Summary of Reports Relevant to the Waiau River Working Party

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Preface

This report provides a brief summary of reports which the Working Party, either collectively, individually or as part of a task group, have reviewed since its commencement in 1990.

Wherever the executive summaries from reports have been reproduced, quotation marks {" "} have been used to indicate sections taken verbatim from the various reports.

Entire copies of all of the reports summarised here can be viewed at the Southland Regional Council, Cnr Price Street and North Road, Invercargill.

Teri McClelland
Project Manager
February 1996

Mahingakai Values of the Waiau River by C P Mitchell & K T A Davis-Te Mairie; July 1994

Summary

"This Mahingakai study examined the status of the original biological resources of the Waiau River. ...

Mahingakai of the Waiau River was found to be dominated by eels. Eels were most abundant in the lower river and declined in abundance in the upper catchment. But there were still sufficient everywhere for the casual fisherman to take a catch. However, the average size of eels was small in most areas. ...

The second species (in terms of biomass) in the Waiau River system is brown trout. ...

Other native fishes of less importance as mahingakai remain in the catchment. Smelt and koaro (*Galaxias brevipinnis*) whitebait could be caught from the lakes in sufficient numbers to make a meal. However, the main whitebait fishery was in the lower river, in the immediate vicinity of the mouth. This fishery is based upon inanga (*Galaxias maculatus*), a fish essentially confined to the lagoon area.

Although salinities were too low for shellfish beds, the lagoon was a rich source of many fish. Yelloweyed mullet were an abundant, easily netted source of food. Flounder and eels were also common. ...

Many native fish were found to move up the main Waiau River, particularly when flows were low and stable. Eels obviously migrate right through the system and lampreys reach Monowai and Mararoa Weir. Flooding of the river is likely to push many of the other fishes back downstream into the lagoon.

Mahingakai in side streams is dominated by eels, although a range of small native fishes is also present. Manmade ponding areas were found to provide excellent eel habitat and were favored by shortfinned eels, the most rapidly growing species of eel. Longfinned eel growth was best in the large inland rivers on the Eastern shores of the lakes, possibly due to high summer water temperatures.

Mararoa Weir, the Lake Te Anau Control Weir and the weirs on the outlets to Lake Monowai form obvious barriers for eel migration into major areas of habitat. But size and age structure of eel populations in these areas suggest that some recruitment still occurs, despite these structures. Eels are well adapted to maintaining stocks in areas where recruitment is poor.

Adult eels must migrate back to the sea to breed. Sustainable management of the eel resource of the Waiau River demands that some consideration be give [sic] to the life-cycle peculiarities of this fish. One area where eels of the upper river in particular, are vulnerable, is at Manapouri and Monowai Power Stations. Migration on flood peaks, when all the Weirs are likely to be opened and spilling, may ensure that at least a portion of eels from the upper catchment will go to sea unharmed, the remainder must pass through the turbines. Operating parameters and dimensions of the Manapouri turbines suggests that perhaps 19% of eels will survive turbine passage. Survival of mature eels at Monowai is essentially zero. ..."

Enhancement of Whitebait Habitat in the Lower Waiau River, by C P Mitchell; November 1994 : 17pp.

Summary

"An examination of whitebait samples from the Waiau River found that the fishery was dominated by juveniles of the common whitebait or inanga (*Galaxias maculatus*). Results of sampling in the lagoon area clearly showed that this species was the most abundant whitebait species. As normal for New Zealand rivers, sampling throughout the Waiau catchment found that inanga was restricted in distribution to lowland sections of the Waiau River. ...

Field studies showed that shallow lagoons and ponded areas around the margins of the lagoon were favored micro-habitat for *Galaxias maculatus*. ... It is suggested that the best way to enhance whitebait stocks in the Waiau Lagoon would be to create more shallow ponded habitat. However, there are some difficulties with this approach. The major problem is that the soil type, even in the wettest areas of farmland purchased by ECNZ, is still a relatively light and free draining soil. The area has largely been built up by repeated deposits of flood borne sands and gravels. ...

It is recommended that an existing series of former river channels, which lie close to or slightly below the water table through the area, be deepened to provide permanent ponding. In this way some 5.7 km of habitat could be constructed, plus one ponding area of 370 m^2. At present the length of habitat suitable for inanga is estimated at 320 m. Simple deepening the existing channels throughout their length will allow groundwater to be intercepted. This alone should provide the modest water flows which inanga require. ...

Once the work has stabilised there should be an investigation of the densities of inanga that develop over summer in the canals. Based upon this information, gradual improvements to the design and thus the productivity of the system can then be considered.

The Submerged Vegetation of Lakes Hauroko, Te Anau, Manapouri and Monowai, Fiordland, New Zealand and Effects of Water Level Fluctuations, by R D S Wells, et.al. NIWA; September 1993 : 40pp.

Summary

"The submerged vegetation of Lakes Hauroko, Te Anau, Manapouri and Monowai was surveyed in March 1993 using a standardised SCUBA survey technique, to provide the first detailed description of the submerged vegetation of these lakes."

These Fiordland lakes are of glacial origin and generally steep sided and deep. The waters are little impacted by human activities, other than manipulation of the levels of Lakes Te Anau, Manapouri and Monowai for hydro-electricity generation. Water levels have been managed according to the 1970 guidelines which are within the natural range. ... The current operating regimes in these three lakes have left no obvious disturbance patterns in the submerged vegetation relative to Lake Hauroko, which is subject to similar but natural fluctuation in water level. ..."

"The submerged vegetation was predominantly comprised of native species. *Isoetes alpinus* dominated the short growing, shallow-water plants in all lakes and *Hydatella inconspicua*, a rare endemic plant found elsewhere only in Northland du[n]e lakes, was present in all the lakes except Lake Monowai."

Elodea canadensis was the only introduced "oxygen weed" species and was the most abundant tall vascular species. *Elodea* was found in Lakes Te Anau, Manapouri, and Monowai but not Lake Hauroko. *Juncus bulbosus*, a less obtrusive introduced species, was present in all lakes except Lake Te Anau. *Potamogeton cheesemanii, Myriophyllum propinquum* and *M. triphyllum* were common tall growing native species."

"The most common group of plants were the charophytes. *Chara fibrosa* was the dominant charophyte in Lake Hauroko, whereas in the other lakes possibly due to lower water clarity and/or higher nutrient conditions, *Chara corallina* was dominant. The lower depth limits of the vegetation were between 13 and 19 metres, with Lake Hauroko, the clearest lake, having the deepest vegetation. Bryophytes (mosses and liverworts) were widespread in all the lakes, but were not as abundant or as deep as in the ultra-clear, nearby Lakes Wakatipu and Wanaka. The lower water clarity of lakes in the present study is the result of the predominance of beech forest in the catchments which colours the lake water with tannins."

Fish Passage Requirements at Lake Te Anau Control, by Maurice Rodway; 1993 : 3pp.

Summary

This report determined that flow velocities at the gates would usually be in the order of 1.6 to 3.7 m/s. These velocities are at the gate openings only as velocities upstream and down stream are less and expected to decrease rapidly. Calculations were then done to determine which, if any, fish would be denied access into the Lake due to having to pass through these velocities in the gates.

The report found that "... fish from about 150mm in length and up could swim through the gates at flows of up to about 2 m/s. Larger fish should have few problems at virtually all flows. This means that all native fish without climbing ability and all trout up to about one year old cannot swim through the gates."

The possible solution given in the report is to provide a separate fish pass for native fish and investigate the possibility of creating replacement spawning facilities on the upstream side of the structure.

Proposed Salmon Ranching Trial Waiau River Southland Engineering Concept Report, by Works Consultancy, October 1991 : 38pp.

Summary

This is a report on an investigation of potential sites in the Waiau River which would be suitable for the establishment of a salmon ranching operation. The preferred site for the initial trials of salmon rearing and release was downstream of the Monowai Power Station, with water drawn from the Exciter Generator. The preferred site for fish capture facilities was 1.2km upstream of the Waiau River mouth.

Climatic Change - A Review of Impacts on New Zealand, Ministry for the Environment; April 1990

Summary

This report was primarily concerned with anticipated impacts upon New Zealand, in terms of society and national economy, given various climate change scenarios up to the year 2050. It found that many areas of New Zealand society and economy would be able to respond successfully to the climatic change assumed in the scenarios. However, a major uncertainty was the possibility that the frequency or severity of extreme events (floods or droughts) might significantly change, and result in disproportionately great impacts on society and the economy.

The particular areas where impacts would be noticeable and severs were identified as:

- the coastline;
- natural resources;
- native plants, animal and ecosystems;
- socially and economically disadvantaged sectors of communities.

The report also identified an indirect impact of global climatic change, being a change in the demand or supply of international trade with overseas trading partners.

Finally, three primary areas in which more adequate information was required were identified. These were:

- monitoring of climate, sea level, and the responses of the land and people;
- improved understanding of inter-relationships, in order to predict responses;
- dissemination of reliable information to all community sectors, for better planning.

Climatic Change - Impacts on New Zealand, Ministry for the Environment, May 1990 : 244pp.

Summary

This document is the companion to *Climatic Change - A Review of Impacts on New Zealand*, which is outlined above. It contains the detailed findings of the New Zealand Climate Change Programme's Impacts Working Group, which are presented in four major sections.

The first section discusses potential changes and scenarios, including extreme events and natural hazards. The second section discusses biophysical impacts for the following specific topic areas:

- atmosphere
- soils and landscape processes
- water resources
- snow and ice
- coastal impacts - physical
- natural ecosystems
- forest ecosystems
- freshwater fisheries
- estuaries

- marine fish, fisheries and aquaculture
- Antarctica
- agricultural resources.

The third section discusses economic and social impacts for the following specific topic areas:

- water industry
- forest industry
- transport
- energy
- marine fishing industry
- agricultural industries
- recreation and tourism
- New Zealand trade
- human health
- housing
- employment
- population dynamics
- tokelau (a group of 3 atolls North of New Zealand)
- Maori and their resources
- personal social impacts
- communities
- management of risk in a changing environment
- local government.

The appendices in the fourth section include scenarios for regional climate change. Each region has two scenarios, one based on a temperature rise between 1.0 to 1.8 degrees and one based on a temperature rise between 2.8 to 3.5 degrees.

Responding to Climate Change - A Discussion of Options for New Zealand, Ministry for the Environment; May 1990 : 54pp.

Summary

The aim of this discussion document was to review the possible ways in which the Government may respond to the issues surrounding climate change. It was released in May 1990 with public submissions closing in June 1990 and the Policy Working Group reporting to the Government in July 1990.

The document identified 76 limitation options under the headings:

- Generic;
- Energy;
- Agriculture, Forestry, Land Use, and Industry,

in addition to several options which are identified, but were discarded, as their potential to reduce greenhouse emissions was considered insignificant.

The document then discusses the adaptive process to climatic change and potential sectorial responses and maori perspectives.

Finally, the document discusses further research, monitoring and technology development.

Climate Change - The Consensus and The Debate, Ministry for the Environment, May 1991 : 48pp.

Summary

This report presents was currently known about climate change, what the main areas of uncertainty were, and what was being done to reduce the scientific uncertainties. It also describes national and international policy responses to the prospect of global warming.

The main emissions important with regard to enhanced greenhouse warming are identified as carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide.

The report outlines New Zealand policy development which, at that time, consisted of:

- taking action now to reduce emissions of greenhouse gases because of the risk of adverse global impacts;
- limiting the buildup of greenhouse gases as a priority, rather than focusing on adaptation;
- preference for cost-effective measures which do not reduce New Zealand's competitive advantage and have a net benefit for New Zealand society;
- flexibility in climate change response strategies;
- a 20% reduction of 1990 carbon dioxide emissions by 2005 (this date was brought forward to 2000 in November 1990).

Evidence of Judith Helen Lawrence in the matter of an Application by ECNZ for an Air Discharge Permit for the Huntly Power Station, by J H Lawrence; undated : 17pp.

This statement of evidence outlines the Government's Climate Change Policy, its programme for meeting its international obligations with regard to CO_2 reduction in particular, and how this relates to the submission on the air emission discharge permit application for the Huntly Power Station.

With regard to the Government's expectations of local government on CO_2 emissions, this evidence statement notes, "The Minister does not, however, expect the Council to require reductions in CO_2 emissions, and offsets, nor does he require Council to develop regional reduction targets. This would be inappropriate in the absence of national policy instruments to address climate change. However, the Government doe not expect local government to ignore CO_2 emissions of significance and expects industry, when making long term investments and applying for consents with long terms, to factor the climate change issue into their proposals."

Lakes Manapouri and Te Anau Flooding : October-November 1988, by H J Freestone; February 1989 : 34pp.

Summary

This report sets out the hydrological data regarding flooding in lakes Te Anau and Manapouri during October and November 1988. It compares actual observed flood levels with calculated natural levels and current outlet flow capacity of both lakes with the natural channel capacities prior to the establishment of control structures.

The report notes that the 1988 floods were the largest since records began in 1926 and the second largest since the 1878 flood, however they were still below the probably maximum flood level. Computer simulated natural levels showed that the actual levels in both lakes were lower than what would have naturally occurred. It also found that neither the Te Anau nor Manapouri outflows were less that the natural channel capacity, and concluded that the control structure capacity did not limit discharge more than would have occurred naturally.

The report also concluded that the peak flood flows at Tuatapere were less than would have occurred naturally, as the October 1988 flood peak only ranked 8th in the 14 years of annual flood peaks.

Finally the report stated, "The duration flood guidelines were exceeded because the flood, due to its extreme nature, could not be contained within the rules. Calculations however have shown that the natural conditions would have exceeded the guidelines by an even greater amount. The guidelines do not need to be changed to cope with this inadequacy but should be recognised as referring only to the situation where the lake levels are actually being controlled by Electricorp's operations."

Proposed Operating Procedures for the Lake Te Anau Control Structure - Draft Discussion Document, ECNZ; March 1991 : 33pp.

Summary

Following a meeting of ECNZ, Guardians of the Lakes, Fish & Game Council, MAF, and the Southland Regional Council, a proposed management regime for the operation of the Lake Te Anau control structure was drafted. This report outlines the regime, which consisted of:

- an extreme minimum outflow of 80 cumecs from Lake Te Anau.
- retain the operating minimum of 115 cumecs from Lake Te Anau.
- present operating procedures to apply for Lake Te Anau for levels above 203.3 m
- daily changes to outflows be limited to as low as possible, and daily up and down flow fluctuations should be eliminated, especially for flows below 180 cumecs.
- maximum flow changes should be limited to 20 cumecs per hour.
- **either** outflows can be reduced by a maximum of 100 cumecs per day for flows above 180 cumecs and by 30 cumecs per day for flows between 180-115 cumecs **or** outflows can be reduced by a maximum of 20% per day of the previous day's flow for flows above 115 cumecs.
- flows below 115 cumecs only after consultation with the Guardians, the Southland Regional Council and the Southland Fish and Game Council.
- flows lower than the extreme outflow of 80 cumecs may occur only if the extreme minimum level at Lake Te Anau is to be exceeded (or indicated so) and only

if agreed to by the Guardians after full consultation by ECNZ with the Regional Council and the Fish and Game Council.

- outflows may be increased for non flood operation at a maximum rate of 100 cumecs per day for flows above 180 cumecs, and by 50 cumecs per day for flows below 180 cumecs. Operation for flood events will permit a maximum increase of 200 cumecs for flows above 180 cumecs, and 100 cumecs for flows below 180 cumecs. Flood events to be defined.
- endeavours be made during the fish spawning an incubation period to maintain flows in the Upper Waiau River.
- these proposals should be trialled and/or modeled on past records.
- any proposal thought acceptable should be adopted on a 'consultative trial period'.

DRAFT Te Anau Flow Guidelines - Modeling, by K S W Ong, et.al. Works Consultancy Services, March 1992 : 44pp.

Summary

This report contains numerical modeling of some of the recommendations set out in the *Draft Proposed Operating Procedures for the Lake Te Anau Control Structure*. It consists primarily of hydrological graphs showing the modeling outcomes. The recommendations of this report focus primarily on further investigative modeling to be carried out.

In particular, the report noted that while a best scenario could be picked for low flow modeling, for flood flows all scenarios performed worse than the actual Lake records. Therefore the recommendation was that other options should be investigated, rather than the 30 m^3/s and 100 m^3/s. Another aspect of the study which the report recommends should be studied is of events starting above RL 203.3 m.

Finally, the report noted that the 20% and 30% performed best and if they should gain acceptance, then further events should be modeled in order to ensure that a wide set of conditions apply.

Water Tables in Slipway Beach, Lake Manapouri: controls and effects on the beach system, by R A Pickrell, March 1978 : 7pp.

Summary

"The results from a continuous 42-d study of water table levels in Slipway Beach, Lake Manapouri, 12 November-23 December 1974, are described, and correlation and multiple regression analyses are used to identify controlling processes. Groundwater fluctuations are largest on the upper and lower foreshore, where the elapsed rainfall and position of the shoreline are the dominant controls. Fluctuations are smallest in the mid foreshore; this pattern is the reverse of that found in oceanic beaches where tidal oscillations in sea level control the level of the water table in the foreshore. Beach morphology is affected by the groundwater in two ways: spring sapping of the water table from the top of the foreshore during heavy rains produces rill channels, and shore-normal exchanges of sediment associated with changes in lake level are accelerated."

Beach and nearshore morphology of Lakes Manapouri and Te Anau, New Zealand: natural models of the continental shelf, by R A Pickrill, 1978 : 14pp.

Summary

"The foreshore and nearshore morphology of beaches around Lakes Manapouri and Te Anau, New Zealand, have developed a distinctive shelf form in response to lake wave processes. The characteristics of this shelf form vary systematically with the degree of exposure to wave activity. Shelf width ranges between 10.5 and 87.2 m and extends to depths of 1.2-5.8 m beneath mean lake level.

The sediment distribution across the shelf reflects the shore normal dissipation of wave energy. Sandy bed load sediments fine lakeward to the outer edge of the shelf. Over the shelf edge, on the steep offshore slope, muddy sediments are dropped out of suspension. Wave climate studies show the outer edge of the shelf to be formed in response to infrequent, high energy wave events during periods of low lake levels when waves are highly effective in disturbing sandy sediments on the outer shelf. Parallels are drawn between the morphology and sediments on lacustrine shelves and prograding oceanic continental shelves."

Beach Changes on Low Energy Shorelines, Lakes Manapouri and Te Anau, New Zealand, by R A Pickrill, 1985 : 11pp.

Summary

"Sand and gravel beaches around the shores of Lakes Manapouri and Te Anau, New Zealand generally respond to fluctuations in wave energy and still water level in a similar manner to large lake and ocean beaches. However, there are some important differences. Short fetch lengths produce a narrow range of wave conditions and shore normal changes to the beach profile are minimal in order to maintain an equilibrium form. Largest beach changes are induced by fluctuations in lake level and alongshore transport of sediment in closed beach compartments. Low energy levels limit the size of sediment in transport and much of the shoreline is protected by lag pavement beaches, the size of the lag and winnowed sediment being controlled by maximum wave conditions. Frequent calms allow all types of beach morphology to be drowned or stranded by lake level fluctuations."

Assessment of the Possible Effects of Reducing the Lake Level at Lake Pukaki to Range 518-513m, by ECNZ; 1992 : 66pp.

Summary

This assessment of potential effects of Lake drawdown was compiled following a seven month drought which affected ECNZ's hydro-electric power system. The "...assessment is based on work carried out for the Waitaki Working Party, anecdotal evidence and personal observation." Issues covered are aesthetics (visual effects assessment carried out by Boffa Miskell Partners); dust and shorelines (potential physical impacts study by Professor R M Kirk); wildlife (assessment of impacts on black stilt compiled by ECNZ with notes from Department of Conservation); and hydrology (use of low level storage report by Works Consultancy). Finally was the recommendation that the Waitaki Working Party be reconvened to assess and approve study briefs on the topics of wildlife, dust, trubidity, aesthetics and use of the area for waahi tapu and other values.

The Effects of Lake Level Changes on the Littoral Ecology of Lake Coleridge by Mark James, et. al.; June 1995

Summary

The brief of this study was to assess the effect of lake level fluctuations on the ecology of Lake Coleridge. The study includes:

1. a review of existing information on the effects of lake level fluctuations;

2. a survey of the littoral zone in February 1995 to provide baseline data prior to drawdown;

3. a comparison of the ecological values of Lake Coleridge with similar controlled and uncontrolled lakes based on published and unpublished literature and the results of the survey (2);

4. an assessment of the effects of lake level fluctuations on the ecology of Lake Coleridge and recommendations for a monitoring programme.

Lake-level fluctuations, both high and low, induce littoral zone erosion. Low levels have the potential to induce erosion of the nearshore shelf, casting material down the offshore face over the macrophyte bed habitat and eroding the belt of muddy substrate favoured by macrophytes. Also, lowering lake levels can be expected to create more turbid nearshore waters at the northwestern corner, where mud originating from the inflow canals is trapped on the broad shelf and resuspended by southerly waves. At high levels, storm waves erode the toe of the hillslopes, initiating mass movement of slope material that supplies both coarse materials onto the beach profile and fine sediment into the water.

The survey results demonstrated that Lake Coleridge has a diverse macroinvertebrate fauna and abundance is comparable with most South Island lakes. Macrophyte distribution is an important factor influencing macroinvertebrate abundance, biomass and diversity. On exposed shores the depth distribution of peak macrophytes and macroinvertebrate abundance was at 9-13 m compared with 4-7.5 m (504.6-501.2 m a.s.l.) at less exposed sites. The community with highest ecological value in terms of abundance and diversity was found in the weed beds.

There is no evidence that fluctuating lake levels have directly affected macroinvertebrate taxa richness or abundance in Lake Coleridge compared with unregulated lakes.

Exposure to wave action, erosion and sediment inputs appear to be the most important determinant of depth distribution through mechanical disruption, substrate deposition and light penetration.

Common bullies, the most ubiquitous fish species in Lake Coleridge and a food source for trout and salmon, had a wide depth distribution in the littoral zone, extending down to at least 20 m, deeper that that expected based on macrophyte distribution. Their numbers and those of trout could be indirectly affected by the proposed drawdown through compression of suitable littoral habitat. Changes in abundance of fish could be assessed through a repeat survey of some bully trapping sites, and through continuing the annual creel census for trout and salmon.

The Effects of One Year and Ten Year Flood Events on the Circulation and Mixing in Doubtful Sound : Numerical Model Simulations, by Malcolm Bowman and David Dietrich; November 1995 : 81pp.

Summary

This is a preliminary draft of a report which used numerical modeling to simulate the circulation and mixing of water in Doubtful Sound during major storm events. It assesses the response of the fiord to one and ten year storm events, in terms of the changes to the low salinity surface layer in the fiord.

Although this is only a preliminary draft, the conclusions noted that the lower salinity surface layer in the fiord is in the range of 16 to 22 m depending upon rainfall and power station discharge. However, it also noted that the results were only applicable to summer conditions, and the expectation was that the properties of the tailrace jet current and the lower salinity layer would be different in different seasons.

Does Freshwater Discharge Cause Mortality of Fjord-Living Zooplankton?, by Stein Kaartvedt and Dag L Aksnes; 1992 : 9pp.

Summary

"We suggest that the presence of dead zooplankton in samples from a Norwegian fjord could be ascribed to freshwater induced mortality. Discharge from a hydroelectric power plant generated an inward countercurrent which transported plankton towards the freshwater source. In the turbulent mixing zone near the freshwater outlet, zooplankton could presumably not avoid vertical mixing into low salinity water, where they were killed by osmotic stress."

A Survey of Recreation on the Waiau River, Southland 1982 - 1985, by J M Riddell; May 1989 : 67pp.

Summary

This report outlines and discusses a recreational survey carried out on the lower Waiau River (from the Weir to the Mouth) during the months October to March (inclusive) for the years 1982/83, 1983/84, 1984/85.

The report noted the Waiau River as being a major recreational resource in Southland. Eight recreational activities were recorded, with the three most important being whitebaiting, onlooking and angling. For the survey period (1982 - 1985) an estimated 19,159 people used the River for recreational purposes, with weekend and holiday usage being much greater than weekday usage.

Only 15% of the Southland angling effort was aimed at the Waiau River, however it was the remoteness and scenic beauty of the river which were the attraction for the people who did use the Waiau.

Tuatapere Water Supply Headworks and Treatment Study, by Royds Consulting; May and June 1994 : 40pp and 60pp respectively.

Summary

These reports (preliminary and final draft) assess the environmental quality of existing water sources for Tuatapere; identify and assess alternative water sources; and identify the capital costs for each option.

The report noted that the current supply would receive a D (unsatisfactory) grading under the Ministry of Health system, and suggested that the Waiau River be abandoned as a source. The recommendation of the report was that a new bore (with prescribed treatment installations) be installed halfway between the bush bore and the river and that the existing bush bore be upgraded (if necessary) in order that it could be used as a backup for the new bore.

Visitor Monitoring Manual - Methods to Count, Record and Analyse Information about Visitor Numbers, by Department of Conservation, January 1992 : 84pp.

Summary

This manual contains "... advice and methods for counting, recording and analysing data about the number of visitors to lands... . The scope of these guidelines is basic visitor information: estimating the number of visits to recreation facilities and services.". The manual primarily contains information on how to establish a visitor monitoring programme using several examples. It was developed for use by the Department's conservancy and field centre staff.

The Economic Value of Increased Flows in the Ashburton River, by Massey University; Undated (probably 1992) : 105pp.

Summary

The aim of this report was to help address the balance between consumptive (abstraction for irrigation and stockwater) and non-consumptive (wildlife habitat, fisheries and recreation) uses of the Ashburton River. Using contingent valuation, a nonmarket technique, the economic value of increased flows in the Ashburton River to Canterbury residents is estimated.

The report's findings were that while 48% of the people within the Ashburton district used the Ashburton River, only 9% of those outside the Ashburton district used the river. However, of those who did not use the river, 20% indicated they would use the river if flows increased by 50%, while 13% indicated they would use the river if stream flows increased.

Two methods were used to determine peoples' willingness to pay for more water (iterative bidding process and dichotomous choice method) with both methods giving similar results. Both approaches gave a skewed distribution of prices, suggesting that a small proportion of the population placed a high value on in-stream flows.

The conclusion was an estimated economic value of increasing the minimum stream flows of the Ashburton River by 50% was between $2.47 million and $5.15 million per annum. The majority of the economic value for the river was outside of the Ashburton district due to the majority of the Canterbury population residing in Christchurch city.

1990 Application for Water Rights - Waitaki River System Hydro-Electric Operations, by ECNZ; 1990 : 3 volumes and agreements 710pp.

Summary

This is a collection of the materials submitted by ECNZ in with its application for resource consents for the Waitaki Power System. The collection includes the agreements (28pp) which were signed by Waitaki Working Party members; the Working Party report (overview of the process, study briefs, minutes, etc. - 247pp); Volumes 1 and 2 of the Working Party report (support documentation for application, reports commissioned by Working Party, etc. - 435pp).

Lower Waiau River Investigations Into Cause and Remedies for Flood Damage October/November 1988 - Interim Report, Electricity Corporation of New Zealand Ltd; April 1989 : 36pp.

Summary

This report outlines agreements which were made between the (former) Southland Catchment Board, Electricorp Production and the lower Waiau River community after the 1988 flood. These agreements were:

- that a site by site investigation be instigated;
- investigations be carried out into the cause of erosion and resultant damage;
- the Catchment Board would prepare a works plan to enable the Lower Waiau to pass flood flows without damage;
- Electricorp Production would fund the cost of a hydrologist/hydraulic engineer if the Catchment Board needed additional support;
- Electricorp would fund the installation of a publicly interrogable recorder at the Mararoa Weir and half the cost of an additional facility below Monowai;
- the Catchment Board would install telemetry on these sites to provide flood warning service for the lower Waiau River.

The report then outlines the progress made on the each of the agreed matters, and concludes that works plan should be available prior to the 1990/91 financial year.

Waiau River : Collection of Engineering Reports, various authors, compiled by ECNZ; 1990 : 137pp.

Summary

This compilation of engineering reports, specific to the lower Waiau River, includes:

- an assessment of aerial photographs (dated 1946, 1974, 1980, and 1988), by the Hydrology Centre;
- reports on river erosion management options for the following properties: CJ Carr; RG Pearce; WK Allen; DB Stalker;
- the Interim Report outlined above.

The aerial photograph assessments present the photographs and outlines and there is not a summary as such. The erosion management reports suggested options from "do nothing" to the reinstatement of fences to planting of willows.

Willows and River Channel Morpho-Dynamics, by A Hajnal (thesis); November 1993 : 113pp.

Summary

"The Mararoa River is a dynamic gravel-based river in western Southland, South Island, New Zealand. Analysis of aerial photographs and field data indicates that willows have played an important role in channel adjustments along the lower course of the Mararoa River. Aerial photographs from 1948 predate the introduction of willows onto the Mararoa

River, showing a river reach which has low sinuosity, multiple channels and high instability. Aerial photographs from 1957, 1970, 1970, 1982 and 1991; show a gradual change in planform to a reach which has one or two moderately stable channels of higher sinuosity. The change in planform can be summarised as a change in river type from a braided to a wandering gravel-bed style.

Field analysis of bar surfaces in the reach between the Key Bridge and Fern Hill show that willows are an important control in the distribution of geomorphic units on bars. Willows were shown to influence localised fluvial processes such as bank accretion, flow resistance, slope buttressing, bar development, and formation of log jams and debris constrictions. On a larger scale, willows have contributed to the formation of willows swamps, channel abandonment, channel degradation and frequent localised flooding of the floodplain. Willow/River interactions vary spatially and temporally according to discharge levels and sediment availability. These variables, combined with human modifications in the catchment, control willow and river channel morpho-dynamics."

The Use of Channel Maintenance Flow Concepts in the Forest Service, by D Rosgen, et. al.; March 1986 : 8pp.

Summary

This report describes a channel maintenance flow procedure developed by the USDA Forest Service. "Channel maintenance flows consist of a specified range and duration of flows designed to provide for the self-maintenance of stream channels. If such flows are not available, stream channels will in the long term accumulate sediment, accelerate bank erosion, and increase the potential for vegetation encroachment and other processes which reduce their capacity to pass flood flows. Increased streambank erosion, increased lateral extension (migration), encroachment of floodplains, and increased risk of flood damage potentially result due to channel adjustments from flow reduction. Channel maintenance flows are developed for projects on National Forest lands where diminished natural stream flows are proposed."

At present, the procedure is only applied to snowmelt dominated, perennial streams incised in alluvium which can be moved in part by flows at or below bankfull discharge. The report also noted that the procedure for quantifying channel maintenance flows is an evolving methodology expected to remain dynamic and undergo considerable change as more data are compiled to obtain better documentation of river system response to changes in flow regulation.

Shoreline Erosion, Lower Waiau River (Pearl Harbour to Home Creek), Manapouri, by Dr R M Kirk; December 1989 : 23pp.

Summary

Covering all the shorelines of the Waiau River between the outlet of Lake Manapouri and Home Creek, this report looks at the causes and some possible means of control for ongoing river bank erosion occurring principally on the true right bank of the Waiau River. The report noted that the erosion was, for the most part, a consequence of boat wake, but that it was the action of several factors in conjunction which lead to the observed effects.

The study found accelerated bank erosion to be widespread along the south bank, especially opposite the two wharf complexes and to a lesser extent along both banks of the common channel between the berths and the Lake. Several options for control are discussed in the report with a floating tyre breakwaters being favoured. Floating tyre breakwaters are described as "...relatively low cost, low technology devices and are known to be successful in operation." These structures are also seen to have the advantage of being "... easily removed in their entirety and disposed of." with their disposal not marking the shore.

Erosion and Sedimentation on the Waiau River and Coast - An interim report to the Erosion and Sedimentation Task Group, by Brierley, Kirk & Shulmeister, January 1992 : 32pp.

Summary

"This document contains two independent reports on the current state of knowledge of the Waiau River and Waiau Coastal System. These reports were compiled after a preliminary visit to the Waiau in December 1991..."

"The first report by Dr G J Brierley provides a preliminary river reach analysis for the Waiau River. It also highlights areas where research is required and suggests a methodology for approaching these questions."

"The second report by Dr J Shulmeister and Prof R M Kirk describes the Waiau coastal system in the light of current understanding of gravel river coasts. It identifies several major areas where current knowledge is incomplete, in respect of the Waiau, and outlines the research required to correct this situation. A timetable for research is also provided."

"Both reports stress the absence of prior scientific work on the Waiau and the need for fundamental information on the behaviour of the river and coast to be put in place so that areas of concern and future management can be addressed. Though the river and the coast can be examined independently, the systems are interlinked and should ideally be investigated in tandem."

Possible Origins of Turbidity and Suspended Sediment in the Mararoa-Whitestone Catchment, by G H Macky; April 1994 : 34pp.

Summary

The purpose of this report was to identify the possible orgins of suspended sediment in the Mararoa-Whitestone catchment, given the existing information, and determine what further data were required.

The conclusion was that there appeared to be many possible sources in the catchments, and that the suspended sediment yield from the lower catchment was higher than that from the headwaters. Turbidity and suspended sediment in the Mararoa appeared to be related to the flow rate only during freshes (flows in excess of 100 m^3/s) and the 40 m^3/s trigger for discharging turbid water was seen as inappropriate.

The recommendation was for continuous turbidity readings from four points:

- Mararoa at the Cliffs
- Mararoa at the Key
- Whitestone near Fred Burn confluence
- Whitestone at Hill Road

combined with turbidity sampling at other sites. The report finally noted that sources of high turbidity in Waituna Creek, and two other streams, should be traced via an inspection.

Waiau River Valley Groundwater Monitoring by Works Consultancy; March - December 1993 : 4 volumes, 21pp each.

Summary

These reports present the results of groundwater level monitoring carried out in the lower Waiau River valley during 1993. The results of the 1993 monitoring are compared with the results of 1969-1973 monitoring. There are 4 volumes - one for each of the quarterly surveys (March, July, September, December). Results are depicted in graphic form showing bore level and river level at each site.

The Developing Market for Energy Efficiency in New Zealand, Electricity Corporation of New Zealand Ltd; November 1992 : 55pp.

Summary

During the 1970s and early 1980s, the overall amount of energy used in New Zealand to produce each dollar of goods and services rose quite dramatically. This was quite different to most other industrialised countries where the long-run trend of falling energy intensity merely slowed down in the 1950s and 1960s. There are a number of reasons why New Zealand stood out. These include increasing mechanisation and automation in industry and the impact of major projects such as the Synfuels plant, the refinery expansion, the Glenbrook steel mill expansion, and developments at the Tiwai Point aluminium smelter.

Over the next 15 years, New Zealand could begin to move back in line as underlying changes in the efficiency of energy use take effect, according to a major study on end use energy efficiency by ECNZ. The combination of the lessons learned in a major review of overseas experience, the nature of the energy sector reforms, and the results of scenario analyses on energy and the economy, suggests that normal commercial incentives in a competitive market for energy services will result in significant improvements in New Zealand's energy efficiency.

There are already signs that the electricity industry is beginning to regroup to respond to the new business environment to be introduced by energy sector reforms and there are already examples of the industry promoting new, efficient, electro-technologies. The electricity industry can now be expected to develop a range of energy efficiency services as a way of adding value to the simple retailing of electrons, which seems likely to be a relatively low margin business. New electro-technologies can also be expected to displace less efficient usage of fossil fuels in homes, offices, and industry. Co-generation seems poised to develop into a significant niche market. The gas industry is also likely to respond to this new competition. While there will no doubt be some instances where market failures may appropriately be addressed by standards and codes (including transport energy), significant progress in energy efficiency can be anticipated because it is clearly in the interests of the electricity industry and its customers."

Electricity Supply & Demand in New Zealand (discussion paper and summary), ECNZ; May 1994 : 69pp.

Summary
(taken from Executive Summary Conclusion)

"According to all the scenarios, electricity use will rise at a rate that is roughly in proportion to the growth in the economy. And new electricity stations will be required despite the introduction of energy efficiency and conservation measures. All the scenarios predict a large drop in energy intensity but a relatively small change in electricity intensity. This is because of the already apparent move to new efficient electro-technologies that use more electricity but less energy overall.

The source of additional generation will depend on the speed of economic growth, political factors and resource constraints. If the economy grows quickly there are likely to be more opportunities for industrial companies to invest in co-generation plant. If a carbon tax is introduced, thermal generation will not grow as rapidly and more expensive resources will

need to be developed for electricity generation. Similarly, if resource constraints further limit the use of water in electricity generation, other more expensive sources of energy will be needed. These could include coal, gas, wind or oil.

The prediction of electricity supply and demand is a complex and imprecise science as it depends on a number of interrelated factors. Many of these, such as the world economy and changing markets, are beyond New Zealand's control. Changing political and social values make it difficult for electricity planners to know what form of generation will be acceptable. But there seems to be wide agreement over the increasing demand for electricity in a growing economy."

The Rising Energy Intensity of the New Zealand Economy, (working paper series 10/91) by I G Bertram; September 1991 : 45pp.

Summary

"Recently-published figures from the International Energy Agency indicate that in a world economy characterised by rising efficiency of energy use. New Zealand has been an anomaly. Between 1973 and 1988 the energy intensity (energy required per unit of Gross Domestic Product) fell 24% for the OECD countries on average, 31% in Japan, and 10% in Australia, whereas in New Zealand it rose 31%.

The working paper explores the New Zealand data in detail to identify the source of this behaviour and its possible causes. It is shown that the rising energy intensity of the New Zealand economy cannot be fully accounted for by reference merely to structural changes (the rise of energy-intensive petrochemicals industries, for example). Previous findings by Patterson (1989) of falling energy productivity in some sectors of the economy receive some support. Transport deregulation (including the removal of tariff protection for the local motor-vehicle and oil sectors, and the ending of regulatory restrictions on competition with Railways Corporation and Air New Zealand) clearly contributed also. Relative-price trends are shown to have provided no clear incentives to conserve energy, though other countries with strong energy-conservation records appear to have quite similar prices, suggesting that government non-price policies may have had an important effect on intensity in those countries.

The very low rate of adoption of energy-saving technology in the New Zealand economy to date, coupled with clear evidence that there exist major opportunities to improve the efficiency of energy use, suggest that the time is ripe for a sharp reversal of the rising trend in New Zealand's energy intensity."

Making a Market for Energy Efficiency, (executive summary only) by Simon Terry; July 1991 : 6pp.

Summary

This report explores mechanisms for achieving a higher level of energy efficiency in New Zealand. Since 90% of carbon dioxide emissions in New Zealand are energy-related, reductions in energy use are the focus of achieving the Government's target of a 20% reduction on 1990 levels of carbon dioxide. However, this study focuses on mechanisms for energy efficiency which can be justified on economic grounds alone.

Two barriers to energy efficiency are identified:

- those consumers directly encounter, and
- wider ones which are features of the energy market in New Zealand.

The greatest barrier to consumers was identified as financial, being the cost of efficiency improvements.

The preferred mechanism for promoting energy efficiency was for supply authorities to conduct avoided cost tenders (the cost of producing an additional unit of power which can otherwise be saved was termed the 'avoided cost'). This was considered the best single step, justified on economic ground alone, without fundamentally altering institutional and contractual frameworks.

Access to Resources: The Impact of the Current Regulatory Environment on the Electricity Corporation of New Zealand (ECNZ), by ECNZ; February 1993 : 14pp.

Summary

This report was requested by the Commerce Select Committee and explains the impact of the Resource Management Act 1991 on the Corporation. The report notes that "... ECNZ is required to renew all resource consents under new environmental requirements midway through the economic life of its assets. The RMA introduced a comprehensive and much more rigorous regulatory framework governing access to resources and directed at environmental protection, with scant recognition for existing investment. This represents a major change and risk to the Corporation."

In terms of actual impacts, the report found that, "The renewal of resource consents to date has resulted in an overall loss of 235 Gwh per annum." The report then predicts that, "If water is restricted, more generation will be required from thermal stations. This is costly in economic and environmental terms and conflicts with the Government's policy to stabilise and reduce CO_2 emissions." The report also predicts that new generation facilities will be required earlier than planned, due to the loss of generating capacity. Finally, "the cost to ECNZ of consent renewals in the period 1993-2001 is estimated at $15 million."

The report concludes with several issues which merit further and careful consideration. These are:

- energy efficiency,
- confirming existing resource allocations,
- finding alternative means of meeting community concerns than the current requirements of the RMA,
- providing for compensation for environmental effects,
- exploring alternative approaches to resource allocation and use to achieve desired environmental objectives at minimum cost,
- ensuring that current investment is protected.

The Management of Electricorp Production's Energy Resources, ECNZ; March 1992 : 12pp.

Summary

This report is a description of how the energy resources are managed to minimise the cost of thermal generation while operating the electricity system within the constraints of water rights, minimum flows and the configuration of the transmission system to meet the demand for electricity.

"In summary then, the Corporation's power system, the generating plant and the transmission network, are managed on an integrated basis using the energy resources water, gas, coal and oil. The Manapouri power station and catchment are operated as an integral part of the overall system making a major contribution to the resource of the system. The loss of water into the catchment will significantly affect the overall operation of the system, particularly in dry years when the reduced resource has its greatest value to the South Island and the system as a whole."

The Role of Manapouri within the ECNZ Generation System: A Report Prepared for the National Issues Taskgroup, by Howie, Brasell, & Powell; October 1993 : 41pp.

Summary

This report contained information on the integrated nature of the ECNZ generation network, the unique characteristics of the operation of the Manapouri power station, its importance in the national electricity network and links to broader issues such as future supply, energy efficiency and electricity pricing.

The report describes the daily, weekly and annual demand cycles which influence how the generation network is operated. It also describes the management of energy resources via the operating plan, merit order and dispatch of individual plant. The report outlines important characteristics of generation from the Manapouri power station and its high position on the merit order.

The report also describes the factors which affect electricity demand, such as pricing, uptake of end-use energy and electricity efficiency improvements. It also differentiates between plant capacity and generation, stating that while there may be surplus capacity at times of normal hydrological inflows, there is no surplus of generation.

The report then discusses emerging generation technologies that may contribute to future electricity generation, such as wind power. It concludes with an examination of possible trade-offs involved in a resource allocation decision.