

Hydropower and the Environment:

Survey of the environmental and social impacts and the effectiveness of mitigation measures in hydropower development

IEA Technical Report

Volume II

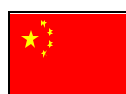
Appendices



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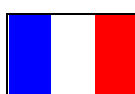
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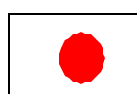
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OVERVIEW OF THE IEA IMPLEMENTING AGREEMENT FOR HYDROPOWER TECHNOLOGIES AND PROGRAMMES

The Hydropower Implementing Agreement is a collaborative programme among nine countries: Canada, China, Finland, France, Japan, Norway, Spain, Sweden and the United Kingdom. These countries are represented by various organizations including electric utilities, government departments and regulatory organizations, electricity research organizations, and universities. The overall objective is to improve both technical and institutional aspects of the existing hydropower industry, and to increase the future deployment of hydropower in an environmentally and socially responsible manner.

HYDROPOWER

Hydropower is the only renewable energy technology which is presently commercially viable on a large scale. It has four major advantages: it is renewable, it produces negligible amounts of greenhouse gases, it is the least costly way of storing large amounts of electricity, and it can easily adjust the amount of electricity produced to the amount demanded by consumers. Hydropower accounts for about 17 % of global generating capacity, and about 20 % of the energy produced each year.

ACTIVITIES

Four tasks are operational, they are: 1. upgrading of hydropower installations, 2. small scale hydropower, 3. environmental and social impacts of hydropower, and 4. training in hydropower. Most tasks have taken about five years to complete, they started in March 1994 and the results will be available in May 2000. To date, the work and publications of the Agreement have been aimed at professionals in the respective fields.

UPGRADING

The upgrading of existing hydropower installations is by far the lowest cost renewable energy available today. It can sometimes provide additional energy at less than one tenth the cost of a new project. One task force of the Agreement is studying certain technical issues related to upgrading projects.

SMALL SCALE HYDROPOWER

Advances in fully automated hydropower installations and reductions in manufacturing costs have made small scale hydropower increasingly attractive. The small scale hydropower task force will provide supporting information to facilitate the development of new projects.

ENVIRONMENTAL AND SOCIAL ISSUES

For some hydropower projects the environmental and social impacts have been the subject of vigorous debate. There is a need to communicate objective information to the public, so that countries can make good decisions with respect to hydropower projects. The environmental task force will provide such information on possible social and environmental impacts and on mitigation measures.

TRAINING

The availability of well-trained personnel is a key requirement in the hydropower sector. The training task force is concentrating on training in operations and maintenance, and planning of hydro power projects.

THE INTERNATIONAL ENERGY AGENCY – IMPLEMENTING
AGREEMENT FOR HYDROPOWER TECHNOLOGIES AND
PROGRAMMES

Annex III
Hydropower and the Environment

Subtask 1

**SURVEY OF THE ENVIRONMENTAL AND
SOCIAL IMPACTS AND THE
EFFECTIVENESS OF MITIGATION
MEASURES IN HYDROPOWER
DEVELOPMENT**

Volume II

Appendices

The views presented in this report do not necessarily represent the views of the International Energy Agency, nor the government represented therein.

May 2000

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Appendix 6: Activities commonly associated with different impact groups specified on project and locality

Project name	Location	Activity	Impact	Count of impact
Agavanzal	Downstream area	Altering long-term river flow	Change in ecosystem community populations	2
Agavanzal	Downstream area	Altering long-term river flow	Change in water quality	4
Agavanzal	Downstream area	Altering long-term river flow	Change in water quantity	1
Agavanzal	Other broad areas	Altering long-term river flow	Change in ecosystem community populations	1
Agavanzal	Other broad areas	Altering long-term river flow	Change in water quality	1
Agavanzal	Other broad areas	Altering long-term river flow	Change in water quantity	1
Agavanzal	Reservoir area	Altering long-term river flow	Change in biota habitat	7
Agavanzal	Reservoir area	Altering long-term river flow	Change in local economy	1
Agavanzal	Reservoir area	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Agavanzal	Reservoir area	Altering long-term river flow	Change in water quality	3
Agavanzal	Reservoir area	Altering long-term river flow	Change in water quantity	1
Aurland I	Downstream area	Altering long-term river flow	Change in biota habitat	4
Aurland I	Downstream area	Altering long-term river flow	Change in water quality	1
Aurland I	Downstream area	Altering long-term river flow	Change in water quantity	4
Aurland I	Other broad areas	Altering long-term river flow	Change in biota habitat	8
Aurland I	Other broad areas	Altering long-term river flow	Change in ecosystem community populations	1
Aurland I	Other broad areas	Altering long-term river flow	Change in local economy	1
Aurland I	Other broad areas	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Aurland I	Other broad areas	Altering long-term river flow	Change in transportation and servicing	1
Aurland I	Other broad areas	Altering long-term river flow	Change in water quality	1
Aurland I	Other broad areas	Altering long-term river flow	Cumulative effects of hydro and other facilities	1
Aurland I	Other broad areas	Blasting and drilling	Change in biota habitat	1
Aurland I	Other broad areas	Constructing onshore installations	Change in biota habitat	2
Aurland I	Other broad areas	Impounding (reservoir filling)	Change in resource use – aquatic biota	1
Aurland I	Other broad areas	Project and maintenance spending	Change in local economy	1
Aurland I	Other broad areas	Road maintenance	Change in transportation and servicing	1
Aurland I	Other broad areas	Vehicle movement	Change in transportation and servicing	1

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Aurland I	Other specific areas in the catchment	Altering long-term river flow	Change in social and community structure	4
Aurland I	Reservoir area	Impounding (reservoir filling)	Change in biota habitat	1
Aurland I	Reservoir area	Impounding (reservoir filling)	Change in water quality	1
Aurland I	Reservoir area	Impounding (reservoir filling)	Change in water quantity	2
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Change in biota habitat	16
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Change in local economy	12
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Change in social and community structure	10
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Change in water quality	8
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Change in water quantity	12
Great Ruaha, Mtera	Construction disturbance area	Altering long-term river flow	Climatic and local air quality changes	2
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Change in biota habitat	14
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Change in local economy	12
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Change in social and community structure	10
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Change in water quality	8
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Change in water quantity	12
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	2
Great Ruaha, Mtera	Reservoir area	Altering long-term river flow	Physical impacts	2

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Hunderfossen	Construction disturbance area	Excavating and filling on land	Change in local economy	2
Hunderfossen	Downstream area	Altering river flow route (diversion)	Change in biota habitat	1
Hunderfossen	Downstream area	Altering river flow route (diversion)	Change in biota mobility	1
Hunderfossen	Downstream area	Altering river flow route (diversion)	Change in water quantity	1
Hunderfossen	Other broad areas	Altering river flow route (diversion)	Change in material translocation	1
Hunderfossen	Other broad areas	Altering river flow route (diversion)	Change in resource use – aquatic biota	1
Hunderfossen	Other broad areas	Constructing onshore installations	Change in local economy	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in ecosystem community populations	12
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in transportation and servicing	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in water quality	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Change in water quantity	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Increased erosion	1
Kokkosniva	Construction disturbance area	Altering long-term river flow	Sedimentation	1
Kokkosniva	Downstream area	Altering long-term river flow	Change in ecosystem community populations	4
Kokkosniva	Downstream area	Altering long-term river flow	Change in water quality	3
Kokkosniva	Other specific areas in the catchment	Altering long-term river flow	Change in ecosystem community populations	11

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Kokkosniva	Other specific areas in the catchment	Altering long-term river flow	Change in social and community structure	2
Kokkosniva	Reservoir area	Altering long-term river flow	Change in biota habitat	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in community and social services	4
Kokkosniva	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	7
Kokkosniva	Reservoir area	Altering long-term river flow	Change in local economy	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in resource use – aquatic biota	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in resource use – terrestrial biota	1
Kokkosniva	Reservoir area	Altering long-term river flow	Change in water quality	5
Kokkosniva	Reservoir area	Altering long-term river flow	Change in water quantity	1
Kokkosniva	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	2
Kurkiaska	Construction disturbance area	Altering long-term river flow	Change in biota habitat	4
Kurkiaska	Construction disturbance area	Altering long-term river flow	Change in ecosystem community populations	3
Kurkiaska	Construction disturbance area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Kurkiaska	Construction disturbance area	Altering long-term river flow	Change in transportation and servicing	1
Kurkiaska	Downstream area	Altering long-term river flow	Change in ecosystem community populations	4
Kurkiaska	Downstream area	Altering long-term river flow	Change in water quality	3
Kurkiaska	Other specific areas in the catchment	Altering long-term river flow	Change in community and social services	1

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Kurkiaska	Other specific areas in the catchment	Altering long-term river flow	Change in ecosystem community populations	11
Kurkiaska	Reservoir area	Altering long-term river flow	Change in biota habitat	1
Kurkiaska	Reservoir area	Altering long-term river flow	Change in community and social services	4
Kurkiaska	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	5
Kurkiaska	Reservoir area	Altering long-term river flow	Change in local economy	2
Kurkiaska	Reservoir area	Altering long-term river flow	Change in resource use – aquatic biota	1
Kurkiaska	Reservoir area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Kurkiaska	Reservoir area	Altering long-term river flow	Change in resource use – recreational areas etc.	3
Kurkiaska	Reservoir area	Altering long-term river flow	Change in water quality	5
Kurkiaska	Reservoir area	Altering long-term river flow	Change in water quantity	2
Kurkiaska	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	2
Kurotani	Construction disturbance area	Altering long-term river flow	Change in biota habitat	24
Kurotani	Reservoir area	Altering long-term river flow	Change in biota habitat	15
Kurotani	Reservoir area	Altering long-term river flow	Change in local economy	6
Kurotani	Reservoir area	Altering long-term river flow	Change in water quality	21
Kurotani	Reservoir area	Altering long-term river flow	Change in water quantity	3
Kurotani	Reservoir area	Altering long-term river flow	Noise and human presence effects on biota	3
Kurotani	Reservoir area	Altering long-term river flow	Sedimentation	3
La Grande 2A	Construction disturbance area	Aggregate extraction	Change in biota habitat	1
La Grande 2A	Construction disturbance area	Blasting and drilling	Change in biota habitat	1
La Grande 2A	Construction disturbance area	Installing and maintaining work camps, laydown areas, parking lots	Change in community and social services	2

(Appendix 6: Continued)

La Grande 2A	Downstream area	Altering long-term river flow	Removal of vegetation	1
Project name	Location	Activity	Impact	Count of impact
La Grande 2A	Downstream area	Altering river flow route (diversion)	Change in water quantity	3
La Grande 2A	Downstream area	Altering river flow route (diversion)	Change in resource use – water	2
La Grande 2A	Downstream area	Information delivery (reporting, meetings, hearings, consultation)	Change in biota habitat	3
La Grande 2A	Downstream area	Information delivery (reporting, meetings, hearings, consultation)	Change in community and social services	1
La Grande 2A	Downstream area	Operating at peak efficiency	Biotoxicity	2
La Grande 2A	Downstream area	Operating at peak efficiency	Change in community and social services	2
La Grande 2A	Downstream area	Operating at peak efficiency	Change in material translocation	1
La Grande 2A	Downstream area	Operating at peak efficiency	Change in resource use – aquatic biota	4
La Grande 2A	Downstream area	Operating at peak efficiency	Change in resource use – terrestrial biota	1
La Grande 2A	Downstream area	Operating at peak efficiency	Change in transportation and servicing	2
La Grande 2A	Downstream area	Operating at peak efficiency	Change in water quantity	7
La Grande 2A	Downstream area	Operating at peak efficiency	Change in resource use – water	1
La Grande 2A	Downstream area	Operating at peak efficiency	Increased erosion	2
La Grande 2A	Downstream area	Using local services and amenities	Change in community and social services	1
La Remolina - Riano	Downstream area	Altering long-term river flow	Change in ecosystem community populations	3
La Remolina - Riano	Downstream area	Altering long-term river flow	Change in water quality	6
La Remolina - Riano	Downstream area	Altering long-term river flow	Change in water quantity	4
La Remolina - Riano	Other broad areas	Altering long-term river flow	Change in ecosystem community populations	1
La Remolina - Riano	Other broad areas	Altering long-term river flow	Change in water quality	5

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
La Remolina - Riano	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	2
La Remolina - Riano	Reservoir area	Altering long-term river flow	Change in resource use – terrestrial biota	1
La Remolina - Riano	Reservoir area	Altering long-term river flow	Change in social and community structure	3
La Remolina - Riano	Reservoir area	Altering long-term river flow	Change in water quality	5
La Remolina - Riano	Reservoir area	Altering long-term river flow	Change in water quantity	1
La Remolina - Riano	Reservoir area	Altering long-term river flow	Removal of vegetation	1
Lokka	Construction disturbance area	Altering long-term river flow	Change in biota habitat	8
Lokka	Construction disturbance area	Altering long-term river flow	Change in community and social services	4
Lokka	Construction disturbance area	Altering long-term river flow	Change in ecosystem community populations	10
Lokka	Construction disturbance area	Altering long-term river flow	Change in local economy	2
Lokka	Construction disturbance area	Altering long-term river flow	Change in resource use – aquatic biota	2
Lokka	Construction disturbance area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	6
Lokka	Construction disturbance area	Altering long-term river flow	Change in resource use – recreational areas etc.	4
Lokka	Construction disturbance area	Altering long-term river flow	Change in social and community structure	4
Lokka	Construction disturbance area	Altering long-term river flow	Change in water quality	10

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Lokka	Construction disturbance area	Altering long-term river flow	Change in water quantity	6
Lokka	Construction disturbance area	Altering long-term river flow	Change in resource use – water	2
Lokka	Construction disturbance area	Altering long-term river flow	Climatic and local air quality changes	4
Lokka	Downstream area	Altering long-term river flow	Change in ecosystem community populations	6
Lokka	Downstream area	Altering long-term river flow	Change in water quality	4
Lokka	Other specific areas in the catchment	Altering long-term river flow	Change in ecosystem community populations	18
Lokka	Other specific areas in the catchment	Altering long-term river flow	Change in social and community structure	4
Lokka	Reservoir area	Altering long-term river flow	Change in biota habitat	2
Lokka	Reservoir area	Altering long-term river flow	Change in community and social services	8
Lokka	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	12
Lokka	Reservoir area	Altering long-term river flow	Change in resource use – aquatic biota	2
Lokka	Reservoir area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	2
Lokka	Reservoir area	Altering long-term river flow	Change in water quality	10
Lokka	Reservoir area	Altering long-term river flow	Change in water quantity	2
Lokka	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	4
Maan	Construction disturbance area	Blasting and drilling	Noise and human presence effects on biota	3
Maan	Construction disturbance area	Dewatering and draining	Change in water quality	3
Maan	Downstream area	Altering long-term river flow	Change in water quantity	6
Maan	Downstream area	Altering short-term river flow	Change in water quantity	3
Maan	Downstream area	Dewatering and draining	Change in water quality	3

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Maan	Downstream area	Impounding (reservoir filling)	Change in water quality	9
Maan	Reservoir area	Altering long-term river flow	Change in biota habitat	9
Maan	Reservoir area	Altering long-term river flow	Change in water quantity	6
Maan	Reservoir area	Dewatering and draining	Change in land use and policy plans	3
Maan	Reservoir area	Impounding (reservoir filling)	Change in water quality	6
Mingtán pumped storage	Construction disturbance area	Blasting and drilling	Noise and human presence effects on biota	2
Mingtán pumped storage	Construction disturbance area	Dewatering and draining	Change in water quality	2
Mingtán pumped storage	Downstream area	Altering long-term river flow	Change in water quantity	2
Mingtán pumped storage	Downstream area	Altering short-term river flow	Change in water quantity	2
Mingtán pumped storage	Downstream area	Dewatering and draining	Change in water quality	2
Mingtán pumped storage	Downstream area	Impounding (reservoir filling)	Change in water quality	4
Mingtán pumped storage	Reservoir area	Altering long-term river flow	Change in biota habitat	8
Mingtán pumped storage	Reservoir area	Altering long-term river flow	Change in water quantity	4
Mingtán pumped storage	Reservoir area	Impounding (reservoir filling)	Change in water quality	4
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Change in biota habitat	2
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Change in local economy	1
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Change in resource use – recreational areas etc.	1

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Change in water quality	1
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Increased erosion	1
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Noise and human presence effects on biota	1
Mis Dam-Sospirolo	Construction disturbance area	Altering long-term river flow	Removal of vegetation	2
Mis Dam-Sospirolo	Downstream area	Altering long-term river flow	Change in biota habitat	1
Mis Dam-Sospirolo	Downstream area	Altering long-term river flow	Change in ecosystem community populations	2
Mis Dam-Sospirolo	Downstream area	Altering long-term river flow	Change in local economy	1
Mis Dam-Sospirolo	Downstream area	Altering long-term river flow	Change in water quality	2
Mis Dam-Sospirolo	Downstream area	Altering long-term river flow	Change in water quantity	1
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Change in biota habitat	3
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	1
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Increased erosion	1
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Noise and human presence effects on biota	1
Mis Dam-Sospirolo	Reservoir area	Altering long-term river flow	Sedimentation	1

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Okumino	Construction disturbance area	Altering long-term river flow	Change in biota habitat	22
Okumino	Construction disturbance area	Altering long-term river flow	Change in local economy	24
Okumino	Construction disturbance area	Altering long-term river flow	Change in social and community structure	10
Okumino	Construction disturbance area	Altering long-term river flow	Change in water quality	12
Okumino	Downstream area	Altering long-term river flow	Change in biota habitat	18
Okumino	Downstream area	Altering long-term river flow	Change in water quality	12
Okumino	Other broad areas	Altering long-term river flow	Change in biota habitat	20
Okumino	Other broad areas	Altering long-term river flow	Change in water quality	12
Okumino	Reservoir area	Altering long-term river flow	Change in biota habitat	22
Okumino	Reservoir area	Altering long-term river flow	Change in water quality	12
Petäjaskoski	Downstream area	Operating at maximum power	Change in biota habitat	6
Petäjaskoski	Downstream area	Operating at maximum power	Change in housing and property values	5
Petäjaskoski	Downstream area	Operating at maximum power	Change in resource use – recreational areas etc.	1
Petäjaskoski	Downstream area	Operating at maximum power	Change in water quality	4
Petäjaskoski	Downstream area	Operating at maximum power	Change in water quantity	1
Petäjaskoski	Downstream area	Operating at maximum power	Increased erosion	1
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in biota habitat	3
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in local economy	5
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in resource use – aquatic biota	3
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	2

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in social and community structure	2
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in water quality	5
Porttipahta	Construction disturbance area	Altering long-term river flow	Change in water quantity	2
Porttipahta	Construction disturbance area	Altering long-term river flow	Climatic and local air quality changes	2
Porttipahta	Construction disturbance area	Altering long-term river flow	Increased erosion	1
Porttipahta	Downstream area	Altering long-term river flow	Change in ecosystem community populations	5
Porttipahta	Other broad areas	Altering long-term river flow	Change in water quantity	1
Porttipahta	Other specific areas in the catchment	Altering long-term river flow	Change in ecosystem community populations	9
Porttipahta	Other specific areas in the catchment	Altering long-term river flow	Change in social and community structure	1
Porttipahta	Reservoir area	Altering long-term river flow	Change in biota habitat	1
Porttipahta	Reservoir area	Altering long-term river flow	Change in community and social services	3
Porttipahta	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	4
Porttipahta	Reservoir area	Altering long-term river flow	Change in local economy	1
Porttipahta	Reservoir area	Altering long-term river flow	Change in resource use – aquatic biota	1
Porttipahta	Reservoir area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Porttipahta	Reservoir area	Altering long-term river flow	Change in water quality	5
Porttipahta	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	2

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Rivière des Prairies (spillway rehabilitation)	Construction disturbance area	Site rehabilitation	Change in channel morphology	5
Robert-Bourassa	Construction disturbance area	Aggregate extraction	Change in biota habitat	2
Robert-Bourassa	Construction disturbance area	Aggregate extraction	Removal of vegetation	5
Robert-Bourassa	Construction disturbance area	Blasting and drilling	Noise and human presence effects on biota	1
Robert-Bourassa	Construction disturbance area	Chemical spilling	Biotoxicity	1
Robert-Bourassa	Construction disturbance area	Excavating and fill placement in water	Change in resource use – water	1
Robert-Bourassa	Construction disturbance area	Excavating and filling on land	Removal of vegetation	1
Robert-Bourassa	Construction disturbance area	Installing and maintaining work camps, laydown areas, parking lots	Change in community and social services	1
Robert-Bourassa	Construction disturbance area	Installing and maintaining work camps, laydown areas, parking lots	Change in land use and policy plans	1
Robert-Bourassa	Construction disturbance area	Site rehabilitation	Removal of vegetation	2
Robert-Bourassa	Construction disturbance area	Using local services and amenities	Change in land use and policy plans	3
Robert-Bourassa	Construction disturbance area	Using local services and amenities	Change in social and community structure	2
Robert-Bourassa	Construction disturbance area	Worker leisure activities	Change in resource use – recreational areas etc.	1
Robert-Bourassa	Downstream area	Altering long-term river flow	Change in biota habitat	4
Robert-Bourassa	Downstream area	Altering long-term river flow	Change in resource use – aquatic biota	1
Robert-Bourassa	Downstream area	Altering long-term river flow	Change in water quality	2

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Robert-Bourassa	Downstream area	Altering long-term river flow	Change in water quantity	6
Robert-Bourassa	Downstream area	Altering long-term river flow	Increased erosion	2
Robert-Bourassa	Downstream area	Altering short-term river flow	Change in water quality	2
Robert-Bourassa	Downstream area	Constructing onshore installations	Increased erosion	1
Robert-Bourassa	Downstream area	Environmental inventory and sampling	Change in ecosystem community populations	1
Robert-Bourassa	Downstream area	Environmental inventory and sampling	Human health effects of toxins	1
Robert-Bourassa	Downstream area	Impounding (reservoir filling)	Change in water quality	5
Robert-Bourassa	Downstream area	Impounding (reservoir filling)	Change in water quantity	2
Robert-Bourassa	Downstream area	Impounding (reservoir filling)	Change in resource use – water	1
Robert-Bourassa	Reservoir area	Altering long-term river flow	Change in biota habitat	4
Robert-Bourassa	Reservoir area	Altering long-term river flow	Change in human safety risk	1
Robert-Bourassa	Reservoir area	Environmental inventory and sampling	Change in biota habitat	3
Robert-Bourassa	Reservoir area	Environmental inventory and sampling	Change in ecosystem community populations	6
Robert-Bourassa	Reservoir area	Environmental inventory and sampling	Change in land use and policy plans	3
Robert-Bourassa	Reservoir area	Environmental inventory and sampling	Change in water quality	1
Robert-Bourassa	Reservoir area	Environmental inventory and sampling	Soil inundation	3
Robert-Bourassa	Reservoir area	Impounding (reservoir filling)	Biotoxicity	3
Robert-Bourassa	Reservoir area	Impounding (reservoir filling)	Change in human safety risk	1
Robert-Bourassa	Reservoir area	Vegetation disposal	Change in human safety risk	4
Shin-Takanosu	Construction disturbance area	Altering long-term river flow	Climatic and local air quality changes	1
Shin-Takanosu	Downstream area	Altering long-term river flow	Change in biota habitat	1

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Shin-Takanosu	Downstream area	Altering long-term river flow	Change in ecosystem community populations	10
Shin-Takanosu	Downstream area	Altering long-term river flow	Change in local economy	8
Shin-Takanosu	Downstream area	Altering long-term river flow	Change in water quality	5
Shin-Takanosu	Downstream area	Altering long-term river flow	Change in water quantity	3
Shin-Takanosu	Other broad areas	Altering long-term river flow	Change in biota habitat	10
Shin-Takanosu	Other broad areas	Altering long-term river flow	Change in local economy	4
Shin-Takanosu	Other broad areas	Altering long-term river flow	Change in water quality	4
Shin-Takanosu	Other broad areas	Altering long-term river flow	Noise and human presence effects on biota	1
Shin-Takanosu	Other broad areas	Altering long-term river flow	Physical impacts	1
Shin-Takanosu	Reservoir area	Altering long-term river flow	Change in biota habitat	1
Shin-Takanosu	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	10
Shin-Takanosu	Reservoir area	Altering long-term river flow	Change in local economy	6
Shin-Takanosu	Reservoir area	Altering long-term river flow	Change in water quality	5
Shin-Takanosu	Reservoir area	Altering long-term river flow	Change in water quantity	2
Shin-Takanosu	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	1
Shin-Takanosu	Reservoir area	Altering long-term river flow	Physical impacts	1
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Change in biota habitat	72
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Change in local economy	18
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Change in resource use – recreational areas etc.	9
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Change in water quality	9
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Change in water quantity	9
Stjørdalselva	Construction disturbance area	Altering long-term river flow	Climatic and local air quality changes	9
Stjørdalselva	Downstream area	Altering long-term river flow	Change in biota habitat	9

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Stjørdalselva	Downstream area	Altering long-term river flow	Change in local economy	9
Stjørdalselva	Downstream area	Altering long-term river flow	Change in water quality	9
Stjørdalselva	Downstream area	Altering long-term river flow	Change in water quantity	9
Stjørdalselva	Downstream area	Altering long-term river flow	Climatic and local air quality changes	9
Stjørdalselva	Other broad areas	Altering long-term river flow	Change in biota habitat	9
Stjørdalselva	Other broad areas	Altering long-term river flow	Change in local economy	9
Stjørdalselva	Other broad areas	Altering long-term river flow	Climatic and local air quality changes	9
Stjørdalselva	Reservoir area	Altering long-term river flow	Change in biota habitat	18
Stjørdalselva	Reservoir area	Altering long-term river flow	Change in local economy	9
Stjørdalselva	Reservoir area	Altering long-term river flow	Change in water quality	9
Stjørdalselva	Reservoir area	Altering long-term river flow	Change in water quantity	9
Stjørdalselva	Reservoir area	Altering long-term river flow	Climatic and local air quality changes	9
Takami	Downstream area	Altering long-term river flow	Change in biota habitat	30
Takami	Downstream area	Altering long-term river flow	Change in local economy	36
Takami	Downstream area	Altering long-term river flow	Change in water quality	15
Takami	Downstream area	Altering long-term river flow	Change in water quantity	6
Takami	Other broad areas	Altering long-term river flow	Change in biota habitat	45
Takami	Other broad areas	Altering long-term river flow	Change in local economy	3
Takami	Other broad areas	Altering long-term river flow	Change in water quality	12
Takami	Reservoir area	Altering long-term river flow	Change in biota habitat	51
Takami	Reservoir area	Altering long-term river flow	Change in local economy	6
Takami	Reservoir area	Altering long-term river flow	Change in water quality	18
Takami	Reservoir area	Altering long-term river flow	Change in water quantity	9
Valparaiso	Downstream area	Altering long-term river flow	Change in biota habitat	1
Valparaiso	Downstream area	Altering long-term river flow	Change in ecosystem community populations	1
Valparaiso	Downstream area	Altering long-term river flow	Change in resource use – aquatic biota	1
Valparaiso	Downstream area	Altering long-term river flow	Change in water quality	5

(Appendix 6: Continued)

Project name	Location	Activity	Impact	Count of impact
Valparaiso	Downstream area	Altering long-term river flow	Change in water quantity	1
Valparaiso	Other broad areas	Altering long-term river flow	Change in ecosystem community populations	1
Valparaiso	Other broad areas	Altering long-term river flow	Change in resource use – aquatic biota	1
Valparaiso	Other broad areas	Altering long-term river flow	Change in water quality	1
Valparaiso	Other broad areas	Altering long-term river flow	Change in water quantity	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in biota habitat	3
Valparaiso	Reservoir area	Altering long-term river flow	Change in ecosystem community populations	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in local economy	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in resource use – aquatic biota	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in resource use – forestry, mining, agriculture	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in resource use – recreational areas etc.	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in resource use – terrestrial biota	3
Valparaiso	Reservoir area	Altering long-term river flow	Change in social and community structure	1
Valparaiso	Reservoir area	Altering long-term river flow	Change in water quality	2
Valparaiso	Reservoir area	Altering long-term river flow	Change in water quantity	2

Appendix 7: Activities commonly connected to mitigation measures

Activity	Mitigation measures	Count of mitigation measures
Aggregate extraction	Erosion prevention and control	1
Aggregate extraction	Protecting or mitigating changes to landscape	1
Aggregate extraction	Protection, replacement and control of vegetation	4
Aggregate extraction	Sedimentation prevention and control	1
Altering long-term river flow	Economic impact management	64
Altering long-term river flow	Erosion prevention and control	10
Altering long-term river flow	Fish protection	58
Altering long-term river flow	Human health and safety risk management	2
Altering long-term river flow	Minimising soil contamination and loss of soil due to inundation	1
Altering long-term river flow	Mitigating cumulative effects of multiple hydroelectric facilities	1
Altering long-term river flow	Mitigating effects on resource use	1
Altering long-term river flow	Other	39
Altering long-term river flow	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	4
Altering long-term river flow	Protecting or mitigating changes to landscape	41
Altering long-term river flow	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	21
Altering long-term river flow	Protection, replacement and control of vegetation	61
Altering long-term river flow	Sedimentation prevention and control	7
Altering long-term river flow	Social impact management	41
Altering long-term river flow	Water quality protection and adjustments	80
Altering long-term river flow	Water quantity control (flow, velocity, level; including ice formation and movements)	65
Altering river flow route (diversion)	Fish protection	3
Altering river flow route (diversion)	Water quantity control (flow, velocity, level; including ice formation and movements)	2
Altering short-term river flow	Water quantity control (flow, velocity, level; including ice formation and movements)	2
Blasting and drilling	Fish protection	1
Blasting and drilling	Other	1
Blasting and drilling	Protecting or mitigating changes to landscape	1
Chemical spilling	Minimising soil contamination and loss of soil due to inundation	1
Constructing onshore installations	Protecting or mitigating changes to landscape	2
Constructing onshore installations	Social impact management	1
Dewatering and draining	Economic impact management	3
Dewatering and draining	Water quality protection and adjustments	10
Environmental inventory and sampling	Climatic and local air quality controls	4
Environmental inventory and sampling	Human health and safety risk management	1

(Appendix 7: Continued)

Activity	Mitigation measures	Count of mitigation measures
Environmental inventory and sampling	Mitigating effects on resource use	1
Environmental inventory and sampling	Other	2
Environmental inventory and sampling	Protection, replacement and control of vegetation	3
Environmental inventory and sampling	Social impact management	2
Excavating and filling on land	Protecting or mitigating changes to landscape	1
Excavating and filling on land	Protection, replacement and control of vegetation	1
Impounding (reservoir filling)	Economic impact management	3
Impounding (reservoir filling)	Erosion prevention and control	1
Impounding (reservoir filling)	Fish protection	4
Impounding (reservoir filling)	Human health and safety risk management	2
Impounding (reservoir filling)	Mitigating effects on resource use	1
Impounding (reservoir filling)	Other	4
Impounding (reservoir filling)	Water quality protection and adjustments	10
Information delivery (reporting, meetings, hearings, consultation)	Economic impact management	1
Information delivery (reporting, meetings, hearings, consultation)	Human health and safety risk management	1
Information delivery (reporting, meetings, hearings, consultation)	Mitigating effects on resource use	1
Installing and maintaining work camps, laydown areas, parking lots	Human health and safety risk management	1
Installing and maintaining work camps, laydown areas, parking lots	Mitigating cumulative effects of multiple hydroelectric facilities	1
Installing and maintaining work camps, laydown areas, parking lots	Other	1
Installing and maintaining work camps, laydown areas, parking lots	Social impact management	1
Operating at maximum power	Other	5
Operating at maximum power	Water quantity control (flow, velocity, level; including ice formation and movements)	1
Operating at peak efficiency	Erosion prevention and control	1
Operating at peak efficiency	Human health and safety risk management	2
Operating at peak efficiency	Mitigating effects on resource use	5
Operating at peak efficiency	Other	2
Operating at peak efficiency	Protection, replacement and control of vegetation	3
Operating at peak efficiency	Social impact management	1
Operating at peak efficiency	Water quality protection and adjustments	1
Operating at peak efficiency	Water quantity control (flow, velocity, level; including ice formation and movements)	6
Project and maintenance spending	Economic impact management	1
Road maintenance	Economic impact management	1
Site rehabilitation	Erosion prevention and control	1
Site rehabilitation	Fish protection	1

(Appendix 7: Continued)

Activity	Mitigation measures	Count of mitigation measures
Site rehabilitation	Other	2
Site rehabilitation	Protection, replacement and control of vegetation	2
Using local services and amenities	Economic impact management	3
Using local services and amenities	Mitigating effects on resource use	1
Using local services and amenities	Other	1
Using local services and amenities	Social impact management	1
Vegetation disposal	Human health and safety risk management	1
Vegetation disposal	Mitigating effects on resource use	1
Vegetation disposal	Protecting or minimising changes in channel morphology	1
Vegetation disposal	Protecting or mitigating changes to landscape	1

Appendix 8: Activities, impacts, count of impacts, main environmental issues and mitigation measures

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Aggregate extraction	Change in biota habitat	1	Landscape	Access roads	Protection, replacement and control of vegetation
Aggregate extraction	Change in biota habitat	1	Landscape	Access roads	Protecting or mitigating changes to landscape
Aggregate extraction	Removal of vegetation	2	Terrestrial biology	Fauna (mammals)	Protection, replacement and control of vegetation
Aggregate extraction	Removal of vegetation	1	Terrestrial biology	Fauna (mammals)	Erosion prevention and control
Aggregate extraction	Removal of vegetation	1	Terrestrial biology	Flora	Protection, replacement and control of vegetation
Aggregate extraction	Removal of vegetation	1	Terrestrial biology	Flora	Sedimentation prevention and control
Altering long-term river flow	Change in biota habitat	24	Landscape	Landscape appreciation	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in biota habitat	18	Landscape	Landscape appreciation	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	17	Aquatic biology	Fish community	Fish protection
Altering long-term river flow	Change in biota habitat	16	Terrestrial biology	Flora	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	15	Aquatic biology	Fish community	Other
Altering long-term river flow	Change in biota habitat	14	Aquatic biology	Fish migration	Fish protection
Altering long-term river flow	Change in biota habitat	9	Landscape	Rock tips	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in biota habitat	9	Terrestrial biology	Fauna (mammals)	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)
Altering long-term river flow	Change in biota habitat	9	Terrestrial biology	Red-listed species	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in biota habitat	6	Landscape	Access roads	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	6	Local climate	Water temperature	Water quality protection and adjustments
Altering long-term river flow	Change in biota habitat	6	Social	Noise and vibration	Social impact management
Altering long-term river flow	Change in biota habitat	3	Aquatic biology	Fauna	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in biota habitat	3	Economy	Forestry	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	3	Economy	Recreational areas	Economic impact management
Altering long-term river flow	Change in biota habitat	3	Landscape	Access roads	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in biota habitat	3	Landscape	Landscape appreciation	Social impact management
Altering long-term river flow	Change in biota habitat	3	Landscape	Landscape appreciation	Other
Altering long-term river flow	Change in biota habitat	3	Terrestrial biology	Fauna (birds)	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	3	Terrestrial biology	Fauna (insects)	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	3	Terrestrial biology	Fauna (mammals)	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	2	Aquatic biology	Flora	Other
Altering long-term river flow	Change in biota habitat	2	Aquatic biology	Flora	Protection, replacement and control of vegetation
Altering long-term river flow	Change in biota habitat	2	Economy	Recreational areas	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in biota habitat	1	Aquatic biology	Fish community	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in biota habitat	1	Economy	Fisheries (fish stocking)	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)
Altering long-term river flow	Change in biota habitat	1	Economy	Fisheries (fish stocking)	Fish protection
Altering long-term river flow	Change in biota habitat	1	Economy	Recreational areas	Mitigating cumulative effects of multiple hydroelectric facilities
Altering long-term river flow	Change in biota habitat	1	Economy	Recreational areas	Water quality protection and adjustments
Altering long-term river flow	Change in biota habitat	1	Economy	Recreational areas	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in biota habitat	1	Economy	Recreational areas	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in biota habitat	1	Landscape	Access roads	Other
Altering long-term river flow	Change in biota habitat	1	Landscape	Landscape appreciation	Minimising soil contamination and loss of soil due to inundation
Altering long-term river flow	Change in biota habitat	1	Terrestrial biology	Flora	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in community and social services	2	Economy	Commerce	Water quality protection and adjustments
Altering long-term river flow	Change in community and social services	2	Economy	Water supply	Social impact management
Altering long-term river flow	Change in community and social services	1	Social	Resettlement	Economic impact management
Altering long-term river flow	Change in ecosystem community populations	8	Aquatic biology	Fish community	Fish protection

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in ecosystem community populations	5	Aquatic biology	Fish migration	Fish protection
Altering long-term river flow	Change in ecosystem community populations	4	Economy	Fisheries (fish stocking)	Fish protection
Altering long-term river flow	Change in ecosystem community populations	2	Landscape	Landscape appreciation	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in ecosystem community populations	1	Aquatic biology	Fauna	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)
Altering long-term river flow	Change in ecosystem community populations	1	Aquatic biology	Fauna	Water quality protection and adjustments
Altering long-term river flow	Change in ecosystem community populations	1	Aquatic biology	Fish community	Other
Altering long-term river flow	Change in ecosystem community populations	1	Aquatic biology	Fish community	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in ecosystem community populations	1	Aquatic biology	Flora	Water quality protection and adjustments
Altering long-term river flow	Change in ecosystem community populations	1	Landscape	Access roads	Social impact management
Altering long-term river flow	Change in ecosystem community populations	1	Terrestrial biology	Red-listed species	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)
Altering long-term river flow	Change in local economy	15	Economy	Fisheries (others)	Economic impact management
Altering long-term river flow	Change in local economy	12	Economy	Transportation	Economic impact management
Altering long-term river flow	Change in local economy	10	Economy	Tourism employment	Economic impact management
Altering long-term river flow	Change in local economy	5	Economy	Fisheries (others)	Fish protection

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in local economy	3	Economy	Agriculture	Water quality protection and adjustments
Altering long-term river flow	Change in local economy	3	Economy	Fisheries (fish stocking)	Fish protection
Altering long-term river flow	Change in local economy	3	Economy	Forestry	Protection, replacement and control of vegetation
Altering long-term river flow	Change in local economy	3	Economy	Recreational areas	Economic impact management
Altering long-term river flow	Change in local economy	3	Economy	Recreational areas	Social impact management
Altering long-term river flow	Change in local economy	3	Economy	Reindeer husbandry	Economic impact management
Altering long-term river flow	Change in local economy	2	Economy	Agriculture	Protection, replacement and control of vegetation
Altering long-term river flow	Change in local economy	2	Economy	Hospitals	Social impact management
Altering long-term river flow	Change in local economy	2	Economy	Reindeer husbandry	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources
Altering long-term river flow	Change in local economy	2	Economy	Schools	Social impact management
Altering long-term river flow	Change in local economy	2	Economy	Water supply	Social impact management
Altering long-term river flow	Change in local economy	1	Economy	Agriculture	Economic impact management
Altering long-term river flow	Change in local economy	1	Economy	Reindeer husbandry	Social impact management
Altering long-term river flow	Change in resource use – aquatic biota	1	Aquatic biology	Mercury	Mitigating effects on resource use
Altering long-term river flow	Change in resource use – aquatic biota	1	Economy	Fisheries (fish stocking)	Fish protection

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in resource use – forestry, mining, agriculture	5	Economy	Forestry	Economic impact management
Altering long-term river flow	Change in resource use – forestry, mining, agriculture	4	Economy	Agriculture	Economic impact management
Altering long-term river flow	Change in resource use – forestry, mining, agriculture	3	Economy	Forestry	Other
Altering long-term river flow	Change in resource use – recreational areas etc.	4	Economy	Recreational areas	Social impact management
Altering long-term river flow	Change in resource use – recreational areas etc.	1	Economy	Recreational areas	Economic impact management
Altering long-term river flow	Change in resource use – terrestrial biota	1	Landscape	Access roads	Social impact management
Altering long-term river flow	Change in social and community structure	4	Social	Resettlement	Economic impact management
Altering long-term river flow	Change in social and community structure	2	Social	Resettlement	Social impact management
Altering long-term river flow	Change in social and community structure	2	Social	Waterborne diseases	Social impact management
Altering long-term river flow	Change in social and community structure	1	Social	Indigenous people	Social impact management
Altering long-term river flow	Change in social and community structure	1	Social	Places of religious/historical value	Social impact management
Altering long-term river flow	Change in social and community structure	1	Social	Social intrusion	Social impact management
Altering long-term river flow	Change in transportation and servicing	1	Economy	Tourism employment	Economic impact management
Altering long-term river flow	Change in transportation and servicing	1	Landscape	Access roads	Social impact management

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in water quality	13	Water quality	Temperature	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	12	Water quality	Drainage from construction work	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	12	Water quality	Turbidity or suspended solids	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	9	Water quality	Eutrophication	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	9	Water quality	Transport of elements and matter	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	4	Local climate	Water temperature	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	3	Water quality	Heavy metals	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	2	Water quality	Oxygen content	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	1	Economy	Water supply	Water quality protection and adjustments
Altering long-term river flow	Change in water quality	1	Estuarine and coastal habitat	Salt intrusion/plume	Other
Altering long-term river flow	Change in water quality	1	Water quality	Eutrophication	Other
Altering long-term river flow	Change in water quantity	36	Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in water quantity	16	Hydrology	Flood frequency	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in water quantity	9	Hydrology	Groundwater level	Other
Altering long-term river flow	Change in water quantity	6	Hydrology	Erosion	Erosion prevention and control

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Change in water quantity	3	Hydrology	Recipient	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in water quantity	2	Hydrology	Sedimentation	Sedimentation prevention and control
Altering long-term river flow	Change in water quantity	1	Aquatic biology	Fauna	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in water quantity	1	Estuarine and coastal habitat	Circulation	Other
Altering long-term river flow	Change in water quantity	1	Estuarine and coastal habitat	Salt intrusion/plume	Other
Altering long-term river flow	Change in water quantity	1	Hydrology	Flood frequency	Erosion prevention and control
Altering long-term river flow	Change in water quantity	1	Hydrology	Flow regime	Economic impact management
Altering long-term river flow	Change in water quantity	1	Hydrology	Flow regime	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in water quantity	1	Hydrology	Groundwater level	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Change in water quantity	1	Landscape	Landscape appreciation	Protecting or mitigating changes to landscape
Altering long-term river flow	Change in water quantity	1	Social	Resettlement	Social impact management
Altering long-term river flow	Change in water quantity	1	Social	Resettlement	Erosion prevention and control
Altering long-term river flow	Increased erosion	1	Hydrology	Erosion	Erosion prevention and control
Altering long-term river flow	Increased erosion	1	Hydrology	Erosion	Water quality protection and adjustments
Altering long-term river flow	Increased erosion	1	Hydrology	Fluvial geomorphology	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering long-term river flow	Increased erosion	1	Hydrology	Fluvial geomorphology	Erosion prevention and control

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Altering long-term river flow	Noise and human presence effects on biota	3	Social	Noise and vibration	Social impact management
Altering long-term river flow	Physical impacts	2	Geophysics	Earthquakes	Human health and safety risk management
Altering long-term river flow	Physical impacts	2	Social	Noise and vibration	Social impact management
Altering long-term river flow	Removal of vegetation	2	Landscape	Landscape appreciation	Protection, replacement and control of vegetation
Altering long-term river flow	Removal of vegetation	1	Landscape	Landscape appreciation	Other
Altering long-term river flow	Sedimentation	5	Hydrology	Sedimentation	Sedimentation prevention and control
Altering river flow route (diversion)	Change in biota habitat	1	Aquatic biology	Fish community	Fish protection
Altering river flow route (diversion)	Change in biota mobility	1	Aquatic biology	Fish migration	Fish protection
Altering river flow route (diversion)	Change in material translocation	1	Economy	Forestry	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering river flow route (diversion)	Change in resource use – aquatic biota	1	Economy	Fisheries (fish stocking)	Fish protection
Altering river flow route (diversion)	Change in water quantity	1	Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)
Altering short-term river flow	Change in water quantity	2	Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)
Blasting and drilling	Change in biota habitat	1	Aquatic biology	Fish community	Fish protection
Blasting and drilling	Change in biota habitat	1	Landscape	Rock tips	Protecting or mitigating changes to landscape
Blasting and drilling	Noise and human presence effects on biota	1	Social	Noise and vibration	Other
Chemical spilling	Biotoxicity	1	Water quality	Heavy metals	Minimising soil contamination and loss of soil due to inundation
Constructing onshore installations	Change in biota habitat	1	Landscape	Quarries	Protecting or mitigating changes to landscape

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Constructing onshore installations	Change in biota habitat	1	Landscape	Transmission lines	Protecting or mitigating changes to landscape
Constructing onshore installations	Change in local economy	1	Economy	Tourism employment	Social impact management
Dewatering and draining	Change in land use and policy plans	3	Economy	Agriculture	Economic impact management
Dewatering and draining	Change in water quality	10	Water quality	Drainage from construction work	Water quality protection and adjustments
Environmental inventory and sampling	Change in biota habitat	1	Water quality	Heavy metals	Human health and safety risk management
Environmental inventory and sampling	Change in ecosystem community populations	1	Aquatic biology	Fauna	Social impact management
Environmental inventory and sampling	Change in ecosystem community populations	1	Aquatic biology	Flora	Protection, replacement and control of vegetation
Environmental inventory and sampling	Change in ecosystem community populations	1	Local climate	Air temperature	Climatic and local air quality controls
Environmental inventory and sampling	Change in ecosystem community populations	1	Local climate	Fog frequency	Climatic and local air quality controls
Environmental inventory and sampling	Change in ecosystem community populations	1	Local climate	Water temperature	Climatic and local air quality controls
Environmental inventory and sampling	Change in ecosystem community populations	1	Local climate	Wind	Climatic and local air quality controls
Environmental inventory and sampling	Change in land use and policy plans	2	Social	Indigenous people	Protection, replacement and control of vegetation
Environmental inventory and sampling	Change in land use and policy plans	1	Social	Indigenous people	Social impact management
Environmental inventory and sampling	Soil inundation	2	Economy	Fisheries (others)	Other
Environmental inventory and sampling	Soil inundation	1	Economy	Fisheries (others)	Mitigating effects on resource use

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Excavating and filling on land	Change in local economy	1	Landscape	Rock tips	Protecting or mitigating changes to landscape
Excavating and filling on land	Change in local economy	1	Landscape	Rock tips	Protection, replacement and control of vegetation
Impounding (reservoir filling)	Biotoxicity	1	Aquatic biology	Mercury	Human health and safety risk management
Impounding (reservoir filling)	Biotoxicity	1	Aquatic biology	Mercury	Mitigating effects on resource use
Impounding (reservoir filling)	Biotoxicity	1	Aquatic biology	Mercury	Other
Impounding (reservoir filling)	Change in biota habitat	1	Aquatic biology	Fish community	Fish protection
Impounding (reservoir filling)	Change in human safety risk	1	Geophysics	Earthquakes	Human health and safety risk management
Impounding (reservoir filling)	Change in water quality	10	Water quality	Turbidity or suspended solids	Water quality protection and adjustments
Impounding (reservoir filling)	Change in water quality	3	Economy	Agriculture	Economic impact management
Impounding (reservoir filling)	Change in water quality	2	Aquatic biology	Fish community	Fish protection
Impounding (reservoir filling)	Change in water quality	1	Aquatic biology	Fish community	Other
Impounding (reservoir filling)	Change in water quality	1	Estuarine and coastal habitat	Salt intrusion/ plume	Other
Impounding (reservoir filling)	Change in water quality	1	Water quality	Turbidity or suspended solids	Erosion prevention and control
Impounding (reservoir filling)	Change in water quantity	1	Aquatic biology	Fauna	Fish protection
Impounding (reservoir filling)	Change in water quantity	1	Estuarine and coastal habitat	Salt intrusion/ plume	Other

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Information delivery (reporting, meetings, hearings, consultation)	Change in biota habitat	1	Aquatic biology	Mercury	Human health and safety risk management
Information delivery (reporting, meetings, hearings, consultation)	Change in biota habitat	1	Estuarine and coastal habitat	Coastal habitats	Mitigating effects on resource use
Information delivery (reporting, meetings, hearings, consultation)	Change in community and social services	1	Economy	Industry	Economic impact management
Installing and maintaining work camps, laydown areas, parking lots	Change in community and social services	1	Economy	Commerce	Mitigating cumulative effects of multiple hydroelectric facilities
Installing and maintaining work camps, laydown areas, parking lots	Change in community and social services	1	Economy	Commerce	Other
Installing and maintaining work camps, laydown areas, parking lots	Change in community and social services	1	Economy	Industry	Human health and safety risk management
Installing and maintaining work camps, laydown areas, parking lots	Change in land use and policy plans	1	Economy	Industry	Social impact management
Operating at maximum power	Change in housing and property values	3	Hydrology	Erosion	Other
Operating at maximum power	Change in housing and property values	2	Other	Others	Other
Operating at maximum power	Change in water quantity	1	Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)
Operating at peak efficiency	Biotoxicity	1	Aquatic biology	Mercury	Human health and safety risk management
Operating at peak efficiency	Biotoxicity	1	Aquatic biology	Mercury	Mitigating effects on resource use
Operating at peak efficiency	Change in community and social services	1	Social	Social intrusion	Other

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Operating at peak efficiency	Change in community and social services	1	Social	Social intrusion	Social impact management
Operating at peak efficiency	Change in resource use – aquatic biota	1	Aquatic biology	Fish community	Mitigating effects on resource use
Operating at peak efficiency	Change in resource use – aquatic biota	1	Aquatic biology	Fish migration	Other
Operating at peak efficiency	Change in resource use – aquatic biota	1	Estuarine and coastal habitat	Coastal habitats	Mitigating effects on resource use
Operating at peak efficiency	Change in resource use – aquatic biota	1	Estuarine and coastal habitat	Coastal habitats	Protection, replacement and control of vegetation
Operating at peak efficiency	Change in resource use – terrestrial biota	1	Terrestrial biology	Fauna (birds)	Protection, replacement and control of vegetation
Operating at peak efficiency	Change in transportation and servicing	1	Social	Indigenous people	Mitigating effects on resource use
Operating at peak efficiency	Change in transportation and servicing	1	Social	Indigenous people	Human health and safety risk management
Operating at peak efficiency	Change in water quantity	1	Aquatic biology	Fish community	Mitigating effects on resource use
Operating at peak efficiency	Change in water quantity	1	Aquatic biology	Fish migration	Water quality protection and adjustments
Operating at peak efficiency	Change in water quantity	1	Aquatic biology	Flora	Protection, replacement and control of vegetation
Operating at peak efficiency	Change in water quantity	1	Estuarine and coastal habitat	Circulation	Water quantity control (flow, velocity, level; including ice formation and movements)
Operating at peak efficiency	Change in water quantity	1	Estuarine and coastal habitat	Coastal habitats	Water quantity control (flow, velocity, level; including ice formation and movements)
Operating at peak efficiency	Change in water quantity	1	Estuarine and coastal habitat	Salt intrusion/plume	Water quantity control (flow, velocity, level; including ice formation and movements)
Operating at peak efficiency	Change in water quantity	1	Estuarine and coastal habitat	Sediment dynamics	Water quantity control (flow, velocity, level; including ice formation and movements)
Operating at peak efficiency	Change in resource use – water	1	Other	Others	Water quantity control (flow, velocity, level; including ice formation and movements)

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Operating at peak efficiency	Increased erosion	1	Landscape	Landscape appreciation	Erosion prevention and control
Operating at peak efficiency	Increased erosion	1	Landscape	Landscape appreciation	Water quantity control (flow, velocity, level; including ice formation and movements)
Project and maintenance spending	Change in local economy	1	Economy	Commerce	Economic impact management
Road maintenance	Change in transportation and servicing	1	Economy	Transportation	Economic impact management
Site rehabilitation	Change in channel morphology	1	Aquatic biology	Fish community	Fish protection
Site rehabilitation	Change in channel morphology	1	Landscape	Landscape appreciation	Other
Site rehabilitation	Change in channel morphology	1	Social	Noise and vibration	Other
Site rehabilitation	Change in channel morphology	1	Terrestrial biology	Flora	Protection, replacement and control of vegetation
Site rehabilitation	Removal of vegetation	1	Landscape	Landscape appreciation	Erosion prevention and control
Site rehabilitation	Removal of vegetation	1	Landscape	Landscape appreciation	Protection, replacement and control of vegetation
Using local services and amenities	Change in community and social services	1	Economy	Industry	Economic impact management
Using local services and amenities	Change in land use and policy plans	1	Social	Indigenous people	Economic impact management
Using local services and amenities	Change in land use and policy plans	1	Social	Indigenous people	Mitigating effects on resource use
Using local services and amenities	Change in land use and policy plans	1	Social	Indigenous people	Social impact management
Using local services and amenities	Change in social and community structure	1	Social	Indigenous people	Economic impact management
Using local services and amenities	Change in social and community structure	1	Social	Indigenous people	Other

(Appendix 8: Continued)

Activity	Impact	Count of impact	Environmental type	Environmental component	Mitigation measures
Vegetation disposal	Change in human safety risk	1	Social	Indigenous people	Protecting or mitigating changes to landscape
Vegetation disposal	Change in human safety risk	1	Social	Indigenous people	Human health and safety risk management
Vegetation disposal	Change in human safety risk	1	Social	Indigenous people	Mitigating effects on resource use
Vegetation disposal	Change in human safety risk	1	Social	Indigenous people	Protecting or minimising changes in channel morphology

Appendix 9: Main environmental issues and the success of mitigation measures

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Aquatic biology	Fauna	Water quantity control (flow, velocity, level; including ice formation and movements)	High	4
Aquatic biology	Fauna	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	High	1
Aquatic biology	Fauna	Social impact management	Low	1
Aquatic biology	Fauna	Fish protection	High	1
Aquatic biology	Fish community	Fish protection	High	26
Aquatic biology	Fish community	Other	High	14
Aquatic biology	Fish community	Fish protection	Low	4
Aquatic biology	Fish community	Water quantity control (flow, velocity, level; including ice formation and movements)	High	2
Aquatic biology	Fish community	Mitigating effects on resource use	Low	2
Aquatic biology	Fish community	Other	Low	1
Aquatic biology	Fish migration	Fish protection	High	16
Aquatic biology	Fish migration	Fish protection	Indifferent	4
Aquatic biology	Fish migration	Other	Low	1
Aquatic biology	Fish migration	Water quality protection and adjustments	Low	1
Aquatic biology	Flora	Protection, replacement and control of vegetation	High	3
Aquatic biology	Flora	Other	High	2
Aquatic biology	Flora	Protection, replacement and control of vegetation	Indifferent	1
Aquatic biology	Flora	Water quality protection and adjustments	High	1
Aquatic biology	Mercury	Human health and safety risk management	High	3
Aquatic biology	Mercury	Mitigating effects on resource use	High	3
Aquatic biology	Mercury	Other	Low	1
Economy	Agriculture	Economic impact management	High	11
Economy	Agriculture	Water quality protection and adjustments	High	3
Economy	Agriculture	Protection, replacement and control of vegetation	High	2

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Economy	Commerce	Economic impact management	High	1
Economy	Commerce	Mitigating cumulative effects of multiple hydroelectric facilities	High	1
Economy	Commerce	Other	High	1
Economy	Fisheries (fish stocking)	Fish protection	High	9
Economy	Fisheries (fish stocking)	Fish protection	Low	1
Economy	Fisheries (fish stocking)	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	Low	1
Economy	Fisheries (others)	Economic impact management	Indifferent	9
Economy	Fisheries (others)	Fish protection	High	5
Economy	Fisheries (others)	Economic impact management	Low	3
Economy	Fisheries (others)	Economic impact management	High	3
Economy	Fisheries (others)	Other	High	2
Economy	Fisheries (others)	Mitigating effects on resource use	High	1
Economy	Forestry	Protection, replacement and control of vegetation	High	6
Economy	Forestry	Economic impact management	High	5
Economy	Forestry	Other	High	3
Economy	Forestry	Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	1
Economy	Hospitals	Social impact management	High	2
Economy	Industry	Economic impact management	High	2
Economy	Industry	Human health and safety risk management	High	1
Economy	Industry	Social impact management	High	1
Economy	Recreational areas	Economic impact management	Low	6
Economy	Recreational areas	Social impact management	Low	5

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Economy	Recreational areas	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	Low	2
Economy	Recreational areas	Social impact management	High	2
Economy	Recreational areas	Mitigating cumulative effects of multiple hydroelectric facilities	Low	1
Economy	Recreational areas	Economic impact management	High	1
Economy	Recreational areas	Protecting or mitigating changes to landscape	Low	1
Economy	Reindeer husbandry	Economic impact management	High	3
Economy	Reindeer husbandry	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	High	2
Economy	Reindeer husbandry	Social impact management	High	1
Economy	Schools	Social impact management	High	2
Economy	Tourism employment	Economic impact management	Low	9
Economy	Tourism employment	Social impact management	High	1
Economy	Transportation	Economic impact management	High	9
Economy	Transportation	Economic impact management	Low	3
Economy	Water supply	Social impact management	High	4
Economy	Water supply	Water quality protection and adjustments	High	1
Estuarine and coastal habitat	Circulation	Other	High	1
Estuarine and coastal habitat	Circulation	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Estuarine and coastal habitat	Coastal habitats	Mitigating effects on resource use	High	1
Estuarine and coastal habitat	Coastal habitats	Mitigating effects on resource use	Low	1
Estuarine and coastal habitat	Coastal habitats	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Estuarine and coastal habitat	Salt intrusion/plume	Other	High	4

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Estuarine and coastal habitat	Salt intrusion/plume	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Estuarine and coastal habitat	Sediment dynamics	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Geophysics	Earthquakes	Human health and safety risk management	High	2
Geophysics	Earthquakes	Human health and safety risk management	Indifferent	1
Hydrology	Erosion	Erosion prevention and control	Low	4
Hydrology	Erosion	Erosion prevention and control	High	3
Hydrology	Erosion	Other	High	3
Hydrology	Erosion	Water quality protection and adjustments	High	1
Hydrology	Flood frequency	Water quantity control (flow, velocity, level; including ice formation and movements)	High	16
Hydrology	Flood frequency	Erosion prevention and control	High	1
Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)	High	38
Hydrology	Flow regime	Economic impact management	High	1
Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	1
Hydrology	Flow regime	Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1
Hydrology	Flow regime	Protecting or mitigating changes to landscape	Low	1
Hydrology	Fluvial geomorphology	Erosion prevention and control	High	1
Hydrology	Fluvial geomorphology	Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1
Hydrology	Groundwater level	Other	High	9
Hydrology	Recipient	Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	3
Hydrology	Sedimentation	Sedimentation prevention and control	High	6
Hydrology	Sedimentation	Sedimentation prevention and control	Low	1

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Landscape	Access roads	Protection, replacement and control of vegetation	Low	6
Landscape	Access roads	Protecting or mitigating changes to landscape	High	3
Landscape	Access roads	Social impact management	High	3
Landscape	Access roads	Protecting or mitigating changes to landscape	Low	1
Landscape	Access roads	Protection, replacement and control of vegetation	High	1
Landscape	Access roads	Other	High	1
Landscape	Landscape appreciation	Protection, replacement and control of vegetation	High	18
Landscape	Landscape appreciation	Protecting or mitigating changes to landscape	High	17
Landscape	Landscape appreciation	Protecting or mitigating changes to landscape	Low	9
Landscape	Landscape appreciation	Other	High	4
Landscape	Landscape appreciation	Protection, replacement and control of vegetation	Low	3
Landscape	Landscape appreciation	Erosion prevention and control	High	2
Landscape	Landscape appreciation	Minimising soil contamination and loss of soil due to inundation	High	1
Landscape	Landscape appreciation	Social impact management	High	1
Landscape	Landscape appreciation	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Landscape	Rock tips	Protecting or mitigating changes to landscape	High	11
Landscape	Rock tips	Protection, replacement and control of vegetation	High	1
Landscape	Transmission lines	Protecting or mitigating changes to landscape	High	1
Local climate	Air temperature	Climatic and local air quality controls	Indifferent	1
Local climate	Fog frequency	Climatic and local air quality controls	Indifferent	1
Local climate	Water temperature	Water quality protection and adjustments	High	9

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Local climate	Water temperature	Climatic and local air quality controls	Indifferent	1
Local climate	Wind	Climatic and local air quality controls	Indifferent	1
Other	Others	Other	High	2
Other	Others	Water quantity control (flow, velocity, level; including ice formation and movements)	High	1
Social	Indigenous people	Mitigating effects on resource use	High	3
Social	Indigenous people	Human health and safety risk management	High	2
Social	Indigenous people	Protection, replacement and control of vegetation	High	1
Social	Indigenous people	Social impact management	Indifferent	1
Social	Indigenous people	Social impact management	High	1
Social	Indigenous people	Protection, replacement and control of vegetation	Low	1
Social	Indigenous people	Social impact management	Low	1
Social	Indigenous people	Other	High	1
Social	Indigenous people	Economic impact management	Low	1
Social	Indigenous people	Economic impact management	High	1
Social	Indigenous people	Protecting or minimising changes in channel morphology	High	1
Social	Indigenous people	Protecting or mitigating changes to landscape	High	1
Social	Noise and vibration	Social impact management	High	8
Social	Noise and vibration	Social impact management	Low	3
Social	Noise and vibration	Other	High	2
Social	Places of religious/historical value	Social impact management	High	1
Social	Resettlement	Economic impact management	High	5
Social	Resettlement	Social impact management	High	3
Social	Resettlement	Erosion prevention and control	High	1
Social	Social intrusion	Social impact management	High	2
Social	Waterborne diseases	Social impact management	High	2
Terrestrial biology	Fauna (birds)	Protection, replacement and control of vegetation	High	4

(Appendix 9: Continued)

Environmental type	Environmental component	Mitigation measures	Success character.	Count of success character.
Terrestrial biology	Fauna (insects)	Protection, replacement and control of vegetation	High	3
Terrestrial biology	Fauna (mammals)	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	Low	9
Terrestrial biology	Fauna (mammals)	Protection, replacement and control of vegetation	High	5
Terrestrial biology	Fauna (mammals)	Erosion prevention and control	High	1
Terrestrial biology	Flora	Protection, replacement and control of vegetation	High	16
Terrestrial biology	Flora	Protection, replacement and control of vegetation	Indifferent	2
Terrestrial biology	Flora	Sedimentation prevention and control	High	1
Terrestrial biology	Flora	Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1
Water quality	Drainage from construction work	Water quality protection and adjustments	High	22
Water quality	Eutrophication	Water quality protection and adjustments	High	6
Water quality	Eutrophication	Water quality protection and adjustments	Low	2
Water quality	Eutrophication	Other	Low	1
Water quality	Heavy metals	Water quality protection and adjustments	High	3
Water quality	Heavy metals	Human health and safety risk management	Indifferent	1
Water quality	Heavy metals	Minimising soil contamination and loss of soil due to inundation	High	1
Water quality	Oxygen content	Water quality protection and adjustments	High	2
Water quality	Temperature	Water quality protection and adjustments	High	12
Water quality	Temperature	Water quality protection and adjustments	Indifferent	1
Water quality	Transport of elements and matter	Water quality protection and adjustments	High	9
Water quality	Turbidity or suspended solids	Water quality protection and adjustments	High	22
Water quality	Turbidity or suspended solids	Erosion prevention and control	Indifferent	1

Appendix 10: Main environmental issues, and count of degree of success of the various mitigation measures

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Climatic and local air quality controls	Indifferent	1	Local climate	Air temperature
Climatic and local air quality controls	Indifferent	1	Local climate	Fog frequency
Climatic and local air quality controls	Indifferent	1	Local climate	Water temperature
Climatic and local air quality controls	Indifferent	1	Local climate	Wind
Economic impact management	High	11	Economy	Agriculture
Economic impact management	Indifferent	9	Economy	Fisheries (others)
Economic impact management	Low	9	Economy	Tourism employment
Economic impact management	High	9	Economy	Transportation
Economic impact management	Low	6	Economy	Recreational areas
Economic impact management	High	5	Economy	Forestry
Economic impact management	High	5	Social	Resettlement
Economic impact management	High	3	Economy	Fisheries (others)
Economic impact management	Low	3	Economy	Fisheries (others)
Economic impact management	High	3	Economy	Reindeer husbandry
Economic impact management	Low	3	Economy	Transportation
Economic impact management	High	2	Economy	Industry
Economic impact management	High	1	Economy	Commerce
Economic impact management	High	1	Economy	Recreational areas
Economic impact management	High	1	Hydrology	Flow regime
Economic impact management	Low	1	Social	Indigenous people
Economic impact management	High	1	Social	Indigenous people
Erosion prevention and control	Low	4	Hydrology	Erosion
Erosion prevention and control	High	3	Hydrology	Erosion
Erosion prevention and control	High	2	Landscape	Landscape appreciation
Erosion prevention and control	High	1	Hydrology	Flood frequency
Erosion prevention and control	High	1	Hydrology	Fluvial geomorphology
Erosion prevention and control	High	1	Social	Resettlement

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Erosion prevention and control	High	1	Terrestrial biology	Fauna (mammals)
Erosion prevention and control	Indifferent	1	Water quality	Turbidity or suspended solids
Fish protection	High	26	Aquatic biology	Fish community
Fish protection	High	16	Aquatic biology	Fish migration
Fish protection	High	9	Economy	Fisheries (fish stocking)
Fish protection	High	5	Economy	Fisheries (others)
Fish protection	Low	4	Aquatic biology	Fish community
Fish protection	Indifferent	4	Aquatic biology	Fish migration
Fish protection	High	1	Aquatic biology	Fauna
Fish protection	Low	1	Economy	Fisheries (fish stocking)
Human health and safety risk management	High	3	Aquatic biology	Mercury
Human health and safety risk management	High	2	Geophysics	Earthquakes
Human health and safety risk management	High	2	Social	Indigenous people
Human health and safety risk management	High	1	Economy	Industry
Human health and safety risk management	Indifferent	1	Geophysics	Earthquakes
Human health and safety risk management	Indifferent	1	Water quality	Heavy metals
Minimising soil contamination and loss of soil due to inundation	High	1	Landscape	Landscape appreciation
Minimising soil contamination and loss of soil due to inundation	High	1	Water quality	Heavy metals
Mitigating cumulative effects of multiple hydroelectric facilities	High	1	Economy	Commerce
Mitigating cumulative effects of multiple hydroelectric facilities	Low	1	Economy	Recreational areas
Mitigating effects on resource use	High	3	Aquatic biology	Mercury
Mitigating effects on resource use	High	3	Social	Indigenous people
Mitigating effects on resource use	Low	2	Aquatic biology	Fish community
Mitigating effects on resource use	High	1	Economy	Fisheries (others)

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Mitigating effects on resource use	Low	1	Estuarine and coastal habitat	Coastal habitats
Mitigating effects on resource use	High	1	Estuarine and coastal habitat	Coastal habitats
Other	High	14	Aquatic biology	Fish community
Other	High	9	Hydrology	Groundwater level
Other	High	4	Estuarine and coastal habitat	Salt intrusion/plume
Other	High	4	Landscape	Landscape appreciation
Other	High	3	Economy	Forestry
Other	High	3	Hydrology	Erosion
Other	High	2	Aquatic biology	Flora
Other	High	2	Economy	Fisheries (others)
Other	High	2	Other	Others
Other	High	2	Social	Noise and vibration
Other	Low	1	Aquatic biology	Fish community
Other	Low	1	Aquatic biology	Fish migration
Other	Low	1	Aquatic biology	Mercury
Other	High	1	Economy	Commerce
Other	High	1	Estuarine and coastal habitat	Circulation
Other	High	1	Landscape	Access roads
Other	High	1	Social	Indigenous people
Other	Low	1	Water quality	Eutrophication
Protecting or minimising changes in channel morphology	High	1	Social	Indigenous people
Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	Low	2	Economy	Recreational areas

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	High	2	Economy	Reindeer husbandry
Protecting or mitigating changes to landscape	High	17	Landscape	Landscape appreciation
Protecting or mitigating changes to landscape	High	11	Landscape	Rock tips
Protecting or mitigating changes to landscape	Low	9	Landscape	Landscape appreciation
Protecting or mitigating changes to landscape	High	3	Landscape	Access roads
Protecting or mitigating changes to landscape	Low	1	Economy	Recreational areas
Protecting or mitigating changes to landscape	Low	1	Hydrology	Flow regime
Protecting or mitigating changes to landscape	Low	1	Landscape	Access roads
Protecting or mitigating changes to landscape	High	1	Landscape	Transmission lines
Protecting or mitigating changes to landscape	High	1	Social	Indigenous people
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	Low	9	Terrestrial biology	Fauna (mammals)
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	High	1	Aquatic biology	Fauna
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	Low	1	Economy	Fisheries (fish stocking)
Protection, replacement and control of vegetation	High	18	Landscape	Landscape appreciation
Protection, replacement and control of vegetation	High	16	Terrestrial biology	Flora
Protection, replacement and control of vegetation	High	6	Economy	Forestry
Protection, replacement and control of vegetation	Low	6	Landscape	Access roads
Protection, replacement and control of vegetation	High	5	Terrestrial biology	Fauna (mammals)
Protection, replacement and control of vegetation	High	4	Terrestrial biology	Fauna (birds)
Protection, replacement and control of vegetation	High	3	Aquatic biology	Flora

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Protection, replacement and control of vegetation	Low	3	Landscape	Landscape appreciation
Protection, replacement and control of vegetation	High	3	Terrestrial biology	Fauna (insects)
Protection, replacement and control of vegetation	High	2	Economy	Agriculture
Protection, replacement and control of vegetation	Indifferent	2	Terrestrial biology	Flora
Protection, replacement and control of vegetation	Indifferent	1	Aquatic biology	Flora
Protection, replacement and control of vegetation	High	1	Landscape	Access roads
Protection, replacement and control of vegetation	High	1	Landscape	Rock tips
Protection, replacement and control of vegetation	High	1	Social	Indigenous people
Protection, replacement and control of vegetation	Low	1	Social	Indigenous people
Sedimentation prevention and control	High	6	Hydrology	Sedimentation
Sedimentation prevention and control	Low	1	Hydrology	Sedimentation
Sedimentation prevention and control	High	1	Terrestrial biology	Flora
Social impact management	High	8	Social	Noise and vibration
Social impact management	Low	5	Economy	Recreational areas
Social impact management	High	4	Economy	Water supply
Social impact management	High	3	Landscape	Access roads
Social impact management	Low	3	Social	Noise and vibration
Social impact management	High	3	Social	Resettlement
Social impact management	High	2	Economy	Hospitals
Social impact management	High	2	Economy	Recreational areas
Social impact management	High	2	Economy	Schools
Social impact management	High	2	Social	Social intrusion
Social impact management	High	2	Social	Waterborne diseases
Social impact management	Low	1	Aquatic biology	Fauna
Social impact management	High	1	Economy	Industry
Social impact management	High	1	Economy	Reindeer husbandry
Social impact management	High	1	Economy	Tourism employment

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Social impact management	High	1	Landscape	Landscape appreciation
Social impact management	Indifferent	1	Social	Indigenous people
Social impact management	Low	1	Social	Indigenous people
Social impact management	High	1	Social	Indigenous people
Social impact management	High	1	Social	Places of religious/historical value
Water quality protection and adjustments	High	22	Water quality	Drainage from construction work
Water quality protection and adjustments	High	22	Water quality	Turbidity or suspended solids
Water quality protection and adjustments	High	12	Water quality	Temperature
Water quality protection and adjustments	High	9	Local climate	Water temperature
Water quality protection and adjustments	High	9	Water quality	Transport of elements and matter
Water quality protection and adjustments	High	6	Water quality	Eutrophication
Water quality protection and adjustments	High	3	Economy	Agriculture
Water quality protection and adjustments	High	3	Water quality	Heavy metals
Water quality protection and adjustments	Low	2	Water quality	Eutrophication
Water quality protection and adjustments	High	2	Water quality	Oxygen content
Water quality protection and adjustments	Low	1	Aquatic biology	Fish migration
Water quality protection and adjustments	High	1	Aquatic biology	Flora
Water quality protection and adjustments	High	1	Economy	Water supply
Water quality protection and adjustments	High	1	Hydrology	Erosion
Water quality protection and adjustments	Indifferent	1	Water quality	Temperature
Water quantity control (flow, velocity, level; including ice formation and movements)	High	38	Hydrology	Flow regime
Water quantity control (flow, velocity, level; including ice formation and movements)	High	16	Hydrology	Flood frequency
Water quantity control (flow, velocity, level; including ice formation and movements)	High	4	Aquatic biology	Fauna
Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	3	Hydrology	Recipient

(Appendix 10: Continued)

Mitigation measures	Success Character.	Count of success character.	Environmental type	Environmental component
Water quantity control (flow, velocity, level; including ice formation and movements)	High	2	Aquatic biology	Fish community
Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	1	Economy	Forestry
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Estuarine and coastal habitat	Circulation
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Estuarine and coastal habitat	Coastal habitats
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Estuarine and coastal habitat	Salt intrusion/plume
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Estuarine and coastal habitat	Sediment dynamics
Water quantity control (flow, velocity, level; including ice formation and movements)	Indifferent	1	Hydrology	Flow regime
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1	Hydrology	Flow regime
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1	Hydrology	Fluvial geomorphology
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Landscape	Landscape appreciation
Water quantity control (flow, velocity, level; including ice formation and movements)	High	1	Other	Others
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	1	Terrestrial biology	Flora

Appendix 11: Environmental component type and count of environmental components in each impact group; physical, biological and socio-economic impacts

Impact group	Environmental type	Environmental component	Count of environmental component
Biotoxicity	Aquatic biology	Mercury	5
Biotoxicity	Water quality	Heavy metals	1
Change in biota habitat	Aquatic biology	Fish community	58
Change in biota habitat	Aquatic biology	Fauna	28
Change in biota habitat	Aquatic biology	Flora	25
Change in biota habitat	Aquatic biology	Fish migration	21
Change in biota habitat	Aquatic biology	Red-listed species	10
Change in biota habitat	Aquatic biology	Mercury	1
Change in biota habitat	Economy	Recreational areas	9
Change in biota habitat	Economy	Forestry	3
Change in biota habitat	Economy	Fisheries (fish stocking)	2
Change in biota habitat	Estuarine and coastal habitat	Coastal habitats	1
Change in biota habitat	Geophysics	Earthquakes	9
Change in biota habitat	Geophysics	Landslide	3
Change in biota habitat	Landscape	Landscape appreciation	88
Change in biota habitat	Landscape	Access roads	23
Change in biota habitat	Landscape	Rock tips	10
Change in biota habitat	Landscape	Quarries	2
Change in biota habitat	Landscape	Transmission lines	1
Change in biota habitat	Local climate	Air humidity	12
Change in biota habitat	Local climate	Air temperature	12
Change in biota habitat	Local climate	Wind	12
Change in biota habitat	Local climate	Water temperature	6
Change in biota habitat	Social	Places of religious/historical value	9
Change in biota habitat	Social	Noise and vibration	6
Change in biota habitat	Terrestrial biology	Fauna (mammals)	35
Change in biota habitat	Terrestrial biology	Flora	32
Change in biota habitat	Terrestrial biology	Fauna (birds)	23
Change in biota habitat	Terrestrial biology	Fauna (insects)	21
Change in biota habitat	Terrestrial biology	Red-listed species	19
Change in biota habitat	Water quality	Temperature	2
Change in biota habitat	Water quality	Heavy metals	1
Change in biota mobility	Aquatic biology	Fish migration	1
Change in channel morphology	Aquatic biology	Fish community	1
Change in channel morphology	Economy	Recreational areas	1
Change in channel morphology	Landscape	Landscape appreciation	1
Change in channel morphology	Social	Noise and vibration	1
Change in channel morphology	Terrestrial biology	Flora	1
Change in community and social services	Economy	Commerce	8
Change in community and social services	Economy	Tourism employment	5
Change in community and social services	Economy	Industry	3

(Appendix 11: Continued)

Impact group	Environmental type	Environmental component	Count of environmental component
Change in community and social services	Economy	Water supply	2
Change in community and social services	Social	Social intrusion	7
Change in community and social services	Social	Resettlement	5
Change in community and social services	Social	Indigenous people	1
Change in ecosystem community populations	Aquatic biology	Fish community	30
Change in ecosystem community populations	Aquatic biology	Fish migration	21
Change in ecosystem community populations	Aquatic biology	Fauna	17
Change in ecosystem community populations	Aquatic biology	Flora	14
Change in ecosystem community populations	Aquatic biology	Mercury	14
Change in ecosystem community populations	Aquatic biology	Red-listed species	8
Change in ecosystem community populations	Economy	Fisheries (fish stocking)	12
Change in ecosystem community populations	Economy	Reindeer husbandry	2
Change in ecosystem community populations	Economy	Commerce	1
Change in ecosystem community populations	Landscape	Landscape appreciation	2
Change in ecosystem community populations	Landscape	Access roads	1
Change in ecosystem community populations	Local climate	Air temperature	1
Change in ecosystem community populations	Local climate	Fog frequency	1
Change in ecosystem community populations	Local climate	Water temperature	1
Change in ecosystem community populations	Local climate	Wind	1
Change in ecosystem community populations	Terrestrial biology	Flora	12
Change in ecosystem community populations	Terrestrial biology	Fauna (mammals)	8
Change in ecosystem community populations	Terrestrial biology	Red-listed species	7
Change in ecosystem community populations	Terrestrial biology	Fauna (birds)	3
Change in ecosystem community populations	Terrestrial biology	Fauna (insects)	2
Change in ecosystem community populations	Water quality	Eutrophication	1
Change in ecosystem community populations	Water quality	Transport of elements and matter	1

(Appendix 11: Continued)

Impact group	Environmental type	Environmental component	Count of environmental component
Change in housing and property values	Hydrology	Erosion	3
Change in housing and property values	Other	Others	2
Change in human safety risk	Geophysics	Earthquakes	1
Change in human safety risk	Social	Indigenous people	4
Change in land use and policy plans	Economy	Agriculture	3
Change in land use and policy plans	Economy	Industry	1
Change in land use and policy plans	Social	Indigenous people	6
Change in local economy	Economy	Fisheries (others)	42
Change in local economy	Economy	Fisheries (fish stocking)	15
Change in local economy	Economy	Agriculture	14
Change in local economy	Economy	Tourism employment	14
Change in local economy	Economy	Transportation	14
Change in local economy	Economy	Forestry	12
Change in local economy	Economy	Water supply	12
Change in local economy	Economy	Recreational areas	11
Change in local economy	Economy	Schools	11
Change in local economy	Economy	Hospitals	10
Change in local economy	Economy	Commerce	9
Change in local economy	Economy	Reindeer husbandry	7
Change in local economy	Economy	Industry	5
Change in local economy	Economy	Population	3
Change in local economy	Economy	Employment	1
Change in local economy	Landscape	Rock tips	2
Change in material translocation	Economy	Forestry	1
Change in resource use – aquatic biota	Aquatic biology	Fish community	2
Change in resource use – aquatic biota	Aquatic biology	Fish migration	2
Change in resource use – aquatic biota	Aquatic biology	Mercury	2
Change in resource use – aquatic biota	Economy	Fisheries (fish stocking)	7
Change in resource use – aquatic biota	Estuarine and coastal habitat	Coastal habitats	2
Change in resource use – forestry, mining, agriculture	Economy	Agriculture	8
Change in resource use – forestry, mining, agriculture	Economy	Forestry	8
Change in resource use – recreational areas etc.	Economy	Recreational areas	10
Change in resource use – recreational areas etc.	Economy	Tourism employment	2

(Appendix 11: Continued)

Impact group	Environmental type	Environmental component	Count of environmental component
Change in resource use – recreational areas etc.	Economy	Fisheries (others)	1
Change in resource use – recreational areas etc.	Social	Social intrusion	9
Change in resource use – terrestrial biota	Landscape	Access roads	1
Change in resource use – terrestrial biota	Terrestrial biology	Fauna (birds)	2
Change in resource use – terrestrial biota	Terrestrial biology	Fauna (mammals)	1
Change in resource use – terrestrial biota	Terrestrial biology	Flora	1
Change in social and community structure	Economy	Commerce	3
Change in social and community structure	Economy	Agriculture	1
Change in social and community structure	Economy	Hospitals	1
Change in social and community structure	Economy	Industry	1
Change in social and community structure	Economy	Schools	1
Change in social and community structure	Social	Indigenous people	13
Change in social and community structure	Social	Resettlement	10
Change in social and community structure	Social	Social intrusion	10
Change in social and community structure	Social	Places of religious/historical value	7
Change in social and community structure	Social	Waterborne diseases	4
Change in social and community structure	Social	Noise and vibration	2
Change in transportation and servicing	Economy	Transportation	2
Change in transportation and servicing	Economy	Tourism employment	1
Change in transportation and servicing	Landscape	Access roads	2
Change in transportation and servicing	Social	Indigenous people	2
Change in water quality	Aquatic biology	Fish community	3
Change in water quality	Economy	Agriculture	3
Change in water quality	Economy	Water supply	1
Change in water quality	Estuarine and coastal habitat	Salt intrusion/plume	2
Change in water quality	Local climate	Water temperature	5
Change in water quality	Water quality	Eutrophication	71

(Appendix 11: Continued)

Impact group	Environmental type	Environmental component	Count of environmental component
Change in water quality	Water quality	Temperature	45
Change in water quality	Water quality	Transport of elements and matter	43
Change in water quality	Water quality	Turbidity or suspended solids	42
Change in water quality	Water quality	Heavy metals	37
Change in water quality	Water quality	Drainage from construction work	31
Change in water quality	Water quality	Oxygen content	12
Change in water quality	Water quality	Floating peat	8
Change in water quality	Water quality	Extended biotic index	1
Change in water quantity	Aquatic biology	Fauna	2
Change in water quantity	Aquatic biology	Fish community	2
Change in water quantity	Aquatic biology	Fish migration	1
Change in water quantity	Aquatic biology	Flora	1
Change in water quantity	Estuarine and coastal habitat	Salt intrusion/plume	3
Change in water quantity	Estuarine and coastal habitat	Circulation	2
Change in water quantity	Estuarine and coastal habitat	Coastal habitats	1
Change in water quantity	Estuarine and coastal habitat	Sediment dynamics	1
Change in water quantity	Hydrology	Flow regime	54
Change in water quantity	Hydrology	Flood frequency	25
Change in water quantity	Hydrology	Groundwater level	22
Change in water quantity	Hydrology	Sedimentation	15
Change in water quantity	Hydrology	Erosion	6
Change in water quantity	Hydrology	Evapotranspiration	4
Change in water quantity	Hydrology	Recipient	3
Change in water quantity	Hydrology	Fluvial geomorphology	2
Change in water quantity	Landscape	Landscape appreciation	1
Change in water quantity	Social	Resettlement	2
Change in resource use – water	Economy	Fisheries (fish stocking)	2
Change in resource use – water	Other	Others	1
Climatic and local air quality changes	Global effects	Greenhouse gas emissions	8
Climatic and local air quality changes	Local climate	Air temperature	45
Climatic and local air quality changes	Local climate	Water temperature	5
Cumulative effects of hydro and other facilities	Economy	Recreational areas	1
Increased erosion	Geophysics	Landslide	1
Increased erosion	Hydrology	Erosion	3
Increased erosion	Hydrology	Fluvial geomorphology	2
Increased erosion	Landscape	Landscape appreciation	2
Noise and human presence effects on biota	Social	Noise and vibration	5
Noise and human presence effects on biota	Terrestrial biology	Fauna (birds)	5

(Appendix 11: Continued)

Impact group	Environmental type	Environmental component	Count of environmental component
Physical impacts	Geophysics	Earthquakes	2
Physical impacts	Social	Noise and vibration	2
Removal of vegetation	Landscape	Landscape appreciation	5
Removal of vegetation	Terrestrial biology	Fauna (mammals)	3
Removal of vegetation	Terrestrial biology	Flora	2
Sedimentation	Hydrology	Sedimentation	5
Soil inundation	Economy	Fisheries (others)	3

Appendix 12. Impacts and counts of expected and documented effects. (Some counts may be repeated within various environmental types or components in the table, explaining why total counts in the database often deviate from the total sum in the columns below)

Biotoxicity

Count of expected permanent effect 6
Count of documented permanent effect 6

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Mercury	0 Indifferent	5	0 Indifferent	5
Water quality	Heavy metals	-1	1	0 Indifferent	1

Change in biota habitat

Count of expected permanent effect 179
Count of documented permanent effect 119

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fauna	-1	5	-1	3
Aquatic biology	Fauna	-1	5	0 Indifferent	2
Aquatic biology	Fauna	0 Indifferent	6	0 Indifferent	2
Aquatic biology	Fauna	2	2	2	2
Aquatic biology	Fish community	-1	5	-2	6
Aquatic biology	Fish community	-2	6	-1	3
Aquatic biology	Fish community	-2	6	-2	6
Aquatic biology	Fish community	-3 Very negative	1	-3 Very negative	1
Aquatic biology	Fish community	1	5	1	1
Aquatic biology	Fish community	1	5	2	6
Aquatic biology	Fish community	2	2	2	6
Aquatic biology	Fish migration	-1	2	-1	4
Aquatic biology	Fish migration	-2	5	-1	4
Aquatic biology	Fish migration	-2	5	-2	2
Aquatic biology	Fish migration	-2	5	-3 Very negative	1
Aquatic biology	Fish migration	0 Indifferent	1	-1	4
Aquatic biology	Flora	2	2	2	2
Aquatic biology	Mercury	0 Indifferent	1	0 Indifferent	1
Economy	Fisheries (fish stocking)	-3 Very negative	2	-3 Very negative	2
Economy	Recreation areas	1	1	1	1
Estuarine and coastal habitat	Coastal habitats	-1	1	-1	1
Geophysics	Earthquakes	0 Indifferent	3	0 Indifferent	3
Geophysics	Landslide	0 Indifferent	1	0 Indifferent	1
Landscape	Access roads	-1	4	-1	2
Landscape	Access roads	-1	4	0 Indifferent	4
Landscape	Access roads	-2	1	0 Indifferent	4
Landscape	Access roads	0 Indifferent	1	0 Indifferent	4
Landscape	Access roads	2	1	3 Very positive	2
Landscape	Access roads	3 Very positive	1	3 Very positive	2
Landscape	Landscape appreciation	-1	6	-1	5
Landscape	Landscape appreciation	-2	6	-2	4
Landscape	Landscape appreciation	-2	6	0 Indifferent	7
Landscape	Landscape appreciation	0 Indifferent	6	0 Indifferent	7
Landscape	Landscape appreciation	1	3	1	3
Landscape	Landscape appreciation	3 Very positive	6	3 Very positive	6
Local climate	Air humidity	0 Indifferent	4	0 Indifferent	4
Local climate	Air temperature	0 Indifferent	4	0 Indifferent	4
Local climate	Water temperature	-3 Very negative	2	1	2
Local climate	Wind	0 Indifferent	4	0 Indifferent	4

(Appendix 12: Continued)

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Social	Noise and vibration	0 Indifferent	2	0 Indifferent	2
Social	Places of religious/historical interest	0 Indifferent	3	0 Indifferent	3
Terrestrial biology	Fauna (birds)	0 Indifferent	7	0 Indifferent	2
Terrestrial biology	Fauna (birds)	0 Indifferent	7	2	3
Terrestrial biology	Fauna (birds)	2	2	2	3
Terrestrial biology	Fauna (insects)	0 Indifferent	8	0 Indifferent	3
Terrestrial biology	Fauna (mammals)	-1	4	-1	3
Terrestrial biology	Fauna (mammals)	0 Indifferent	8	0 Indifferent	3
Terrestrial biology	Flora	-1	3	-1	2
Terrestrial biology	Flora	-3 Very negative	2	-2	1
Terrestrial biology	Flora	-3 Very negative	2	-3 Very negative	1
Terrestrial biology	Flora	0 Indifferent	9	0 Indifferent	4
Water quality	Heavy metals	-1	1	-1	1
Water quality	Temperature	-2	1	-2	1
Water quality	Temperature	0 Indifferent	1	-1	1

Change in biota mobility

Count of expected permanent effect 1

Count of documented permanent effect 1

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fish migration	-2	1	-2	1

Change in channel morphology

Count of expected permanent effect 3

Count of documented permanent effect 3

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Recreation areas	1	1	2	1
Social	Noise and vibration	0 Indifferent	1	0 Indifferent	1
Terrestrial biology	Flora	3 Very positive	1	3 Very positive	1

Change in community and social services

Count of expected permanent effect 16

Count of documented permanent effect 20

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Commerce	-3 Very negative	2	-2	2
Economy	Industry	2	2	2	2
Economy	Industry	3 Very positive	1	3 Very positive	1
Economy	Tourism employment	0 Indifferent	4	2	4
Social	Indigenous people	0 Indifferent	1	0 Indifferent	1
Social	Resettlement	-1	4	1	4
Social	Social intrusion	0 Indifferent	2	0 Indifferent	6

(Appendix 12: Continued)**Change in ecosystem community populations**

Count of expected permanent effect 114

Count of documented permanent effect 106

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fauna	-1	3	-1	1
Aquatic biology	Fauna	0 Indifferent	5	0 Indifferent	4
Aquatic biology	Fauna	0 Indifferent	5	1	1
Aquatic biology	Fauna	1	1	2	1
Aquatic biology	Fauna	3 Very positive	1	3 Very positive	1
Aquatic biology	Fish community	-1	3	2	1
Aquatic biology	Fish community	-2	2	-3 Very negative	1
Aquatic biology	Fish community	-2	2	0 Indifferent	3
Aquatic biology	Fish community	-3 Very negative	11	-1	4
Aquatic biology	Fish community	-3 Very negative	11	-2	5
Aquatic biology	Fish community	-3 Very negative	11	1	3
Aquatic biology	Fish community	-3 Very negative	11	3 Very positive	5
Aquatic biology	Fish community	0 Indifferent	6	0 Indifferent	3
Aquatic biology	Fish community	0 Indifferent	6	1	3
Aquatic biology	Fish migration	-1	5	-1	5
Aquatic biology	Fish migration	-2	3	-1	5
Aquatic biology	Fish migration	-3 Very negative	5	-3 Very negative	5
Aquatic biology	Fish migration	0 Indifferent	5	0 Indifferent	5
Aquatic biology	Flora	-2	1	-1	2
Aquatic biology	Flora	0 Indifferent	6	-1	2
Aquatic biology	Flora	0 Indifferent	6	0 Indifferent	5
Aquatic biology	Flora	3 Very positive	1	2	1
Aquatic biology	Mercury	0 Indifferent	4	0 Indifferent	11
Aquatic biology	Red-listed species	-2	1	-1	1
Aquatic biology	Red-listed species	0 Indifferent	6	0 Indifferent	4
Economy	Fisheries (fish stocking)	-1	1	0 Indifferent	1
Economy	Fisheries (fish stocking)	-2	4	2	4
Economy	Fisheries (fish stocking)	1	1	1	3
Economy	Reindeer husbandry	-3 Very negative	1	-1	1
Landscape	Access roads	1	1	3 Very positive	1
Landscape	Landscape appreciation	1	2	2	2
Local climate	Air temperature	-1	1	0 Indifferent	1
Local climate	Fog frequency	-1	1	-1	1
Local climate	Water temperature	-1	1	-1	1
Local climate	Wind	-1	1	-1	1
Terrestrial biology	Fauna (mammals)	0 Indifferent	5	0 Indifferent	5
Terrestrial biology	Flora	-1	3	-1	1
Terrestrial biology	Flora	-3 Very negative	4	-3 Very negative	4
Terrestrial biology	Flora	0 Indifferent	3	0 Indifferent	3
Terrestrial biology	Red-listed species	-2	2	-1	1
Terrestrial biology	Red-listed species	0 Indifferent	3	0 Indifferent	3
Water quality	Eutrophication	0 Indifferent	1	0 Indifferent	1
Water quality	Transport of elements and matter	0 Indifferent	1	0 Indifferent	1

(Appendix 12: Continued)

Change in human safety risk

Count of expected permanent effect 5

Count of documented permanent effect 5

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Geophysics	Earthquakes	-1	1	-1	1
Social	Indigenous people	-2	4	-1	4

Change in land use and policy plans

Count of expected permanent effect 8

Count of documented permanent effect 8

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Agriculture	-3 Very negative	1	-1	1
Economy	Industry	3 Very positive	1	3 Very positive	1
Social	Indigenous people	-1	3	1	3
Social	Indigenous people	-2	3	0 Indifferent	3

Change in local economy

Count of expected permanent effect 77

Count of documented permanent effect 64

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Agriculture	-3 Very negative	1	1	2
Economy	Agriculture	0 Indifferent	5	0 Indifferent	3
Economy	Agriculture	1	2	1	2
Economy	Agriculture	1	2	2	1
Economy	Agriculture	3 Very positive	1	3 Very positive	1
Economy	Commerce	0 Indifferent	3	0 Indifferent	2
Economy	Employment	0 Indifferent	1	0 Indifferent	1
Economy	Fisheries (fish stocking)	-3 Very negative	1	3 Very positive	1
Economy	Fisheries (fish stocking)	0 Indifferent	1	0 Indifferent	1
Economy	Fisheries (fish stocking)	1	1	1	1
Economy	Fisheries (others)	-1	2	0 Indifferent	3
Economy	Fisheries (others)	-3 Very negative	1	1	1
Economy	Fisheries (others)	0 Indifferent	1	0 Indifferent	3
Economy	Fisheries (others)	2	1	2	1
Economy	Fisheries (others)	3 Very positive	1	3 Very positive	1
Economy	Forestry	-1	1	-1	1
Economy	Forestry	0 Indifferent	6	0 Indifferent	4
Economy	Hospitals	0 Indifferent	3	0 Indifferent	2
Economy	Hospitals	2	2	2	1
Economy	Hospitals	2	2	3 Very positive	1
Economy	Industry	0 Indifferent	2	0 Indifferent	2
Economy	Population	0 Indifferent	1	0 Indifferent	1
Economy	Recreation areas	-1	1	1	3
Economy	Recreation areas	0 Indifferent	3	0 Indifferent	2
Economy	Recreation areas	1	2	1	3
Economy	Reindeer husbandry	-3 Very negative	6	-1	6
Economy	Schools	0 Indifferent	4	0 Indifferent	3
Economy	Schools	2	2	2	1

(Appendix 12: Continued)

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Schools	2	2	3 Very positive	1
Economy	Tourism employment	0 Indifferent	2	0 Indifferent	1
Economy	Tourism employment	0 Indifferent	2	2	1
Economy	Tourism employment	1	1	1	1
Economy	Tourism employment	3 Very positive	1	3 Very positive	1
Economy	Transportation	-2	3	-1	3
Economy	Transportation	0 Indifferent	4	0 Indifferent	2
Economy	Water supply	0 Indifferent	5	0 Indifferent	3
Economy	Water supply	2	2	2	2
Landscape	Rock tips	-1	2	0 Indifferent	2

Change in materials translocation

Count of expected permanent effect 1
Count of documented permanent effect 1

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Forestry	-1	1	0 Indifferent	1

Change in resource use – aquatic biota

Count of expected permanent effect 13
Count of documented permanent effect 14

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fish community	-1	1	1	1
Aquatic biology	Fish community	0 Indifferent	1	-1	1
Aquatic biology	Fish migration	-1	1	-1	1
Aquatic biology	Fish migration	0 Indifferent	1	0 Indifferent	1
Aquatic biology	Mercury	0 Indifferent	1	-1	1
Economy	Fisheries (fish stocking)	-3 Very negative	5	-3 Very negative	1
Economy	Fisheries (fish stocking)	-3 Very negative	5	3 Very positive	4
Economy	Fisheries (fish stocking)	1	1	-1	1
Estuarine and coastal habitat	Coastal habitats	-1	2	-1	2

Change in resource use – forestry, mining, agriculture

Count of expected permanent effect 5
Count of documented permanent effect 5

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Agriculture	0 Indifferent	5	0 Indifferent	5

Change in resource use – recreational areas etc.

Count of expected permanent effect 11
Count of documented permanent effect 7

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Recreation areas	-1	5	0 Indifferent	1
Economy	Recreation areas	-1	5	1	4
Economy	Recreation areas	1	2	3 Very positive	1
Economy	Tourism employment	0 Indifferent	1	2	1

(Appendix 12: Continued)

Change in resource use – terrestrial biota

Count of expected permanent effect 1
 Count of documented permanent effect 1

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Terrestrial biology	Fauna (birds)	-1	1	-1	1

Change in social and community structure

Count of expected permanent effect 23
 Count of documented permanent effect 23

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Social	Indigenous people	0 Indifferent	6	0 Indifferent	5
Social	Indigenous people	2	2	2	2
Social	Noise and vibration	0 Indifferent	1	0 Indifferent	1
Social	Places of religious/historical interest	0 Indifferent	3	0 Indifferent	3
Social	Resettlement	-1	3	-1	1
Social	Resettlement	-1	3	1	2
Social	Resettlement	0 Indifferent	2	0 Indifferent	1
Social	Resettlement	0 Indifferent	2	2	1
Social	Social intrusion	0 Indifferent	3	0 Indifferent	4
Social	Social intrusion	0 Indifferent	3	2	1
Social	Waterborne diseases	-2	2	-2	1
Social	Waterborne diseases	-2	2	0 Indifferent	1

Change in transportation and servicing

Count of expected permanent effect 6
 Count of documented permanent effect 6

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Tourism employment	3 Very positive	1	3 Very positive	1
Economy	Transportation	0 Indifferent	1	2	2
Economy	Transportation	3 Very positive	1	2	2
Landscape	Access roads	-2	1	-2	1
Social	Indigenous people	3 Very positive	2	3 Very positive	2

Change in water quality

Count of expected permanent effect 161
 Count of documented permanent effect 147

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fish community	0 Indifferent	3	-1	3
Economy	Agriculture	-3 Very negative	1	-1	1
Economy	Water supply	-1	1	2	1
Estuarine and coastal habitat	Salt intrusion/plume	0 Indifferent	2	0 Indifferent	2
Local climate	Water temperature	2	1	1	1
Water quality	Drainage from construction work	0 Indifferent	10	0 Indifferent	10
Water quality	Drainage from construction work	2	2	2	1
Water quality	Eutrophication	-1	6	-1	3

(Appendix 12: Continued)

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Water quality	Eutrophication	-1	6	0 Indifferent	26
Water quality	Eutrophication	-2	2	-2	2
Water quality	Eutrophication	-3 Very negative	2	-1	3
Water quality	Eutrophication	0 Indifferent	23	-2	2
Water quality	Eutrophication	0 Indifferent	23	0 Indifferent	26
Water quality	Eutrophication	2	3	2	1
Water quality	Extended biotic index	-1	1	-1	1
Water quality	Floating peat	0 Indifferent	6	-1	1
Water quality	Floating peat	0 Indifferent	6	0 Indifferent	5
Water quality	Heavy metals	-1	1	-1	2
Water quality	Heavy metals	-2	1	-1	2
Water quality	Heavy metals	0 Indifferent	16	0 Indifferent	16
Water quality	Heavy metals	2	3	2	1
Water quality	Oxygen content	-1	2	-1	7
Water quality	Oxygen content	-1	2	-2	3
Water quality	Oxygen content	-2	6	-1	7
Water quality	Oxygen content	0 Indifferent	2	-2	3
Water quality	Temperature	-1	3	-1	3
Water quality	Temperature	-3 Very negative	3	-3 Very negative	1
Water quality	Temperature	-3 Very negative	3	1	3
Water quality	Temperature	0 Indifferent	12	-1	3
Water quality	Temperature	0 Indifferent	12	0 Indifferent	11
Water quality	Temperature	1	1	1	3
Water quality	Temperature	2	3	2	1
Water quality	Transport of elements and matter	-1	1	-1	2
Water quality	Transport of elements and matter	-2	3	-1	2
Water quality	Transport of elements and matter	-2	3	-2	1
Water quality	Transport of elements and matter	0 Indifferent	12	0 Indifferent	12
Water quality	Transport of elements and matter	1	6	1	6
Water quality	Turbidity or suspended solids	-1	3	-2	1
Water quality	Turbidity or suspended solids	-1	3	0 Indifferent	15
Water quality	Turbidity or suspended solids	-3 Very negative	4	0 Indifferent	15
Water quality	Turbidity or suspended solids	-3 Very negative	4	1	2
Water quality	Turbidity or suspended solids	0 Indifferent	11	0 Indifferent	15
Water quality	Turbidity or suspended solids	2	3	2	1
Water quality	Turbidity or suspended solids	3 Very positive	1	3 Very positive	1

(Appendix 12 : Continued)**Change in water quantity**

Count of expected permanent effect 62

Count of documented permanent effect 54

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Aquatic biology	Fauna	-2	1	-2	1
Aquatic biology	Fish community	0 Indifferent	1	-1	1
Aquatic biology	Fish migration	-1	1	-1	1
Aquatic biology	Flora	-1	1	0 Indifferent	1
Estuarine and coastal habitat	Circulation	-1	1	-1	1
Estuarine and coastal habitat	Circulation	-3 Very negative	1	-3 Very negative	1
Estuarine and coastal habitat	Coastal habitats	0 Indifferent	1	-1	1
Estuarine and coastal habitat	Salt intrusion/plume	-1	1	-1	1
Estuarine and coastal habitat	Salt intrusion/plume	0 Indifferent	1	0 Indifferent	1
Estuarine and coastal habitat	Sediment dynamics	0 Indifferent	1	0 Indifferent	1
Hydrology	Erosion	-1	2	0 Indifferent	2
Hydrology	Evaporation	-3 Very negative	2	-3 Very negative	1
Hydrology	Evaporation	-3 Very negative	2	0 Indifferent	1
Hydrology	Flood frequency	-3 Very negative	1	-3 Very negative	1
Hydrology	Flood frequency	0 Indifferent	2	0 Indifferent	2
Hydrology	Flood frequency	3 Very positive	4	3 Very positive	4
Hydrology	Flow regime	-1	13	-1	10
Hydrology	Flow regime	-1	13	-2	2
Hydrology	Flow regime	-3 Very negative	8	-1	10
Hydrology	Flow regime	-3 Very negative	8	-2	2
Hydrology	Flow regime	-3 Very negative	8	-3 Very negative	1
Hydrology	Flow regime	-3 Very negative	8	1	3
Hydrology	Flow regime	-3 Very negative	8	3 Very positive	2
Hydrology	Flow regime	0 Indifferent	6	0 Indifferent	4
Hydrology	Fluvial geomorphology	0 Indifferent	2	0 Indifferent	1
Hydrology	Groundwater level	-1	1	-1	1
Hydrology	Groundwater level	0 Indifferent	3	0 Indifferent	3
Hydrology	Sedimentation	-1	3	-1	1
Hydrology	Sedimentation	-1	3	0 Indifferent	3
Hydrology	Sedimentation	0 Indifferent	2	0 Indifferent	3
Social	Resettlement	-1	2	3 Very positive	2

Change in resource use – water

Count of expected permanent effect 2

Count of documented permanent effect 2

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Fisheries (fish stocking)	-3 Very negative	1	3 Very positive	1
Other	Others	3 Very positive	1	3 Very positive	1

(Appendix 12: Continued)

Climatic and local air quality change

Count of expected permanent effect 14

Count of documented permanent effect 18

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Local climate	Air temperature	-1	2	-1	3
Local climate	Air temperature	-2	2	-1	3
Local climate	Air temperature	0 Indifferent	7	0 Indifferent	6
Local climate	Water temperature	0 Indifferent	2	0 Indifferent	2
Local climate	Water temperature	2	1	2	1

Increased erosion

Count of expected permanent effect 6

Count of documented permanent effect 6

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Geophysics	Landslide	-1	1	-1	1
Hydrology	Erosion	-1	1	-1	1
Hydrology	Fluvial geomorphology	-1	2	-1	2
Landscape	Landscape appreciation	-1	2	-1	2

Noise and human presence effects on biota

Count of expected permanent effect 5

Count of documented permanent effect 5

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Social	Noise and vibration	-1	1	-1	1
Social	Noise and vibration	0 Indifferent	2	0 Indifferent	2
Terrestrial biology	Fauna (birds)	-1	2	-1	2

Physical impacts

Count of expected permanent effect 3

Count of documented permanent effect 2

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Geophysics	Earthquakes	0 Indifferent	1	0 Indifferent	1
Social	Noise and vibration	1	2	1	1

Removal of vegetation

Count of expected permanent effect 9

Count of documented permanent effect 9

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Landscape	Landscape appreciation	-1	2	-1	4
Landscape	Landscape appreciation	-2	2	-1	4
Terrestrial biology	Fauna (mammals)	-1	3	-1	3
Terrestrial biology	Flora	-1	2	-1	2

(Appendix 12: Continued)

Sedimentation

Count of expected permanent effect 2

Count of documented permanent effect 2

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Hydrology	Sedimentation	-2	2	-2	1
Hydrology	Sedimentation	-2	2	0 Indifferent	1

Soil inundation

Count of expected permanent effect 3

Count of documented permanent effect 3

Environmental type	Environmental component	Expected permanent effect		Documented permanent effect	
Economy	Fisheries (others)	1	3	2	3

Appendix 13: Documented permanent effect of impacts and connected mitigation measures

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Biotoxicity	Human health and safety risk management	2	0 Indifferent
Biotoxicity	Minimising soil contamination and loss of soil due to inundation	1	0 Indifferent
Biotoxicity	Mitigating effects on resource use	2	0 Indifferent
Biotoxicity	Other	1	0 Indifferent
Change in biota habitat	Economic impact management	3	1
Change in biota habitat	Fish protection	15	
Change in biota habitat	Fish protection	9	-1
Change in biota habitat	Fish protection	9	-2
Change in biota habitat	Fish protection	2	-3 Very negative
Change in biota habitat	Human health and safety risk management	1	0 Indifferent
Change in biota habitat	Human health and safety risk management	1	-1
Change in biota habitat	Minimising soil contamination and loss of soil due to inundation	1	
Change in biota habitat	Mitigating cumulative effects of multiple hydroelectric facilities	1	
Change in biota habitat	Mitigating effects on resource use	1	-1
Change in biota habitat	Other	9	
Change in biota habitat	Other	6	2
Change in biota habitat	Other	3	3 Very positive
Change in biota habitat	Other	2	-1
Change in biota habitat	Other	1	0 Indifferent
Change in biota habitat	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	2	
Change in biota habitat	Protecting or mitigating changes to landscape	18	-2
Change in biota habitat	Protecting or mitigating changes to landscape	15	
Change in biota habitat	Protecting or mitigating changes to landscape	8	0 Indifferent
Change in biota habitat	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	18	

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in biota habitat	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	1	-3 Very negative
Change in biota habitat	Protection, replacement and control of vegetation	18	-1
Change in biota habitat	Protection, replacement and control of vegetation	18	0 Indifferent
Change in biota habitat	Protection, replacement and control of vegetation	15	
Change in biota habitat	Protection, replacement and control of vegetation	4	3 Very positive
Change in biota habitat	Social impact management	6	0 Indifferent
Change in biota habitat	Social impact management	3	3 Very positive
Change in biota habitat	Water quality protection and adjustments	6	1
Change in biota habitat	Water quality protection and adjustments	1	
Change in biota habitat	Water quantity control (flow, velocity, level; including ice formation and movements)	3	0 Indifferent
Change in biota habitat	Water quantity control (flow, velocity, level; including ice formation and movements)	2	-2
Change in biota habitat	Water quantity control (flow, velocity, level; including ice formation and movements)	1	
Change in biota mobility	Fish protection	1	-2
Change in channel morphology	Fish protection	1	
Change in channel morphology	Other	1	
Change in channel morphology	Other	1	0 Indifferent
Change in channel morphology	Protection, replacement and control of vegetation	1	3 Very positive
Change in community and social services	Economic impact management	2	2
Change in community and social services	Economic impact management	1	1
Change in community and social services	Human health and safety risk management	1	3 Very positive
Change in community and social services	Mitigating cumulative effects of multiple hydroelectric facilities	1	-2
Change in community and social services	Other	1	-2
Change in community and social services	Other	1	0 Indifferent
Change in community and social services	Social impact management	2	

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in community and social services	Social impact management	1	0 Indifferent
Change in community and social services	Water quality protection and adjustments	2	
Change in ecosystem community populations	Climatic and local air quality controls	3	-1
Change in ecosystem community populations	Climatic and local air quality controls	1	0 Indifferent
Change in ecosystem community populations	Fish protection	4	
Change in ecosystem community populations	Fish protection	3	-1
Change in ecosystem community populations	Fish protection	3	1
Change in ecosystem community populations	Fish protection	2	-2
Change in ecosystem community populations	Fish protection	2	2
Change in ecosystem community populations	Fish protection	1	3 Very positive
Change in ecosystem community populations	Fish protection	1	-3 Very negative
Change in ecosystem community populations	Fish protection	1	0 Indifferent
Change in ecosystem community populations	Other	1	0 Indifferent
Change in ecosystem community populations	Protecting or mitigating changes to landscape	2	2
Change in ecosystem community populations	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	2	-1
Change in ecosystem community populations	Protection, replacement and control of vegetation	1	-1
Change in ecosystem community populations	Social impact management	1	3 Very positive
Change in ecosystem community populations	Social impact management	1	2
Change in ecosystem community populations	Water quality protection and adjustments	2	0 Indifferent
Change in ecosystem community populations	Water quantity control (flow, velocity, level; including ice formation and movements)	1	1
Change in housing and property values	Other	5	
Change in human safety risk	Human health and safety risk management	2	-1
Change in human safety risk	Mitigating effects on resource use	1	-1
Change in human safety risk	Protecting or minimising changes in channel morphology	1	-1
Change in human safety risk	Protecting or mitigating changes to landscape	1	-1

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in land use and policy plans	Economic impact management	3	-1
Change in land use and policy plans	Economic impact management	1	1
Change in land use and policy plans	Mitigating effects on resource use	1	1
Change in land use and policy plans	Protection, replacement and control of vegetation	2	0 Indifferent
Change in land use and policy plans	Social impact management	1	3 Very positive
Change in land use and policy plans	Social impact management	1	0 Indifferent
Change in land use and policy plans	Social impact management	1	1
Change in local economy	Economic impact management	20	
Change in local economy	Economic impact management	12	-1
Change in local economy	Economic impact management	8	0 Indifferent
Change in local economy	Economic impact management	3	1
Change in local economy	Economic impact management	1	2
Change in local economy	Economic impact management	1	3 Very positive
Change in local economy	Fish protection	6	1
Change in local economy	Fish protection	2	3 Very positive
Change in local economy	Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	2	-1
Change in local economy	Protecting or mitigating changes to landscape	1	0 Indifferent
Change in local economy	Protection, replacement and control of vegetation	3	-1
Change in local economy	Protection, replacement and control of vegetation	2	2
Change in local economy	Protection, replacement and control of vegetation	1	0 Indifferent
Change in local economy	Social impact management	4	1
Change in local economy	Social impact management	4	3 Very positive
Change in local economy	Social impact management	2	2
Change in local economy	Social impact management	1	-1
Change in local economy	Water quality protection and adjustments	3	1
Change in material translocation	Water quantity control (flow, velocity, level; including ice formation and movements)	1	0 Indifferent

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in resource use – aquatic biota	Fish protection	1	-1
Change in resource use – aquatic biota	Fish protection	1	3 Very positive
Change in resource use – aquatic biota	Mitigating effects on resource use	3	-1
Change in resource use – aquatic biota	Other	1	-1
Change in resource use – aquatic biota	Protection, replacement and control of vegetation	1	-1
Change in resource use – forestry, mining, agriculture	Economic impact management	5	
Change in resource use – forestry, mining, agriculture	Economic impact management	4	0 Indifferent
Change in resource use – forestry, mining, agriculture	Other	3	
Change in resource use – recreational areas etc.	Economic impact management	1	0 Indifferent
Change in resource use – recreational areas etc.	Social impact management	3	1
Change in resource use – recreational areas etc.	Social impact management	1	3 Very positive
Change in resource use – terrestrial biota	Protection, replacement and control of vegetation	1	-1
Change in resource use – terrestrial biota	Social impact management	1	
Change in social and community structure	Economic impact management	3	1
Change in social and community structure	Economic impact management	1	
Change in social and community structure	Economic impact management	1	2
Change in social and community structure	Other	1	2
Change in social and community structure	Social impact management	3	
Change in social and community structure	Social impact management	2	0 Indifferent
Change in social and community structure	Social impact management	2	2
Change in transportation and servicing	Economic impact management	1	3 Very positive
Change in transportation and servicing	Economic impact management	1	2
Change in transportation and servicing	Human health and safety risk management	1	3 Very positive
Change in transportation and servicing	Mitigating effects on resource use	1	3 Very positive
Change in transportation and servicing	Social impact management	1	

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in water quality	Economic impact management	3	-1
Change in water quality	Erosion prevention and control	1	0 Indifferent
Change in water quality	Fish protection	2	-1
Change in water quality	Other	2	0 Indifferent
Change in water quality	Other	1	
Change in water quality	Other	1	-1
Change in water quality	Water quality protection and adjustments	53	0 Indifferent
Change in water quality	Water quality protection and adjustments	13	1
Change in water quality	Water quality protection and adjustments	13	
Change in water quality	Water quality protection and adjustments	4	-1
Change in water quality	Water quality protection and adjustments	1	2
Change in water quality	Water quality protection and adjustments	1	-2
Change in water quantity	Economic impact management	1	1
Change in water quantity	Erosion prevention and control	4	0 Indifferent
Change in water quantity	Erosion prevention and control	3	
Change in water quantity	Erosion prevention and control	1	3 Very positive
Change in water quantity	Fish protection	1	
Change in water quantity	Mitigating effects on resource use	1	-1
Change in water quantity	Other	9	0 Indifferent
Change in water quantity	Other	2	-1
Change in water quantity	Other	1	
Change in water quantity	Protecting or mitigating changes to landscape	1	-1
Change in water quantity	Protecting or mitigating changes to landscape	1	
Change in water quantity	Protection, replacement and control of vegetation	1	0 Indifferent
Change in water quantity	Sedimentation prevention and control	2	0 Indifferent
Change in water quantity	Social impact management	1	3 Very positive
Change in water quantity	Water quality protection and adjustments	1	-1

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	26	-1
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	14	
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	12	3 Very positive
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	6	0 Indifferent
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	3	-2
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	2	1
Change in water quantity	Water quantity control (flow, velocity, level; including ice formation and movements)	2	-3 Very negative
Change in resource use – water	Water quantity control (flow, velocity, level; including ice formation and movements)	1	3 Very positive
Increased erosion	Erosion prevention and control	2	-1
Increased erosion	Erosion prevention and control	1	
Increased erosion	Water quality protection and adjustments	1	
Increased erosion	Water quantity control (flow, velocity, level; including ice formation and movements)	2	-1
Noise and human presence effects on biota	Other	1	0 Indifferent
Noise and human presence effects on biota	Social impact management	3	0 Indifferent
Physical impacts	Human health and safety risk management	2	0 Indifferent
Physical impacts	Social impact management	1	
Physical impacts	Social impact management	1	1
Removal of vegetation	Erosion prevention and control	2	-1
Removal of vegetation	Other	1	-1
Removal of vegetation	Protection, replacement and control of vegetation	5	-1
Removal of vegetation	Protection, replacement and control of vegetation	1	

(Appendix 13: Continued)

Impact	Mitigation measures	Count of mitigation measures	Documented permanent effect
Removal of vegetation	Sedimentation prevention and control	1	-1
Sedimentation	Sedimentation prevention and control	3	0 Indifferent
Sedimentation	Sedimentation prevention and control	1	
Sedimentation	Sedimentation prevention and control	1	-2
Soil inundation	Mitigating effects on resource use	1	2
Soil inundation	Other	2	2

Appendix 14: Mitigation measures; success indifferent

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Climatic and local air quality controls	None	None		SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec. SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec. These two books give a summary of the most important reports on technical and environmental works related to this project. Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences. Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires. This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures. The cost of mitigation measures is CAD 210 mill. and the cost of compensation measures (funding to the Crees) is CAD 454.5 mill., totalling CAD 664.5 mill. for the La Grande project. Projected cost for only Robert-Bourassa is CAD 285 mill. based on the installed capacity and the agreement. That gives an overall percentage of 6% for studies, compensation and mitigation None of the measures are published	Robert-Bourassa
Climatic and local air quality controls	None	The temperature is controlled by the depth of the water intake			
Climatic and local air quality controls	None	No control			
Climatic and local air quality controls	None	No control on air temperature			
Erosion prevention and control	None	Loose sediments (clay) on the bed of the river	Have a minimum flow in absence of ice		
Human health and safety risk management	None	Impossible to prevent or mitigate			
Human health and safety risk management	None	Monitoring for human consumption	Impossible to prevent bioaccumulation in fish and in water		
Protection, replacement and control of vegetation	None	Too much variation in level			
Social impact management	None	Redefinition of limits of traplines near the reservoir or submerged areas	The leaders of the traplines did not want it		
Water quality protection and adjustments	None	No possibility to have control of the water temperature			
Economic impact management	None	Fishery. Building of hatcheries			Stjørðals-elva

(Appendix 14: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	None	Electric fence, works well for bigger fish, but not for small fish	None	Paper written in Finnish	Kokkosniva
Fish protection	None	Electric fence to prohibit migration. Electric fence not effective for small fish			Kurkiaska
Fish protection	Low	The fish ladder built in 1966 has been rather unsuccessful, the fish stocking has had more success. Minimum flows also limit upstream migration and natural recruitment below the dam	A multiple entry has been built into the fish ladder, improving the degree of passage. Changing of downstream minimum flows at certain times to trigger upstream migration would probably be beneficial and this is being tried at present	In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Protection, replacement and control of vegetation	None	Revegetation		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Water quantity control (flow, velocity, level; including ice formation and movements)		Minimum flow. Bigger flow would be better for recreational use of the river Luiro	Increasing the flow		Porttipahta

(Appendix 14: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Minimum flow to the river Luiro			Lokka
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Minimum flows are necessary to maintain aquatic life downstream of the dam, including fish populations	More variable minimum flows may promote upstream fish migration. Higher general minimum flows would enhance downstream production	In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Water quantity control (flow, velocity, level; including ice formation and movements)	None	Storage areas for timber alongside the river were relocated. It was ensured that there was sufficient discharge to float the timber downstream. The dam was constructed with a special gate to allow logs to pass over/through the dam. However, floating of timber soon became uneconomic for reasons not connected to hydropower development, and after construction of the dam transport took place by road and rail		In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen

Appendix 15: Mitigation measures; success low

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Economic impact management	None	Traffic regulation for construction vehicles			Shin-Takanosu
Economic impact management	None	Tourism employment. Building of tourist office and motel		None of the measures are published	Stjørdals-elva
Economic impact management + Social impact management	None	Camp sites		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under “downstream area” (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
Economic impact management	None	New jobs for Cree workers during and after the construction		Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Economic impact management	None	Fishways. Some results have been recognised but they are not documented quantitatively	It is necessary to study the gradient of the fishway		Kurotani
Erosion prevention and control	None	Land use planning. Revegetation. Lack of funds. Absence of an executing agent	Inject funds. Assign a responsible executing agent	Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	None	Almost no fish in the vicinity		SEBJ, 1996. Le complexe hydroélectrique de La Grande Rivière. Réalisation de la deuxième phase. Montréal, Québec.	La Grande 2 A
Mitigating effects on resource use	None	The Cree did not want to fish near the powerhouse during the construction		Hydro-Québec & SEBJ, 1985. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Volume 3 : Répercussions sur l'environnement.	
Mitigating effects on resource use	None	Monitoring the fish population down-stream La Grande 2 A to James Bay and give the informations to the Cree hunters		Hydro-Québec & SEBJ, 1986. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Informations supplémentaires.	
Mitigating effects on resource use	None	Few meetings		These three reports give a good summary of many studies and interventions made on this project. More than 50% of the reports were written by consultants.	
Other: Give information on the capture of fish from La Grande Rivière	None	The pattern of fishing is different since ten to fifteen years; local people do not rely on fish like before		Chartrand, N. & Thérien, N. 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	
Water quality protection and adjustments	None	Find the gradient of salinity near the mouth of La Grande Rivière (plume) during the summer and the winter; evaluate the dispersion of the fish knowing the tolerance of each species to water salinity. Only the velocity of the flow can be an impact in the river		The cost of mitigation measures was CAD 210 mill. and the cost of compensation measures (funding to the Crees) was CAD 454.5 mill., totalling CAD 664.5 mill. for the La Grande project. Projected cost for only La Grande 2 A is CAD 106 mill. based on the installed capacity and the agreement. That gives an overall percentage of 6% for studies, compensation and mitigation	

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	Significant	Compensation flow regime and habitat improvement. The regulated minimum flow is bigger and more stable than natural conditions	Some aspects as water temperature, summer irrigation flows etc. suit the success of mitigation measures	Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
Fish protection	None	Fish stocking. Heavy predation on smolts - low discharge. Suggestion of poor feeding in hatchery reared smolts	Increased discharge during river stocking of smolts. Reduce number of predatory fish		Aurland I
Fish protection	None	Protect the fish during the most critical period of the project		Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Mitigating cumulative effects of multiple hydroelectric facilities	None	New hiking routes, car touring. The new hiking routes have not been as popular, people still use the old routes where impacts are greater			Aurland I
Other: Clearing of tributary mouths	None	Give better access of reservoir fish to tributaries, provide new spawning grounds		Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Other: Publicise the high value of eating fish with low content of mercury	None	Fish is better than other kind of meat for preventing heart disease	More and more informations	Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: Rebuilding of sewerage	None	Rebuilding of sewerage. The sewerage was not correctly designed.			Mis Dam-Sospirolo
Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	None				Aurland I
Protecting or mitigating changes to landscape	None	Access roads. Most of the roads are closed		None of the measures are published	Stjørdals-elva
Protecting or mitigating changes to landscape	None	Re-establish stable gradients		Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Protecting or mitigating changes to landscape	None				Aurland I
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and areas, and particular species other than fish)	None	Fish stocking. Heavy predation on smolts - low discharge. Suggestion of poor feeding in hatchery reared smolts	Increased discharge during river stocking of smolts. Reduce number of predatory fish		Aurland I

(Appendix 15: Continued)

Impact on power output	Mitigation measures	Success reason	Improvement suggested	References and comments	Project name
None	Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and areas, and particular species other than fish)	Building of two thresholds. Protection of beaver population		None of the measures are published	Stjørdals-elva
None	Protection, replacement and control of vegetation	Reconstitution of riparian habitats	Benefit takes more years to appear and it is a very small part of their territory	Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
None	Protection, replacement and control of vegetation	Traffic route adjustments		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under "downstream area" (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
None	Protection, replacement and control of vegetation	Revegetation. Old working methods. Arctic climate	Supplementary planting of trees		Lokka

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Protection, replacement and control of vegetation	None	Revegetation. Old working methods. Arctic climate	Supplementary planting of trees		Porttipahta
Sedimentation prevention and control	None	Sediment removal with digger			Mis Dam-Sospirolo
Social impact management	None	Boathooks. The ice breaks down the hooks			Kurkiaska
Social impact management	None	Relocation		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
Social impact management	Low	Management of reservoir level. The recreational use of the reservoir is not compatible with irrigation during summer.			Mis Dam-Sospirolo
Social impact management	None	Low level machines, time and speed limit			Kurotani

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Social impact management	None	Give information on the relative degree of contamination by mercury of each species of fish		Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Water quality protection and adjustments	None	Deforestation of the reservoir area. The organic matter in the soil is much more than what was removed by the deforestation		Regulated river (downstream area), aquatic biology, fish community: The minimum flow established is 3 m ³ /s representing 10% of the average flow as well as the average flow during August and September. The plant has a 1.5 MW unit for the use of the minimum flow, with a capacity to turbinat 5 m ³ /s. It also has an upper inlet at 6.5 m from the maximum reservoir level, which permits to release to the river the water located in the upper part of the reservoir, having a higher oxygen content	Agavanzal
Water quality protection and adjustments	None	Partial deforestation of the reservoir. Just a part of the organic matter has been removed, remaining the biggest fraction in the soil of the reservoir			Valparaiso

(Appendix 15: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	None		Better control of daily and seasonally variations of flow. The control must be improved	Same comment as in Appendix 14 (Robert-Bourassa)	Robert-Bourassa
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Minimum flows			Aurland I

Appendix 16: Mitigation measures; success high

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Economic impact management	None	Financial compensations. Land in exchange. Sufficient compensation			Lokka
Economic impact management	None				Maan
Economic impact management	None	Economic compensation for the purchase of land and 45 houses			Valparaiso
Economic impact management	None	Financial compensation of houses and forested land			Kurkiaska
Economic impact management	None	Financial compensation of agricultural land. Land in exchange. Sufficient compensation			Porttipahta

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Economic impact management		Water supply for irrigation		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
Economic impact management	Significant	Compensation flow. The river keeps the original function with no trouble on diversions downstream			Kurotani
Economic impact management	None	Traffic regulations for construction vehicles		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under "downstream area" (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
Economic impact management (including social impact management)	None	Boat places, financial compensation, swimming places			Kokkosniva
Economic impact management	None	Financial compensation of forested land and of agricultural land			Kokkosniva

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Economic impact management	None	Enhance local recreational and community facilities. Enhance municipal infrastructure. Provide monetary or other compensation. Support or enhance medical, social and communications services and facilities. Increased income from regulation taxes			Aurland I
Economic impact management	None	Provide appropriate stipulations in the construction contract for the projects and special incitements to contract		SEBJ, 1996. Le complexe hydroélectrique de La Grande Rivière. Réalisation de la deuxième phase. Montréal, Québec. Hydro-Québec & SEBJ, 1985. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Volume 3 : Répercussions sur l'environnement. Hydro-Québec & SEBJ, 1986. Suréquipement de l'aménagement de La Grande 2. Rapport sur les	La Grande 2A
	None	Employment and funding			
Erosion prevention and control	None	Control of future erosion on the shores of the river			
Human health and safety risk management	None	Good exchange of information with Cree health service			
	None	Give information on the security of skidoo roads on the ice of the river and the estuary; recommend best zones for safety			

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Mitigating cumulative effects of multiple hydroelectric facilities	None	Minimise the total impact of the project			
Mitigating effects on resource use	None	Give information on the concentration of mercury in different species and propose fishing in other natural lakes ; programs to subsidise the higher costs			
Mitigating effects on resource use	None	Dig channels between many islands and the coast to secure the navigation with canoe. Make attracting ponds for the geese and the ducks by diking brooks and cutting landing corridors in the trees and shrubs		SEBJ, 1996. Le complexe hydroélectrique de La Grande Rivière. Réalisation de la deuxième phase. Montréal, Québec. Hydro-Québec & SEBJ, 1985. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Volume 3 : Répercussions sur l'environnement. Hydro-Québec & SEBJ, 1986. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Informations supplémentaires.	La Grande 2A
	None	Building of a road on the north side of the river (open also in winter) and access by a bridge over the river at La Grande 1 site. Review of canoe launching/landing sites along the river and the reservoirs		These three reports give a good summary of many studies and interventions made on this project. More than 50% of the reports were written by consultants. Chartrand, N. & Thérien, N. 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: The same area was used for both projects	None	Minimise the total impact of the project			
Protection, replacement and control of vegetation	None	Study of the dynamic of eelgrass beds in relation to an increase of freshwater in winter. In the river, the changes of the aquatic plants show a high relation to hydrologic factors			
Protection, replacement and control of vegetation	None	Control the progression of the shrub towards the open water and monitor the eelgrass beds		SEBJ, 1996. Le complexe hydroélectrique de La Grande Rivière. Réalisation de la deuxième phase. Montréal, Québec. Hydro-Québec & SEBJ, 1985. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Volume 3 : Répercussions sur l'environnement. Hydro-Québec & SEBJ, 1986. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Informations supplémentaires. These three reports give a good summary of many studies and interventions made on this project. More than 50% of the reports were written	La Grande 2A
Social impact management	None	Control of the access of the workers (except Cree) to the Cree village, Chisasibi. Good cooperation between the corporation and the Cree representatives			

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	None	The construction of geese ponds remedies for the greater attraction to the open water near the islands due to an earlier melting of the water near the mouth of the river			
	None	Maintain the protection of the shore near the village of Chisasibi; maintenance of the canoe launching/ landing site near Chisasibi			
Water quantity control (flow, velocity, level; including ice formation and movements)	None	A new permanent water intake has been built for the village of Chisasibi. Hydro Québec must correct the sewage system of the village		SEBJ, 1996. Le complexe hydroélectrique de La Grande Rivière. Réalisation de la deuxième phase. Montréal, Québec. Hydro-Québec & SEBJ, 1985. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Volume 3 : Répercussions sur l'environnement.	La Grande 2A
	None	Study of the dynamics of sedimentation along the river and near the mouth of the river. The sediments settle only in James Bay, near the mouth of the river. The sediments come from the erosion of the shores of the river and from a slow remodelling of the delta of the river		Hydro-Québec & SEBJ, 1986. Suréquipement de l'aménagement de La Grande 2. Rapport sur les études d'avant-projet. Informations supplémentaires. These three reports give a good summary of many studies and interventions made on this project. More than 50% of the reports were written by consultants. Chartrand, N. & Thérien, N. 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour	

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
	None	Specification of a minimum flow of 900 m ³ /s in open water and 200 m ³ /s in winter to prevent salt intrusion into the river. Evaluation of the size of the plume at all river flow and tides for all degrees of salinity			
Economic impact management	None	Give contracts to Cree companies		SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec.	Robert-Bourassa
Erosion prevention and control	None	Better access to roads all year long. Control of erosion of Fort-George island	Occasional check of the stability of the shore near Chissisabi	SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec.	
	None	Protection of the shore near the village and good boat landing	Occasional check of the stability of the gravel	These two books give a summary of the most important reports on technical and environmental works related to this project.	
	None	Reestablishment of low and stable gradients of slopes		Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	
Fish protection	None	No fishing allowed during the filling against the will of the Indians		Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires.	
	None	Exchange of information with the indigenous people		This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures.	
	None	The fish ladder was a security		The cost of mitigation measures is CAD 210 mill.	

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Human health and safety risk management	None	Information on mercury level in fish given to the community			
	None	Camps had the same infrastructure as a village	Have individual rooms for all workers		
	None	Security for navigation			
Minimising soil contamination and loss of soil due to inundation	None	Daily controls		SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec. SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec.	Robert-Bourassa
Mitigating effects on resource use	None	No fishing in the river upstream the first rapid. Monetary compensation to fish elsewhere. Control of mercury in the indigenous population	Better cooperation between the parties	These two books give a summary of the most important reports on technical and environmental works related to this project. Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	
	None	Access ramps for boat and access roads		Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires.	
	None	Compensate for the fishing in other sites	Monitoring of mercury in natural lakes and along James Bay	This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures.	
	None	Better sites for fishing		The cost of mitigation measures is CAD 210 mill. and the cost of compensation measures (funding to the Crees) is CAD 454.5 mill., totalling CAD	
	None	Funds given to the society to minimise the impact on natural resources			

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: Diking of a bay	None	Create a spawning and a rearing zone at the maximal level of the reservoir	Focus on valuable species		
Other: Information on salinity and ice formation	None	Information needed for security and fisheries			
Other: The filling started after ice formation on the river	None	Slower salt intrusion under the ice	Have a minimum flow during the filling	SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec.	Robert-Bourassa
Other: Information on safe routes for boats in summer and skidoos in winter. New roads and facilities available	None	Exchange of informations and mutual trust		SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec. These two books give a summary of the most important reports on technical and environmental works related to this project.	
Other: Minimum flow to prevent salt intrusion in the river	None	Good understanding from the operators of the powerhouse		Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	
Other: Many agreements were concluded between the corporation and the indigenous people to protect their way of life	None	Mutual appreciation		Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires. This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures.	
Other: Industrial sites were placed far from the camps	None	Jobsites are far from the camps		The cost of mitigation measures is CAD 210 mill	

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: Control and disposal of wood debris	None	Cleaning of specific habitats	In some zones, the submerged trees act as aquatic vegetation and provide shelter		
Other: Give information about the best sections of the reservoir	None	This information is provided by numerous studies made during the monitoring			
Other: Fishing places where debris and stumps were removed	None	These sites are also used for monitoring the fish		SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec. SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec. These two books give a summary of the most important reports on technical and environmental works related to this project. Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences. Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires. This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures. The cost of mitigation measures is CAD 210 mill. and the cost of compensation measures (funding to the Crees) is CAD 454.5 mill., totalling CAD 664.5 mill. for the La Grande project. Projected cost for only Robert-Bourassa is CAD 285 mill. based on the installed capacity and the	Robert-Bourassa
Other: Studies on a small scale model	None	The speed of salt intrusion was well predicted			
Protecting or minimising changes in channel morphology	None	Ease flow of water			
Protecting or mitigating changes to landscape	None	The number of emergent trees is lower and disappear earlier			
Protection, replacement and control of vegetation	None	Use of selected seeds and production of inoculated alders and jack pines	Find good species for moist or damp soils		
	None	Soil was removed, set aside, moved back after demobilisation and seeded or planted			
	None	Top soil was set aside during the exploitation of the borrow pits			

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
	None	Planting trees, shrubs and grass			
Protection, replacement and control of vegetation	None	Renewal cuts of willows and alder stands	Good utilisation by mammals and birds but the surface is very small compared to the territory	SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; phase one development. Montréal, Québec. SEBJ, 1988. The La Grande Rivière Hydroelectric Complex ; the environmental challenge. Montréal, Québec.	Robert-Bourassa
Sedimentation prevention and control	None	Establish low gradients		These two books give a summary of the most important reports on technical and environmental works related to this project.	
Social impact management	None	Construction of a new village along the river		Chartrand, N. & Thérien, N. (eds.) 1992. Les enseignements de la phase I du Complexe La Grande. Actes du Colloque tenu à Sherbrooke les 22 et 23 mai 1991 dans le cadre du 59e Congrès de l'Association Canadienne-française pour l'Avancement des Sciences.	
	None	Many jobs were given to individual or indigenous groups or societies		Éditeur officiel du Québec, 1980. La Convention de la Baie-James et du Nord québécois et les conventions complémentaires.	
	None	Workers had limited access to the country and almost no access to the Indian villages		This document is like a treaty between the natives and the governmental authorities; it contains the authorisation of La Grande Complex and the corrective and mitigation measures.	
Water quantity control (flow, velocity, level; including ice formation and movements)	None	Setting a minimum and a maximum flow		The cost of mitigation measures is CAD 210 mill. and the cost of compensation measures (funding to the Crees) is CAD 454.5 mill., totalling CAD 664.5 mill. for the La Grande project. Projected cost for only Robert-Bourassa is CAD 285 mill. based on the installed capacity and the agreement. That gives an overall percentage of 6% for studies, compensation and mitigation	

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Erosion prevention and control	None	Erosion control, embankment boom shelter, clearing of the area above, bank easily sliding. Successful material choices. Advanced working methods			Lokka
Erosion prevention and control (done for the whole project area, not only in the reservoir area)	Low	Successful material choices. Advanced working methods			Kurkiaska
Erosion prevention and control	None	Bank easily sliding. Clearing of the area above. Embankments. Boom shelter. Advanced working methods. Boom wide enough. Successful material choices			Porttipahta
Fish protection	None	Fishways. Some results have been recognised but those are not documented quantitatively	It is necessary to study the gradient of the fishway		Kurotani

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	Significant	Operation of re-regulated dam and power plant (Futakawa). Management of reservoir levels (Takami)		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under "downstream area" (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
Fish protection	None	Fish stocking (Shizunai reservoir)			
Fish protection	Significant	Establishment of fishway			Shin-Takanosu
Fish protection	None	Fish stocking. Cost: NOK 150 000 annually. Fish yield has increased especially in the large reservoirs. This is due to a combination of increased accessibility of the lakes (new roads) and to stocking.			Aurland I
Fish protection	None	Fish stocking has been successful due to good knowledge of the fish population and continuous follow-up of angling catches and population characteristics	Short-term increase in minimum flows may improve upstream migration of spawning fish	In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Fish protection	None	Effective fishing, vigorous fry, good water quality	Cooperation with local fishermen, sufficient research		Kurkiaska

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	None				Mingtan pumped storage
Fish protection	None	Fish stocking, vigorous fry, adequate water quality, effective fishing	Cooperation with local fishermen, sufficient research		Kokkosniva
Fish protection	None				Maan
Fish protection	Low	Long-term data sets for the fish population and a detailed knowledge of the biology of this population of brown trout. Also stocked fish have a high survival rate. The cost of stocking is NOK 500 000 annually, the cost of the minimum flows during winter are not known. Stocking was initiated in 1973		In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Fish protection	None	Biotope adjustment measures		None of the measures are published	Stjørdals-elva

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Fish protection	Significant	Compensation flow. Low flow reduces spawning habitat available. Fish stocking to maintain high biomass density with compensation flows			Mis Dam-Sospirolo
Fish protection	None	Minimum flows		Regulated river (downstream area), aquatic biology, fish community: The minimum flow established is 3 m ³ /s representing 10% of the average flow as well as the average flow during August and September. The plant has a 1.5 MW unit for the use of the minimum flow, with a capacity to turbine 5 m ³ /s. It also has an upper inlet at 6.5 m from the maximum reservoir level, which permits to release to the river the water located in the upper part of the reservoir, having a higher oxygen content	Agavanzal
Fish protection	None	Fishing management. Fish market available		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Fish protection	None	Fish is attracted by the new spawning area			Rivière des Prairie

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Human health and safety risk management	None	Dam safety factor		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Minimising soil contamination and loss of soil due to inundation	Low	Removing of floating peat			Kurkiaska
Other: New up-to-date looking spillway	None				Rivière des Prairie
Other: Road adjustment	None	Same as for embankment (see below)			Petäjäs-koski
Other: Specific measures for noise, dust, etc.	None	Control of noise, e.g. by specific working hours, not to disturb people at night			Rivière des Prairie
Other: Boating channels	None	Same as for embankment (see below)			Petäjäs-koski
Other: Embankment	None	Good planning, cooperation with land owners, successful material choices, advanced working methods			Petäjäs-koski

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: Floating	Low	Building of floating equipment			Lokka
Other: Floating	Low	Building of floating equipment			Porttipahta
Other: Clearing	None	Qualified work			Petäjäs-koski
Other: Regular patrols to look for water needs	None	Removing of water weeds. Patrols done by reservoir owner. No weeds brought by waterflow. No weed transport from other parts as per government regulations		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Other: Landscape adjustment by clearing of shorelines	None				Lokka
Other: Building of two thresholds	None	Keeping groundwater level		None of the measures are published	Stjørdals-elva
Other: Rebuilding of access roads	None	Rebuilding roads			Mis Dam-Sospirolo
Other: Boat places	None	Same as for embankment (see above)			Petäjäs-koski

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Other: Habitat fragmentation	None	Biotop adjustment measures		None of the measures are published	Stjørdals-elva
Other: Fry releasing	None				Mingtan pumped storage
Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	Low	Floating equipment for reindeer. Financial compensation			Kurkiaska
Protecting or mitigating changes to landscape	None	Buried penstock. Utilisation of headrace tunnel. The fine landscape has been kept			Kurotani
Protecting or mitigating changes to landscape	None	Building of thresholds		None of the measures are published	Stjørdals-elva
	None	Rock tips. Vegetation, planting			
Protecting or mitigating changes to landscape	None	Spill-way: Adoption of the radial type gate and selection of its colour			Shin-Takanosu

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Protecting or mitigating changes to landscape	Significant	Removal of floating peat. Good planning and implementation			Kokkosniva
	None	Cooperation with local people and the National Board of Antiquities and Historical Monuments. Good planning and implementation			
Protecting or mitigating changes to landscape	None	Colonisation/planting of vegetation on rock tips. Good vegetation cover, but different from adjacent areas	Area must be fenced off, use seeds from local species		Aurland I
	None	Transmission lines. Route changed to avoid recreational area			
Protecting or mitigating changes to landscape	Low	Coffer dam			Kurkiaska
Protecting or mitigating changes to landscape	None	Landscaping of tips to blend into the landscape		In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	Significant	Compensation flow regime. The regulated minimum flow is bigger and more stable than natural conditions	Some aspects as water temperature, changes in primary production etc. suite the success of mitigation measure	Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
Protection, replacement and control of vegetation	None				Rivière des Prairie
Protection, replacement and control of vegetation	None	Revegetation			Mis Dam-Sospirolo
	Significant	Revegetation			
Protection, replacement and control of vegetation	None	Revegetation, afforestation			Kurotani
Protection, replacement and control of vegetation	None	Use of fertilisers and indigenous vegetation		In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Protection, replacement and control of vegetation	Low	Landscape adjustment. Revegetation. Cooperation with local people and authorities. Good planning and implementation			Kurkiaska

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Protection, replacement and control of vegetation	None	Revegetation		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
Protection, replacement and control of vegetation	None	Foreshore cultivation. Agriculture was done in small scale (the place is a dry area)		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Protection, replacement and control of vegetation	None	Revegetation. Recovery of the soil layer, hydro-sewing and natural recovery			Valparaiso
	None	Cleaning and revegetation of the construction areas. Cleaning of construction residues, morphologic adequation of landfills and revegetation			

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Protection, replacement and control of vegetation	None	Revegetation. The natural restoration is made by soil recovery in the construction area and revegetation		Regulated river (downstream area), aquatic biology, fish community: The minimum flow established is 3 m ³ /s representing 10% of the average flow as well as the average flow during August and September. The plant has a 1.5 MW unit for the use of the minimum flow, with a capacity to turbine 5 m ³ /s. It also has an upper inlet at 6.5 m from the maximum reservoir level, which permits to release to the river the water located in the upper part of the reservoir, having a higher oxygen content	Agavanzal
Protection, replacement and control of vegetation	None	Landscape adjustment by clearing the shoreline. Adequate methods. Motivated working staff			Porttipahta
Protection, replacement and control of vegetation	None	Afforestation, landscape adjustment, revegetation		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under "downstream area" (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
Sedimentation prevention and control	None	Dead storage. Thorough study		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Sedimentation prevention and control	Low	Sedimentation control			Kokkosniva
Sedimentation prevention and control	None	Rubber weir. No trouble due to sedimentation has been recognised			Kurotani
Social impact management	None	Health education and medical care. Provision of schools		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
	None	Financial compensation. Few people resettled. People resettled close by People given better social services.			
	None	Health education. Medical care. Cooperation from locals. Availability of services			
	None	Provision of water supply			
Social impact management	None	Indemnification. Relocation		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Social impact management	None	Water supply in Vuotos			Lokka
Social impact management	None	Traffic regulations for construction vehicles		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under “downstream area” (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
Social impact management	None	Boat channel. Channel deep enough, suitable material at the bottom of the channel			Kurkiaska
	None	Boat places, swimming beaches. Cooperation with local people. Successful material choices		Cost: 0.06%, covers boat places, boat hooks, boat channel and swimming beaches	
	None	Route adjustments			
Social impact management	None	Traffic regulation for construction vehicles			Shin-Takanosu
Social impact management	None	Route adjustment - good planning and implementation			Kokkosniva
	None	Financial compensation			
Social impact management	None	Route adjustments. Advanced methods			Porttipahta

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Social impact management	None	Infrastructure around the dam, such as the development of a camping site has increased tourism in the area. There is also a visitor's centre		In addition to tourist developments around the dam, the routing of some roads and a railway line have been undertaken. This was financed by the developer	Hunderfossen
Water quality protection and adjustments	Significant	Compensation flow. The river keeps the original function with no trouble on diversions downstream			Kurotani
	None	Water-purifying devices			
Water quality protection and adjustments	Significant	Selective intake from reservoir. Water temperature		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under "downstream area" (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami
	None	Water-purifying devices			
Water quality protection and adjustments	None				Mingtan pumped storage
Water quality protection and adjustments	None				Maan
Water quality protection and adjustments	None	Water-purifying devices			Shin-Takanosu

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quality protection and adjustments	None	Water pipes - good quality of ground water, adequate methods			Kokkosniva
	Low	Embankments - successful material choices, advanced working methods			
Water quality protection and adjustments	None	Air injection into the turbine: - Aeration weir - Operation of the Howell-Bunger valve. Supplying 3 mg O ₂ /l to the turbinated water			Valparaiso
	None	Purification of construction releases. Control and treatment of releases from the drainage (sedimentation bags etc.)			
Water quality protection and adjustments	None	Installation of bypass waterway. Diverting the clean river water which is flowing into the pond, to the downstream of the dam directly without storage		The bypass waterway has the purpose to collect the river water which is flowing into the lower regulating pond from the upper streams, by intake weirs built at the six streams respectively, and to divert the water into the downstream of the lower dam directly when inflow becomes clear after high run-off. As for the upper regulating pond, this waterway is not installed because the catchment area of the pond is small enough and so the pond has little influence on the downstream water quality	Okumino

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quality protection and adjustments	Significant	Invasion of aquatic weeds. Planning periodic peak flows and compensation flows to increase weed drift and decrease suitable substrate to grow on		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
	Significant	Oxygen levels. Management of reservoir outlets and hydro-power production. Increase of water aeration and limitation of released hypolimnetic water			
Water quality protection and adjustments	None	Purification of construction releases. Control and treatment of effluents from the treatment plant and the concrete plant		Regulated river (downstream area), aquatic biology, fish community: The minimum flow established is 3 m ³ /s representing 10% of the average flow as well as the average flow during August and September. The plant has a 1.5 MW unit for the use of the	Agavanzal
	None	Air injection in the turbine. By injecting 3.7% of air in volume, there is an increase of 3 mg O ₂ /l in the turbinated water			
Water quality protection and adjustments	None	Boom to trap floating debris. Trash rack at intake. Amount of floating debris is low		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Retaining dams, prohibition of wet land			Kokkosniva
	Low	Building of equipment to minimise flows			
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant	Minimum and maximum flows		None of the measures are published	Stjørdals-elva
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant	Compensation flow. For a long period after dam construction there was no flow downstream. So now, local population appreciate minimum maintained flow			Mis Dam-Sospirolo
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant	Operation of re-regulated dam and power plant (Futakawa). Management of reservoir levels (Takami)		Mitigation measures: Water quality protection and adjustments covered 3.8% of total cost (not each parameter). Protection, replacement and control of vegetation covered 1% of total cost (not each parameter). Documentation: The literature mentioned under “downstream area” (regulated river) also covers the other locations (e.g. reservoir area, other broad areas etc.)	Takami

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant				Mingtán pumped storage
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Instream flows. Important to maintain river flows during summer, both ecologically and for tourism			Aurland I
Water quantity control (flow, velocity, level; including ice formation and movements)	None				Valparaiso
	Significant	Minimum flows (before the filling of Agavanzal)			
Water quantity control (flow, velocity, level; including ice formation and movements)	None	Spillway capacity. Thorough study		Assessment of level of success of the mitigation measures is not well known/documented. This is because there was no particular body assigned to oversee the implementation of the measures and to assess the result	Great Ruaha - Mtera
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant	Compensation flow. The river keeps the original function with no trouble on diversions downstream			Kurotani

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	None	Modulation of flow in the Agavanzal power plant		Regulated river (downstream area), aquatic biology, fish community: The minimum flow established is 3 m ³ /s representing 10% of the average flow as well as the average flow during August and September. The plant has a 1.5 MW unit for the use of the minimum flow, with a capacity to turbinat 5 m ³ /s. It also has an upper inlet at 6.5 m from the maximum reservoir level, which permits to release to the river the water located in the upper part of the reservoir, having a higher oxygen content	Agavanzal
	None	Management of the regulatory reservoir level (Cernadilla).			
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant	Hydropower peaking. Limitation of flow variation rates. The limited flow variation rates are more suitable for the aquatic community		Access roads: Cost of new roads replacing those affected by Riano dam and reservoir was equivalent to the cost of the dam. Social issues: Cost of relocation (Riano dam and reservoir) was much higher than the cost of the dam	La Remolina - Riano
	Significant	Compensation flow regime. The regulated minimum flow is bigger and more stable than natural minimum flow			
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Good timing Sufficient adjustment			Porttipahta

(Appendix 16: Continued)

Mitigation measures	Impact on power output	Success reason	Improvement suggested	References and comments	Project name
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Management of reservoir levels. Good timing. Sufficient adjustment			Lokka
Water quantity control (flow, velocity, level; including ice formation and movements)	Significant				Maan
Water quantity control (flow, velocity, level; including ice formation and movements)	None				Petäjäs-koski
Water quantity control (flow, velocity, level; including ice formation and movements)	Low	Compensation flow			Kurkiaska

User Guide

**International Energy Agency Implementing Agreement for
Hydropower Technologies and Programs**

Questionnaire: Environmental Impacts and Hydropower

Annex III: Hydropower and the Environment



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1 General

This document (in Word 97 format) is located in the same place where the IEA Questionnaire was/is installed.

A Word 97 Viewer is included on the IEA Questionnaire CD

1.1 Installing the IEA Questionnaire

The IEA97 will run only with Windows 95, Windows NT Server or Workstation version 3.51 with Service Pack 5, and Windows NT Server or Workstation version 4.0 with Service Pack 2. You will need at least 12 MB of RAM with Windows 95 and 16 MB of memory with Windows NT. With Windows NT, you must be the administrator or have administrator privileges in order to install.

To install the IEA Questionnaire on Windows 95 or Windows NT Server or Workstation 4.0:

1. Close all programs
2. Insert the IEA97 CD in the CD-ROM drive (or IEA97 Disk 1).
3. Click the **Start** button, point to **Settings**, and then click **Control Panel**.
4. Double-click the Add/Remove Programs icon.
5. On the **Install/Uninstall** tab, click **Install**.
6. Use the **Browse** button to navigate to either the Disk1 folder on the IEA97 CD (or IEA97 Disk 1).
7. Select and run: "Setup.exe"
8. Follow the Set-up instructions on the screen.
9. To start IEA Questionnaire after installation see 0

1.3 Start/log on to IEA Questionnaire page 122

Notes:

- If you installed IEA Questionnaire from a CD-ROM, and you have mapped your CD-ROM drive to a new drive letter since you originally installed IEA Questionnaire, run Set-up again from the CD-ROM. If you are running any IEA Questionnaire files from the CD-ROM, you must uninstall IEA Questionnaire and then install IEA Questionnaire again from the CD-ROM.

1.2 Uninstalling the IEA Questionnaire

To uninstall the IEA Questionnaire on Windows 95 or Windows NT Server or Workstation 4.0:

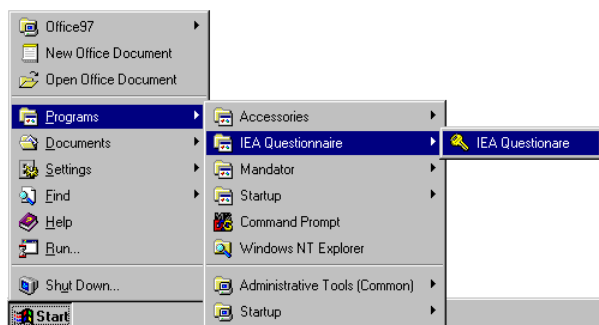
1. Close all programs.
2. Click the Windows Start button, point to Settings, and then click Control Panel.
3. Double-click the Add/Remove Programs icon.
4. Click IEA Questionnaire on the Install/Uninstall tab, and then click Add/Remove.
5. Follow the instructions on the screen.

Notes:

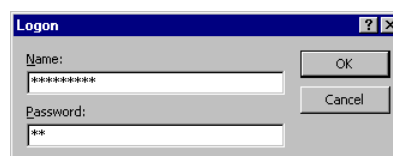
- If you installed IEA Questionnaire from a CD-ROM, and you have mapped your CD-ROM drive to a new drive letter since you originally installed IEA Questionnaire, run Set-up again from the CD-ROM. If you are running any IEA Questionnaire files from the CD-ROM, you must uninstall IEA Questionnaire and then install IEA Questionnaire again from the CD-ROM.
- When you uninstall a IEA Questionnaire by using the **Remove All** option, you may get the following error: "Can't remove 32autole.dll, this file is in use by another application." If you get this error, click **Ignore** and all other files will be removed.

1.3 Start/log on to IEA Questionnaire

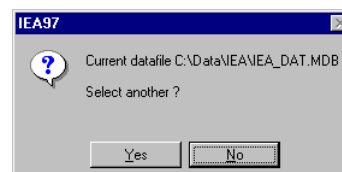
Select Start -> Programs -> IEA Questionnaire to start IEA Questionnaire:



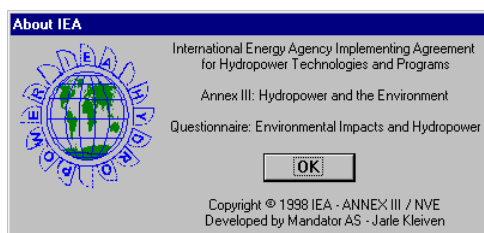
The Logon box is displayed at start-up and you must identify yourself by entering a valid user account name and password (the password are case-sensitive).



Contact NVE to get the username and password:



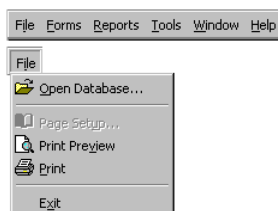
Selecting another data file, see 2.1 Open database, page 122:



1.4 Log off

See 2.5 Exit, page 7.

2 File menu



2.1 Open database

The selected database name is shown on the programs' title bar at the top. A database can contain several projects. Use the File -> Open database menu to change the active database:



The IEA Questionnaire comes with two databases:

1. IEAExmpl.mdb This is an example database with the project Kokkosniva.
2. IEAEmpty.mdb This database is empty and contains no project.

Copy IEAEmpty to a new file with the name as the following:
IEA<countryname>.MDB.

Ex. Norway = IEANorw.mdb;

Finland = IEAFinl.mdb

and use this file for your projects (that will be replicated with NVE's master database).

Both files are installed in the same catalogue where the IEA Questionnaire was installed. Do not use IEAExmpl.mdb or "Change me"; always make a new project.

2.2 Page set-up

Set margins, page orientation, and other page set-up options.

- Open the form/report.
- On the File menu, click Page set-up.
- Click the following tabs for the options you want to set:
 - Margins. To set margins and whether to print data only.
 - Page. To set orientation, paper size, and printer.
 - Columns. To set number, size, and layout of columns for forms, reports, and macros only.
- Click OK.

IEA Questionnaire stores the settings for page set-up options with a form or report, so you set these options only once for each form or report.

2.3 Print preview

Prints active report/form in a window on the screen.

2.4 Print

Prints active report/form to the default printer.

2.5 Exit

You can log off IEA97 with Exit in the File menu. Before IEA97 closing you are asked if you want to "quit IEA97":



3 Forms menu

File Forms Reports Tools Window Help

3.1 General

3.1.1 Record selector

The record selector is a small box  or bar to the left of a record that you can click to select the entire record.

- Indicates the current record, the record has been saved as it appears:



- Indicates that the whole record is marked:



To delete a record, press the record selector and press the DELETE button:



-  Pencil. You are editing this record; changes to the record aren't yet saved. To undo and leave the record, press ESCape:
- * New record. This is a new record that you can enter information in:



3.1.2 Form navigating

With the navigation buttons can you move from form to form:



To close the form select (shortcut = Alt + C):



To go to the last chapter select:



To move to the next form select (if the selected for is the last then it will go to the first form):



To move to the previous form select (if the selected for is the first it will go to the last):

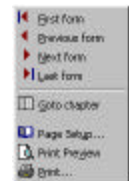


To go to the first form select:



To go to a specific chapter, select the "Go to chapter" button:





3.2 Keyboard and mouse

Navigate between fields	Press
To move to the next field	TAB
To move to the previous field	SHIFT+TAB
Using Combo Boxes	Press
Open an Combo Box	F4 or Alt+Arrow Down
Move one line down	Arrow Down
Move one page down	Page Down
Move one line up	Arrow Up
Move one page up	Page Up
Move out of the combo box	TAB
In the Shift+F2 window	Press
To get a line-shift	Ctrl+Enter

3.3.1 Part 0: Introduction

3.3.1.1 Chapter 0

If the page (shown below) is blank, there is no selected project, then you have to use the Project combo-box to select or make a new project.

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 0: Introduction

Project: Kokkonen

Select existing project, or write the name of a new project

Change project name: Kokkonen

Signature by a superior: Raimo Kokkonen

Filled in by	Company/Institute/department	Signature
▶ Tero Hagberg		
Marko Anttonen	Karekko Oy/Environmental res.	
Jukka Paakkonen		
Jarmo Nuolinen		

One questionnaire should be filled out for each project. A project may include several power stations, reservoirs, etc. The questionnaire has several "Toimio" and it is easier to fill them out in numerical order. It is important that you first fill in the "Part 1: Project data" form but after that you can move around from one form to another by using the navigation buttons at the bottom of the form. Some forms contain sections which may have to be filled out several times to create more than one record - for example, separate records are required if there are more than one powerstation, reservoir, impact, etc. After you have completed some of the entries in the form, you can go back and make corrections if needed.

Navigation controls: [Left Arrow] [Right Arrow] Ch 0 [Go Button]

3.3.2 Part 1: Project data

3.3.2.1 Chapter 1.1 – 1.2.2

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.1 Location, 1.2 Rationale and 1.2.2 History

Project: Jokioinen

1.1.1 Name and geographical position:

Country: Finland Longitude: 27° 13' 33" East Other information:

Province: Lapland Latitude: 67° 13' 22" North

Give: Rovaniemi

1.1.2 Associated Project:

Longitude: E/W Latitude: N/S

1.2.1 Rationale:

After the World War II Finland lost one third of her built hydropower to the Soviet Union. Because of the significant loss of hydropower and the increasing demand of

1.2.2 History:

Planning: 1985 (year started)

Approval: 1987 (year started)

12/08/1987

Construction: 1987 (year started)

01/87 - 12/90

Operation: 1990 (year started)

01/10/1990

Ch 1-1.2.2

3.3.2.2 Chapter 1.3 – 1.4.2.2

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.3 Quality, 1.4 Review, 1.4.2 Maps

Project: Jokioinen

1.3 Quality Management Systems:

ISO 14000 ☐

ISO 9000 ☐

None ☐

Utility specific ☐

1.4.1 Project Purpose:

Domestic water supply ☐

Flood protection ☐

Industrial water supply ☐

Irrigation ☐

Power generation ☒

Primary Secondary

1.4.2.1 Outline map:

Record: 1 of 1

1.4.2.2 Water resources map:

Record: 1 of 1

Legend to maps:

- Planned hydropower plant
- Reservoir
- Existing hydropower plant
- Catchment boundary
- Tunnel, channel
- Project area

1.4.3 Comment to 1.4:

no

Ch 1.3-1.4.2.2

3.3.2.3 Chapter 1.5

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.5 Power station(s) specifications

Project: Jokioinen

1.5 Power station: Jokioinen

Type of project: New project ☒ Upgrading ☐

Run of river ☒

Pump storage seasonal ☐

Pump storage daily ☐

Reservoir ☐

Diversion ☐

Reservoir and diversion:

Number of reservoirs: 1

Number of diversions: 1

Timetable (started year):

Planning: 1985

Construction: 1987

Operation: 1990

Powerplant data:

Gross head (m): 12.0

Installed capacity (MW): 25.0

Max operation flow (m³/s): 260.0

Mean annual energy output: 81.0

Utilisation factor: 37.0

Regulation factor (%): 46.0

Production strategy:

Base load seasonal ☐

Base load daily ☒

Peaking load seasonal ☐

Peaking load daily ☒

Base load (%): 35.0

Peak load (%): 15.0

Record: 1 of 1

Ch 1.5

3.3.2.4 Chapter 1.6

EA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; 1.6 Reservoir(s) specifications

Project:

1.6 Reservoir:

Volume:	Catchment area at intake:	7390.0	Hydrology:	Mean annual inflow:	108.0
	Active storage:	10.0		Mean res. retention time:	5.0
	Dead storage:	38.0		Surface area max:	18.0
	Total regulation height:	1.0		Surface area min:	
Dam:	Dam:	Embankment	Dam size:	Dam height (m):	
	Spillway:	Gated		Dam length (m):	12900.0
	Waterway type:				

Record: of 1

Ch 1.6

3.3.2.5 Connect PowerStation to reservoir

EA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; Connect powerstation to reservoir

Project:

Connect powerstation to reservoir

Kokkominva	Powerstation <-connected to-> Reservoir	Kokkominva reservoir
	Powerstation <-connected to-> Reservoir	

Ch 1.6

3.3.2.6 Chapter 1.7.1.1 – 1.7.2.2

EA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; 1.7 Environmental data; 1.7.1/1.7.2 Climate

Project:

1.7.1.1 Pre-dominant type of biome(s) within catchment

Mountain ☐
 Subarctic ☒
 Peatland/wetland ☐
 Savannah/grassland ☐
 Temperate forest ☐
 Rainforest ☐

1.7.2.1 Climate, mean temperature (degrees C)

Period of measurement: From to

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-13.5	-13.5	-9.0	-2.2	4.8	11.4	14.5	11.7	6.0	-0.4	-6.3	-10.3	-0.5

(average)

Location of monitoring/measuring station:

Name Lat Long East ☐ West ☐ North ☐ South ☐

1.7.2.2 Climate, mean precipitation (mm)

Period of measurement: From to

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
32.0	27.0	33.0	24.0	42.0	62.0	71.0	72.0	49.0	36.0	31.0	529.0	67

(total)

Location of monitoring/measuring station:

Name Lat Long East ☐ West ☐ North ☐ South ☐

Ch 1.7.1.1 - 1.7.2.2

3.3.2.7 Chapter 1.7.2.3a – 1.7.3.2

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.7 Environmental data: 1.7.2 Climate, 1.7.3 Hydrology

Project: Kokkoniemi

1.7.2.3a Evaporation rate: 122 mm/year

1.7.2.3b Location of evaporation monitoring station

Name: Sodankylä Mail: 174 Long: 26 39 North Lat: 67 22 East

Period of measurement: From 1961 to 1990

Jan: Feb: Mar: Apr: May: Jun: Jul: Aug: Sep: Oct: Nov: Dec: Year: 83.0 6.7 (average)

Location of monitoring/measuring station:

Name: Kokkoniemi Mail: 162 Long: 27 19 33 East Lat: 67 13 22 North

1.7.3.1 Hydrology, runoff before regulation (m³/sec)

Period of measurement: From 1990 to 1995

Jan: Feb: Mar: Apr: May: Jun: Jul: Aug: Sep: Oct: Nov: Dec: Year: 106.0 6.7 (average)

Location of monitoring/measuring station:

Name: Kokkoniemi Mail: 162 Long: 27 19 33 East Lat: 67 13 22 North

1.7.3.2 Hydrology, runoff after regulation (m³/sec)

Period of measurement: From 1990 to 1995

Jan: Feb: Mar: Apr: May: Jun: Jul: Aug: Sep: Oct: Nov: Dec: Year: 106.0 6.7 (average)

Location of monitoring/measuring station:

Name: Kokkoniemi Mail: 162 Long: 27 19 33 East Lat: 67 13 22 North

Ch 1.7.2.3 - 1.7.3.2

3.3.2.8 Chapter 1.7.4.1 – 1.7.5.2

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.7 Environmental data: 1.7.4 Catchment data, 1.7.5 Natural and ..

Project: Kokkoniemi

1.7.4 Catchment data

1.7.4.1 Catchment area, main stream and topography

Total catchment area (km²): 51127

Length of main stream (km): 552.0

Highest elevation (m): 483.0

Lowest elevation (m): 0.0

1.7.4.2 Lake area

Total lake area before regulation (km²): 1463.0

Total lake area after regulation (km²): 2196.0

Number of man-made lakes: 2

1.7.4.3 Is the catchment area vulnerable to erosion?

Catchment area vulnerable to erosion: ☐ Yes ☒ No

1.7.5 Natural and cultural amenities in the project area

Presence of natural and cultural amenities in the impact area before regulation

1.7.5.1 Did endangered species (ie. currently or formerly red-listed or endangered) exist within the impact area?

Endangered species: ☒ Yes ☐ No

1.7.5.2 Where there any protected areas within the impacted area?

Protected areas: ☐ Yes ☒ No

Ch 1.7.4 - 1.7.5.2

3.3.2.9 Chapter 1.7.5.3, 1.7.6

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data: 1.7 Environmental data: 1.7.5.3 Natural and cultural amenities

Project: Kokkoniemi

1.7.5.3 Are there any of the following landscape features?

Tip to characterize them

Landscape types

Beautiful river stretches, scenic lakes, springs, etc.: 3 Extraordinary

Beautiful scenery (vistas, picturesque nature, beautiful countryside, landscapes): 3 Extraordinary

Places or relics of religious, historical or cultural importance: 3 Extraordinary

Scenic waterfalls: 3 Extraordinary

Special geological formations (mountains, limestone cliffs, canyons, escarpment): 3 Extraordinary

Special vegetation (beautiful forests, unique trees, high floral diversity, etc.): 2 Important

Visible cultural relics (old barns, temples, old mills, water wheels, etc.): 3 Extraordinary

Other: [Empty field]

1.7.6 Comments

See enclosure

Ch 1.7.5.3

Use “Others” to make a new landscape type.

3.3.2.10

Chapter 1.8.1.1 – 1.8.1.6

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; 1.8 Societal data: 1.8.1.1 – 1.8.1.6

Project:

1.8.1 Population, information, land use and compensation

1.8.1.1 Population density in the project area (persons/km²):

1.8.1.2 Settlement pattern in the project area: before construction: after construction:

1.8.1.3 People resettled in the project area:

1.8.1.4 Distance from the former location to the resettlement area:

1.8.1.6 Did local people or their organizations influence: in project planning: during project construction: in operation:

1.8.1.5 What kind of compensation did the resettled people get? (check all)

Employment ☐
 Lump sum of payment ☐
 New houses ☐
 New land ☐
 No compensation ☐
 Regular payment over several years ☐

Other:

Navigation icons: Previous, Next, Go to 1.8.1, Save

3.3.2.11

Chapter 1.8.1.7 – 1.8.1.10

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; 1.8 Societal data: 1.8.1.7 – 1.8.1.10

Project:

1.8.1 Population, information, land use and compensation

1.8.1.7 Information about the project received by: Coo NGOs Official representatives Organizations from the local population Other:

1.8.1.9 Did the information distributed by the proponents describe: Affected areas: Compensation measures: Technical plans/solutions: Other:

1.8.1.8 When was information given? In the planning phase: During the construction period: After construction:

1.8.1.10 What was the perception of the project in the local population?

	Before	During	After
The local population in general	Uncertain	Positive	Positive
Local groups	Negative	Positive	Positive
NGOs	Positive	Positive	Positive

Navigation icons: Previous, Next, Go to 1.8.1, Save

3.3.2.12

Chapter 1.8.1.11 – 1.8.2

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 1: Project data; 1.8 Societal data: 1.8.1.11 – 1.8.2

Project:

1.8.1.11 Land use

	Before	After	References
Agriculture (including livestock)	Insignificant	Insignificant	
Fishery	Insignificant	Insignificant	
Forestry	Insignificant	Insignificant	
Industry			
Wilderness	Significant	Significant	

Other:

1.8.1.12 Project gains/losses

	Before	After
Ground water	☐	☐
Indoor	☐	☐
Surface water	☐	☐
Wells	☐	☐

Other:

1.8.2 Comments to 1.8

Land area irrigated/cultivated (Ha) Before: After:
 Area protected from flooding (Ha) Before: After:
 Houses protected from flooding ☐ Before: ☐ After: ☐
 Industrial water supply ☐ Before: ☐ After: ☐

Navigation icons: Previous, Next, Go to 1.8.1.11, Save

3.3.3 Part 2 – Issue identification process

3.3.3.1 Chapter 2.1.1 – 2.1.4

IEA questionnaire: Environmental Impact of Hydropower Projects
Part 2: Issue identification process in project planning phase

Project:

2.1.1 What were the key issues?

Field/parameter	Issue(s)
Aquatic biology	☒ fish community (see enclosure 2)
Economy	☒ water traffic, floating, fishery, water supply
Geophysics	
Global effects	
Hydrology	☒ water levels, runoff
Landscape	☒ roads, bridges, landscape of the Suvarnko vi
Local climate	
Social	☒ effects on Suvarnko village
Terrestrial biology	
Water quality	

Others:

2.1.2 How/why were issue to be studied identified?

The studies on the selected issues were required in the Law on Water Rights.

2.1.3 Where the following groups consulted in identifying the environmental issue(s)?

Group consulted	Check
Bank/lenders	☐
Investors/owners	☐
Public	☐
Regulatory authorities	☒
Special interest groups/NGOs	☒

Others:

2.1.4 Please describe any consultation conducted

Navigation: < > Ch 2.1.1 - 2.1.4 >

3.3.4 Part 3 – Verification of impacts

3.3.4.1 Chapter 3.1 General

The form can be in to states, Free- or Locked-mode.

Free mode: Use this mode when you will make new environmental component for the selected project.

All used environmental component for selected project will be showed.

Locked mode: Shows used environmental components for chosen Location/Activity/Impact.

Used environmental components for selected project		Parameters studied		Data quality		Degree	
Env. Type	Component	Before project		After project		Expected	
		Start (year)	No of years	Start (year)	No of years	Qualita	Quant
Aquatic Biology	Fauna						
Aquatic Biology	Fauna						
Aquatic Biology	Fish community			1575	18	Very good	Very good
Aquatic Biology	Fish community	1583	14			Very good	Very good
Aquatic Biology	Fish community	1579	12	1581	06	Very good	Very good
Terrestrial Biology	Fish community						

Location: Construction Disturbance Area
 Activity: Altering Long-term River Flow
 Impact: Change in Ecosystem Community Populations
 Env type: Aquatic Biology
 Env Comp: Fish community

3.3.4.2 Chapter 3.1 Free mode

IEA questionnaire: Environmental Impact of Hydropower Projects
Part 3: Verification of impacts, 3.1 Impacts

Project:

Location:

Activity:

Impact:

Env. Type:

Component:

Buttons: Show grid, Type, New Env. Component

Note: Part 3.2, 3.3, 4.1 and 4.3 is depended on the information given in this form

Used environmental components for selected project		Parameters studied		Data quality		Degree of impact		Pattern sheet (add to sheet)
Env. Type	Component	Before project		After project		Expected		Q-E
		Start (year)	No of years	Start (year)	No of years	Qualita	Quant	
Aquatic Biology	Fish community			1575	18	Very good	Very good	C
Aquatic Biology	Fish community	1583	14			Very good	Very good	C
Aquatic Biology	Fish community	1579	12	1581	06	Very good	Very good	B
Aquatic Biology	Fish community			1577	07	Very good	Very good	B
Aquatic Biology	Fish community							A
Terrestrial Biology	Fish community							C

Navigation: < > Ch 3.1 >

3.3.4.3 Chapter 3.1 Locked mode

EA questionnaire: Environmental Impact of Hydropower Projects

Part 3: Verification of impacts; 3.1 Impacts

Project: Kukhsone

Location: Construction Disturbance Area

Activity: Altering Long-term River Flow

Impact: Change in Ecosystem Community

Env Type: Aquatic Biology

Env Comp: Fauna

Show used

Locked

Note: Part 3.2, 3.3, 4.1 and 4.3 is depended on the information given in this form

Used environmental components for selected Location/Activity/Impact

Env. Type	Component	Parameters studied		Data quality		Degree of impact				Pattern chart (click to show)		
		Before project	After project	Before project	After project	Expected	Documented	Expected	Documented			
Aquatic Biology	Fauna	Start (year)	No of years	Start (year)	No of years	Quality	Quantity	perms. ment	during const.	perms. ment	during const.	(A-E)
Aquatic Biology	Fish community	1979	12	1991	06	Very good	Very good	1	2	2	2	B
Aquatic Biology	Fish	1984	01			Very good	Very good	2	1	1	1	C
Aquatic Biology	Red listed spp.	1984	01	1996	02	Very good	Very good	2		1	2	C

Ch 3.1

When locked mode is enabled, you can only select Location/Activity/Impact with related environmental components.

3.3.4.4 Chapter 3.2

EA questionnaire: Environmental Impact of Hydropower Projects

Part 3: Verification of impacts; 3.2 Documentation

Project: Kukhsone

3.2 Documentation (impacts)

Note: This form is depended on the information given in part 3.1

Location: Construction Disturbance Area

Activity: Altering Long-term River Flow

Impact: Change in Ecosystem Community

Env Type: Aquatic Biology

Env Comp: Fauna

Show

Author	Documentation	Keywords	Documented in	Reported by
see enclosure				

Ch 3.2

3.3.4.5 Chapter 3.3 – 3.4

EA questionnaire: Environmental Impact of Hydropower Projects

Part 3: Verification of impacts; 3.3 Main env. impacts of the project and 3.4 Comments

Project: Kukhsone

3.3 Main environmental impacts of the project

Note: This form is depended on the information given in part 3.1

Location: Construction Disturbance Area

Activity: Altering Long-term River Flow

Impact: Change in Ecosystem Community

Env Type: Aquatic Biology

Issue:

Enclosure no:

Studies undertaken:

3.4 Comments (Please add any comments regarding chapter 3)

See enclosure 4

Ch 3.3-3.4

3.3.5 Part 4 – Mitigation measures

3.3.5.1 Chapter 4.1, 4.3

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 4: Mitigation Measures; 4.1 Outline of common mitigations

Project: Kokkoniva

4.1 and 4.3 Outline of common mitigations/Reasons for successful and not successful mitigations (4.2 see next form) Note: This form is dependent on the information given in part 3.1

Location: Downstream Area Env Type: Aquatic Ecology
 Activity: Altering Long-term River Flow Env Comp: Fish migration
 Impact: Change in Ecosystem Community Po Show 6/10

4.1 Mitigation measures undertaken	Comment to OTHER	General char. of success	Impact on power output	Cost of mitigation in %	4.3 Success reason	Suggested improvements
Fish Protection		High	None	5	Vigorous by water quality	Co-operation with local I
Fish Protection		Indirect	None		Electric fence works well	None

Dr 4.1, 4.3

3.3.5.2 Chapter 4.2, 4.4

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 4: Mitigation Measures; 4.2 Documentation, 4.4 Comments

Project: Kokkoniva

4.2 Documentation (mitigation measures) Note: This form is dependent on the information given in part 4.1

Location: Downstream Area Author: Jari Anttonen Documentation: Keywords: Documented in Reported by:
 Activity: Altering Long-term River Flow
 Impact: Change in Ecosystem Community Po
 Env Type: Aquatic Ecology
 Env Comp: Fish migration
 Mit. Meas: Fish Protection
 Show 1/2

Next Mitigation Measures

4.4 Comments (Please add any comments regarding chapter 4)

No comments

Dr 4.2, 4.4

3.3.6 Part 5 – Regulatory approval process

3.3.6.1 Chapter 5.1.1 – 5.1.3

IEA, questionnaire: Environmental Impact of Hydropower Projects

Part 5: Regulatory approval Process

Project: Kokkoniva

5.1.1 Please enclose a scheme describing the regulatory approval process for this project. If such scheme is not available, please fill in the table below.

Regulatory authorities involved	Brief description of the involvement
The Water Rights Court	Inspection proceedings (see figure and enclosure 5)
The Supreme Administrative Co	

5.1.2 How long did regulatory approval take from final submission of the assessment to the regulatory authorities? 2-5 years

5.1.3 What, if any, conditions of mitigation measures undertaken, were imposed by the regulatory authorities? Also fill in the right column if the measure was suggested by others than the regulatory authorities.

Imposed mitigation measure	Imposed by (regulatory authorities)	Suggested by
Financial compensation	The Water Rights Court	
Erosion control	The Water Rights Court	
Minimise the construction work	The Water Rights Court	

5.1.4 Please describe any project design changes as a consequence of assessments of plans.
 The headwater level was lowered by one metre from the preliminary plan to save the Suurvaikio village.

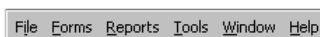
Dr 5

3.4 Outline of used environmental components

Shows used environmental components for selected project:

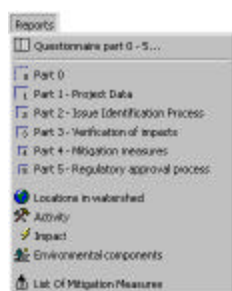


4 Reports menu

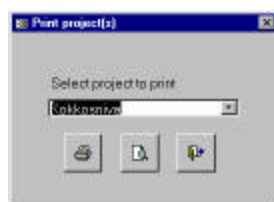


4.1 General

For details print the reports for the example database (IEAExmpl.mda).



4.2 Questionnaire



4.2.1 Questionnaire part 0 – 5

For details print the reports for the example database (IEAExmpl.mda).

4.2.2 Part 0 – Introduction

For details print the reports for the example database (IEAExmpl.mda).

4.2.3 Part 1 – Project data

For details print the reports for the example database (IEAExmpl.mda).

4.2.4 Part 2 – Issue identification process

For details print the reports for the example database (IEAExmpl.mda).

4.2.5 Part 3 – Verification of impacts

For details print the reports for the example database (IEAExmpl.mda).

4.2.6 Part 4 – Mitigation measures

For details print the reports for the example database (IEAExmpl.mda).

4.2.7 Part 5 – Regulatory approval process

For details print the reports for the example database (IEAExmpl.mda).

4.3 Other reports

4.3.1 Locations in watershed

The “Locations in watershed” report shows the different location-types for chapter 3.

4.3.2 Activity

The “Activity” report shows the different activity-types for chapter 3.

4.3.3 Impact

The “Impact” report shows the different impact-types for chapter 3.

4.3.4 Environmental components

The “Environmental components” report shows the different environmental component-types for chapter 3.

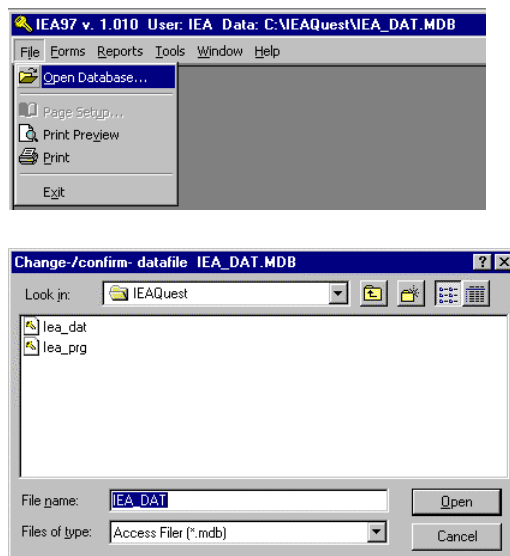
4.3.5 List of mitigation measures

The “List of mitigation measures” report shows the different mitigation measures-types, with comments and examples, for chapter 4.

5 Returning/receiving Questionnaire (project data) to/from NVE

5.1 Returning Questionnaire to NVE

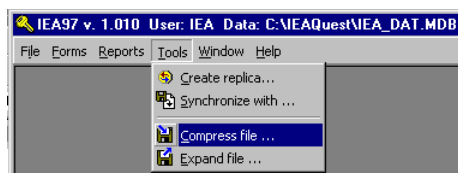
Start IEAQuest and open the database, with the project(s) to return to NVE, as shown below:



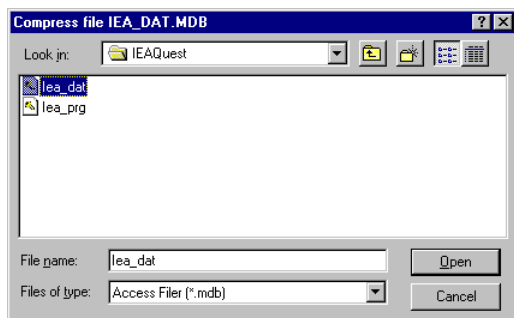
When you have selected the project, the data file name is indicated on the title line (here: C:\IEAQuest\IEA_DAT.MDB):



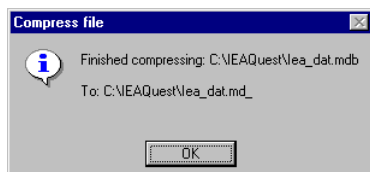
Select Tools -> Compress file:



Select the data file to compress (here: C:\IEAQuest\IEA_DAT.MDB):



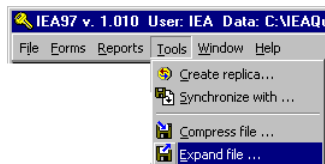
Select the name to compress the data file (here: C:\IEAQuest\IEA_DAT.MD_):



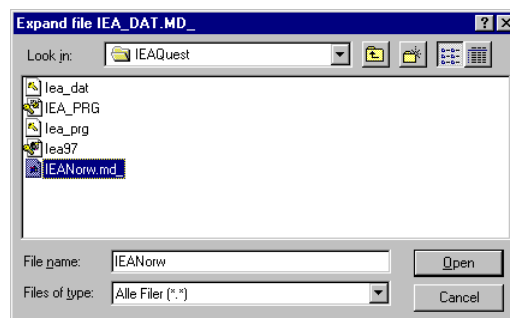
Send the compressed file (here: C:\IEAQuest\IEA_DAT.MD_) to NVE.

5.2 Receiving Questionnaire from NVE

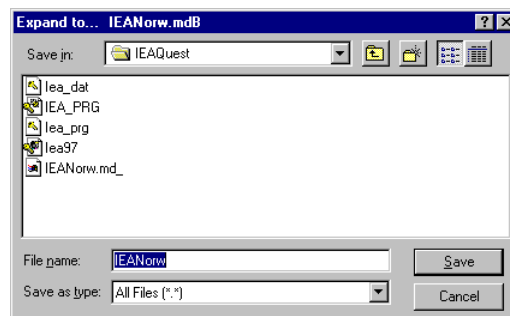
Copy the received file to the IEA Questionnaire catalogue (here: C:\IEAQuest). Start the IEA Questionnaire program and select Tools -> Expand file:



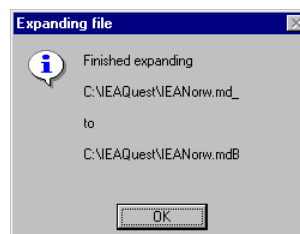
Select the received file (here: C:\IEAQuest\IEANorw.md_):



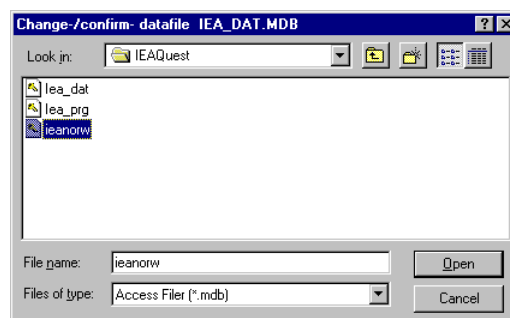
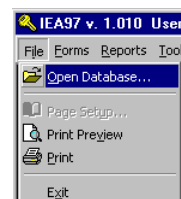
Select the name to expand the file to:



The file was expanded to:

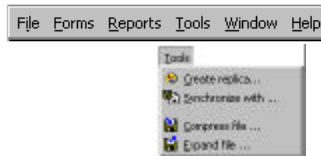


Select File -> Open database to open the received project(s):



And wait until the program has finished re-linking the project database.

6. Tools menu



6.1 Replication/synchronising

Replication enables users at different locations to easily share the changes they are making to a database. It has many practical uses. In the IEA Questionnaire this is used to exchange data between the different users and NVE's master database.

Replication/synchronising can only be done at NVE.

6.1.1 Create a replica

A replica can only be created when the master database is open and the master database is located at NVE.

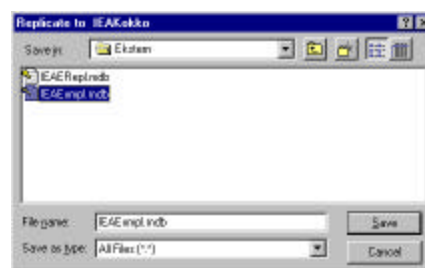
1. Open the master database (IEA_DAT.MDB)
2. Select Tools -> Replicate
3. Select One project, Empty project or All projects:

Project	Country	Area
All projects		
EMPTY REPLICAs		
Kokkonen	Finland	Kemijoki
Change file		

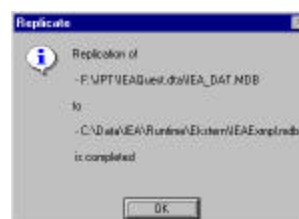
4. Select the Replicate button:



5. Select where and the name of the replica:



6. The replication is finished:



6.1.2 Synchronise a replica

Synchronisation is the process of updating two members of a replica set by exchanging all updated records and objects in each member. Two members are synchronised when the changes in each member have been applied to the other member.

Synchronisation can only be done when the master database is open and the master database is located at NVE.

1. Open the master database (IEA_DAT.MDB)
2. Select tools -> Synchronise with
3. Find the file:



4. Synchronising is finished:



6.2 Compress/expand file

6.2.1 Compress file

To save space, the database files can be stored in a compressed format.

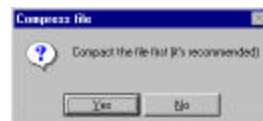
1. Select Tools -> Compress file
2. Select the file to compress and confirm with the Open button:



3. Compress the selected file to <filename>:



4. Compacting the file first is recommended:



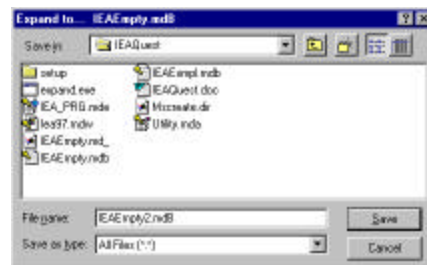
3. Done:

6.2.2 Expand file

1. Select Tools -> Expand file
2. Select the file to expand and confirm with the Open button:



3. Expand the selected file to <Filename>:

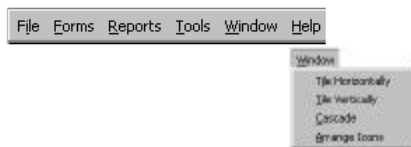


4. Done:



7 Other

7.1 Window menu



7.2 Help menu



7.2.1 About IEA



8. Appendix

8.1 System maintenance

8.1.1 Security

8.1.1.1 Workgroup Administrator (WrkGAdm.exe)

To join a Microsoft Access workgroup

1. Exit Microsoft Access.
2. To start the Workgroup Administrator, do one of the following, depending on which operating system you are using:
 - If you are using Windows 95, use My Computer or Windows Explorer to open the System subfolder in the Windows folder, and then double-click Wrkgadm.exe.
 - If you are using Windows NT Workstation 4.0, use My Computer or Windows Explorer to open the System32 subfolder in the WinNT folder, and then double-click Wrkgadm.exe.
 - If you are using Windows NT Workstation 3.51, open Program Manager, and then double-click the Workgroup Administrator icon in the program group where you installed Microsoft Access.
3. In the Workgroup Administrator dialog box, click Join.
4. Type the path and name of the workgroup information file that defines the Microsoft Access workgroup you want to join, and then click OK, or click Browse and then use the Select Workgroup Information File dialog box to locate the workgroup information file.
5. The next time you start Microsoft Access, it uses the user and group accounts and passwords stored in the workgroup information file for the workgroup you joined.
6. Important:

If you are setting up user-level security and need to make sure that your workgroup and its permissions can't be duplicated, you should make sure the workgroup information file that defines the workgroup you are joining has been created with a unique workgroup ID (WID). If such a workgroup information file doesn't exist, you should create one. For information on creating a new

workgroup information file, click.

Note:

You can also specify a workgroup information file when starting Microsoft Access by using the /wrkgrp command-line option. For information on using start-up command-line options, see the MS Access documentation

8.1.1.2 Workgroup

8.1.1.3 Workgroup information file

The file IEA97.mdw is used as the workgroup file in IEA Questionnaire and if the file is damaged or deleted, then you have to re-install IEA Questionnaire.

8.1.2 User and group accounts

8.1.2.1 General

To use IEA Questionnaire you have to log on with the correct user/password, for more information contact NVE.

8.1.2.2 Create new groups

Contact NVE.

8.1.2.3 Create new users

Contact NVE.

8.1.3 Compress/repair data files

Contact NVE.

Appendix 18: The IEA questionnaire developed for Annex III; “Environmental Impacts and Hydropower”; paper version

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