River Irrigational Hydro Dunstan Creek – 7 MW

Upper Fraser River – 7 MW (h-bend)

Teviot River ‘C’ – 6 MW

Staircase Creek – 5 MW

16 Southland Region

16.1 Catchment #4: Waiau

This catchment has:

- existing hydro-electric power stations (Manapouri and Monowai),
- controlled lake storage (Manapouri and Te Anau).

Table 31 Hydropower opportunities in this catchment with high to medium confidence of proceeding in the next 20 years.

Name	MW	Average Energy Production (GWh pa)	Public Reference
Te Anau Gates	65	350	SREA 2003

16.1.1 Te Anau Gates

The outflow for water from Lake Te Anau into Lake Manapouri is controlled by a gate structure at the entrance to the Upper Waiau River.

There is about 20m head difference between Lakes Te Anau and Manapouri. This head can be utilised for generation of electricity by either an in river low embankment/powerhouse scheme or by construction of a tunnel to a powerhouse on the shore of Lake Manapouri. Either of these schemes could have an installed capacity of around 65 MW (350 GWh). The area is on the edge of the National Park so care in design to protect the Park area would be necessary.

16.2 Other Opportunities in this Region

16.2.1 Prohibited

The Southland region has vast hydro potential but most of it is unavailable within the Fiordland National Park. There is also the Water Conservation (Mataura River) Order 1997.

#11 Mataura Catchment

Waikaia

The Waikaia river tributary of the Mataura offers potential for a 400m head scheme developing 19 MW (80 GWh) from a tunnel diversion. This is currently prohibited by the Water Conservation Order.

Mataura Canal Hydro

Although previous studies emphasised the potential of dams built in gorges it may be possible to develop an out of river canal type hydro generation scheme in parts of the Mataura catchment and so avoid impoundment. This would entail extraction of some flow from the main stream of the river and running this along canals to a power station where it would come back into the river. A canal project could be around 6MW and produce 30-35GWh.

#136 Lake Hauroko

While this project is within the National Park, the successful expansion of the Manapouri power station has shown that hydro projects can be constructed in National Parks without adversely affecting the environmental qualities. Lake Hauroko is approximately 125 m head above Lake Poteriteri and by use of a tunnel and underground power station this head could be used to generate electricity. An alternative is a scheme that uses the head of about 160 m between Lake Hauroko and Te Waewae Bay. In either case a residual flow regime for the Wairaurahiri River would need to be incorporated in any development.

16.2.2 Undefined

The area of the region outside the National Parks has only two significant catchments, the Waiau and the Mataura, and the smaller Oreti.

A comprehensive study of the hydro potential of the region was undertaken in 1983. However this was undertaken under a different era and the type of projects being investigated today are quite different in terms of concept and relationship with adjacent communities.

The possible Southland schemes range from run-of-river which produces base load electricity, to small niche schemes that are suitable for embedded generation similar to that of the existing 0.6 MW Mataura hydro power station.

#4 Waiau Catchment

Lower Waiau Canal Hydro

The flow in the Waiau River is largely dependent on the generation requirements of the Manapouri power station although the Manapouri resource consent sets a minimum flow condition, which would have to be maintained with any generation development.

It may be possible to develop an out of river canal type hydro generation scheme in parts of the lower Waiau catchment. This would entail extraction of some flow from the main stream of the river and running this along canals to a power station where it would come back into the river. If a 12 MW scheme were built it could produce around 55 GWh. This has not been investigated but indications are that it may be possible.

Upgrade Monowai Power Station

The existing Monowai power station has a capacity of 6.3MW and produces 35-40GWh of electricity per annum. Resource consents have recently been obtained for continued operation of the station. Options for additional flow from the Borland River and additional generation using the existing flow have been identified but are not currently considered economic. There may also be environmental issues relating to the Borland option.

Lake Monowai storage could also be coupled with a nearby windfarm to firm the wind energy.

Upper Mararoa

Schemes have previously been considered on the upper Mararoa. Without site investigation it is unknown whether these are viable.

Mararoa Weir

The Mararoa Weir has a small head, which could be utilised for generation of electricity using the residual flow. Other than a penstock and generating equipment no structural work would be required as the weir already has the capacity to handle diversion floodwater.

#20 Oreti Canal Hydro

It may be possible to develop an out of river canal type hydro generation scheme in parts of the Oreti catchment. This would entail extraction of some flow from the main stream of the river and running this along canals to a power station where it would come back into the river. A canal project could be around 6MW and produce 30-35GWh.

Lake Wakatipu Flood Alleviation

The head difference between Lake Wakatipu and the Mataura River near Garston is about 5 m. Investigations have been proposed to assess the viability of providing an alternative discharge from Lake Wakatipu via Garston and Athol possibly to the Upper Mataura or alternatively pumping water using windmills into the Upper Oreti catchment. This would provide opportunity for flow of water through a low head hydro generator, which could provide emergency discharge from Lake Wakatipu to eliminate potential flooding and/or supplement river flows during low flow events. Iwi support for such initiatives would be a fundamental requirement.

Appendix A – Glossary

GWh	Acronym for Gigawatt-hour, a term used to measure energy delivered by generation equipment. i.e. the rate at which megawatts (MW) are generated.
ha	Acronym for hectare, a measure of area equivalent to 10,000 square metres.
Head	This refers to the difference in elevation between the intake water level and the outlet water level for the hydro scheme.
MW	Acronym for megawatt, a term used to measure power capacity of generation equipment.
	Individual MW and GWh data are displayed as integers, whereas totals are calculated using data with decimal places. This may lead to rounding discrepancies.

Other Opportunities
- Undefined

In the "Availabilities and Costs of Renewable Sources of Energy For Generating Electricity and Heat" Report to the Ministry of Economic Development by East Harbour Management Services Ltd, September 2002 (EHMS 2002) these opportunities were not rated at high or medium confidence levels, typically on the basis of one or more of the following uncertainties:

- hydrological information
- project geological information
- economics
- perceived consenting issues
- not known/not listed in earlier reports

p.a.	Per Annum.
Plant Factor	The ratio of mean annual output of a power station to maximum annual output if operating at full capacity for whole year. May also be considered to be the ratio of mean annual flow to maximum flow through the machine.

Scheme Definitions:

Some of the descriptions of schemes have a code e.g. 8/2 or e.g.W34.

The 8/2 usually identifies the 8th river that a study looked at, with 8/2 being the second scheme studied on the river.

W34 means it is a scheme about 34 km upstream of the mouth of the W… River.

Appendix B – Hydro Plant Factor Commentary

One of the parameters for a hydro power station that reflects its performance, and a key input into the design process, is the plant factor (sometimes called the capacity factor).

The plant factor is the ratio of mean annual output (over a number of years of operation) of a power station to its maximum annual output if it operates at full capacity for the whole year. For a hydro power station it may also be considered to be the ratio of the mean annual flow to the maximum flow through the turbines of the power station.

The instantaneous output of a power station is directly related to the flow through its turbines. If the turbines' maximum capability was set to only match the mean annual flow then, for any period where the flow is higher than the mean (assuming little or no water storage is available) some of the flow will be "spilt" and the overall annual output will be less than it would have been if the penstocks, turbines, generators etc were larger. Flows that are lower than the mean will be fully utilised.

To ensure reasonable economics of the investment in the power station, including dams, spillways etc it is usual to provide for the capacity of the penstocks, turbines, generators etc to be capable of using a higher flow than the annual mean flow. Historically, hydro power station components have usually been sized to give an overall plant factor of about 50 to 55%.

Some schemes, especially those where there is an out-of-river canal, may have a greater plant factor than 50% (e.g. Project Aqua with approximately 65%). While this will usually result in less water passing through the canal/power station system to generate electricity than would be the case if a lower plant factor was selected, it allows for more cost-effective sizing and use of the intake, canal, power station equipment etc.

For the purpose of this study we have generally carried through the plant factors that were assumed or required to be met during the investigations that gave rise to the data and information provided, unless more up-to-date information is available. It is quite possible that re-assessment of a particular scheme during further investigations may lead to a more cost-effective option that will have a higher plant factor which will usually be associated with a lower MW level but a lesser reduction in energy (GWh per annum) output.

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