SCIENCE EVALUATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE LOWER CHURCHILL HYDROELECTRIC GENERATION PROJECT TO IDENTIFY DEFICIENCIES WITH RESPECT TO FISH AND FISH HABITAT

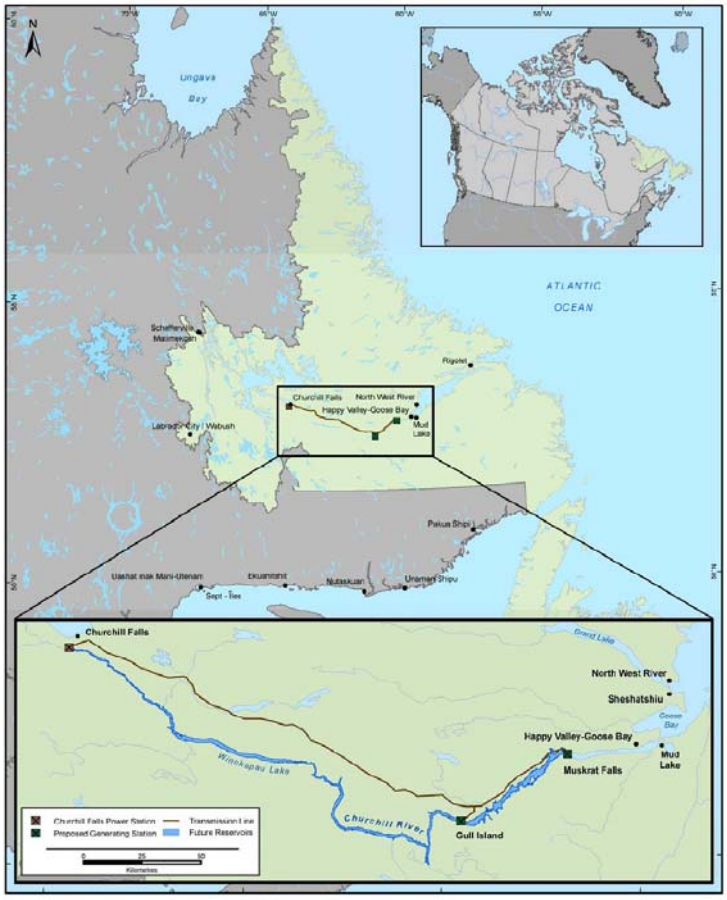

Figure 1: The Lower Churchill Hydroelectric Project (Source: Nalcor Energy 2009, Lower Churchill Project EIS).

Context :

Nalcor Energy has proposed to develop the remaining hydroelectric potential on the Churchill River, Labrador. The proposed project will include the construction of two dams and associated generating stations; one at Gull Island and the second at Muskrat Falls. The construction of these facilities will alter the aquatic environment of the river, below Churchill Falls, as well as the receiving environment (i.e., Lake Melville). This alteration will impact on fish and fish habitat thus making the Department of Fisheries and Oceans (DFO) a responsible authority under the Canadian Environmental Assessment Act (CEAA).

Oceans, Habitat and Species at Risk Branch (DFO) have requested that Science Branch (DFO) provide a review of the information contained in the Environmental Impact Statement (EIS) provided by Nalcor Energy on the Lower Churchill Hydroelectric Generation Project. This information will be provided to

Oceans, Habitat and Species at Risk Branch to help form part of the Department's response to overall adequacy of the EIS as assessed against the guidelines which have been agreed upon by the Government of Canada and the Government of Newfoundland and Labrador. This review evaluated:

1. *The methods used within the descriptions and/or predictions of the aquatic environment.*
2. *The assumptions associated with each methodology, to ensure they are adequately identified and described.*
3. *Any models used for predictions, making sure the level of uncertainty was appropriately described and to ensure precaution has been applied.*

A meeting of the Review of the Lower Churchill Hydroelectric Generation Project was held in St. John's, NL on April 20-21st, 2009 to deal with the above request. Participants included DFO scientists, DFO Oceans, Habitat and Species At Risk Branch, DFO CSAS NHQ, representatives of the Provincial government, representative from the Nunatsiavut government, retired DFO experts, representatives of HATCH, AMEC Earth & Environment, the Torngat Wildlife, Plants & Fisheries Secretariat and representatives of Nalcor.

SUMMARY

- The exclusion of the receiving environment below Muskrat Falls, including Lake Melville from the project description within the EIS was viewed as a major deficiency.

- Additional effort is required to document local knowledge of fish use and fish habitat, especially in addressing the area below Muskrat Falls, including Lake Melville.

- The magnitude of expected 'Changes to fish habitat' and fish populations needs to be considered relative to the 'Loss of fish habitat'. The area of altered habitat is considerably larger than the area of lost habitat, and has the potential to have a more significant impact on the ecology of fishes of the Lower Churchill system.

- Predictions that the new reservoirs will 'advantage' certain species and 'disadvantage' others are not well described in the current documentation.

- There is uncertainty that the resultant reservoirs will exhibit a similar fish habitat usage pattern as is presently described for Winokapau Lake, especially in the stabilization period.

- Limitations, assumptions and uncertainty must be clearly stated and incorporated into the final assessment. It is not necessary to list all analytical information within the EIS overview documents but it is necessary to supply enough information to allow an informed reader to refer to such analysis, especially when broad statements on potential impacts are being made.

- A description of future monitoring programs has not been well described in the current EIS documents. This was a requirement of the EIS guidelines and these monitoring programs should include monitoring objectives, schedules, sampling design as well as spatial and temporal coverage for each monitoring parameter.

- Although specifically stated as '*required mitigation measures*' within the EIS guidelines, neither an '*instream flow needs assessment'* during reservoir filling and operation or a '*fish habitat compensation strategy'* was presented in the EIS.

- The hydrological regime of the expected Gull Island reservoir needs to be modeled. This modelling is required in order to make any predictions regarding future productivity of this area possible. This information is also required for predicting elevated mercury concentrations.

- A number of the component studies used to describe the aquatic environment had small sample sizes and were limited both in spatial and temporal coverage. These limitations add an increased level of risk and uncertainty of any predictions or analysis based on these data.

- Fish passage was not assessed for Muskrat Falls either through a directed study or other biological indicators of fish movement. Isotopic data in the mercury analysis may be used as a first step.

- There are a number of uncertainties associated with using the La Grande hydroelectric system to predict potential changes within the Lower Churchill system. A more robust comparison could be made by using more than one large reservoir system from north temperate areas with a variety of flushing rates and morphological features which are more similar to the Lower Churchill.

- Potential cumulative effects within the aquatic environment were not well addressed in the EIS. In addition, potential interactions with climate change, based on regional models that have been developed for Labrador (i.e. extreme events in spring/fall) were not presented.

- The impact of direct fish mortality from turbine operations was not addressed in a population context.

- The description of the aquatic environment would have benefited by consistently presenting information required to evaluate potential project related effects on a species-by-species basis, and, by the inclusion of an 'ecosystem overview synthesis'.

BACKGROUND

Nalcor Energy is proposing to develop the remaining hydroelectric potential on the Churchill River, Labrador. The proposed project will include two dams with associated generating stations. The first of these sites is proposed to be built at Gull Island which will consist of a 99 m high dam creating a reservoir of approximately 215 km^2 in surface area and 200 km long. The full supply level of this reservoir will be 125 m above sea level with a generating capacity of approximately 2000 MW. The second site is proposed to be at Muskrat falls and will consist of two dams, 33 m and 29 m high, respectively, and will create a reservoir of approximately 41 km^2 in surface area and 60 km long. The full supply level of this site will be 39 m above sea level with an approximate generating capacity of 800 MW.

The construction of these generating facilities, their resultant reservoirs and the operation of the hydroelectric projects will alter the aquatic environment of the Churchill River. This alteration as well as the habitat lost due to the footprint of the dams has the potential to harmfully impact fish and fish habitat, thus making the Department of Fisheries and Oceans (DFO) a responsible authority under the *Canadian Environmental Assessment Act.*

ASSESSMENT

A peer review meeting was held on April 20 and 21, 2009 to discuss the descriptions and predictions pertaining to the aquatic environment that are contained within the EIS for the development of the Lower Churchill Hydroelectric Generation Project. The review was conducted using the information contained in the main EIS documents (Volume 1, Project Planning and Description; Volume 2, Biophysical Assessment; Volume 3, Socio-Economic Assessment and the Executive Summary) as well as the Aquatic Component Studies. The component studies were reviewed under four major themes within the meeting:

1) Fish and Fish Habitat (Table 1);
2) Mercury (Table 2);
3) Hydrology (Table 3);
4) Water Quality and Quantity (Table 4).

A fifth discussion topic within the review meeting focused on cumulative impacts and interactions between the various components of the aquatic environment.

The main purpose of this review was to evaluate the science behind these descriptions and predictions to outline any deficiencies in this documentation. It is important to note that this review focused on the documentation as it was submitted to the Panel. Information developed by the proponent since submission was not directly reviewed. The deficiencies were assessed against the EIS guidelines agreed upon by the Government of Canada and the Government of Newfoundland and Labrador for this project. This CSAS Science Advisory Report is a product of the scientific review and deliberations at that meeting.

Table 1: Component Studies Reviewed in the Fish and Fish Habitat Theme.

Report #	Title	Authors
1	Aquatic Vegetation Study.	AMEC Earth and Environmental Ltd. 2008
2	Seal Abundance and Distribution.	Sikumiut Environmental Management Ltd. 2007
3	Habitat Quantification.	AMEC Earth and Environmental Ltd. and Sikumiut Environmental Management Ltd. 2007
4	2006 Fish and Fish Habitat Baseline Study: Catch-based Utilization Index Validation and Additional Habitat Surveys.	AMEC Earth and Environmental Ltd. 2007
5	HADD Determination Methodology Churchill River, Labrador.	AMEC Earth and Environmental Ltd. 2001
6	Biological Study of the Goose Bay Estuary.	Jacques Whitford 2001
7	Fish Migration and Habitat Use of the Churchill River.	Jacques Whitford 2000
8	Fish and Fish Habitat.	AGRA Earth and Environmental 1999
9	Primary Productivity and Plankton Biomass.	Jacques Whitford 1999
10	Benthic Invertebrate Study of the Churchill River.	Jacques Whitford 1999
11	Lower Churchill River Fish Consumption and Angling Survey.	Minaskuat Inc. 2009

Table 2: Component Studies Reviewed in the Mercury Theme.

Report #	Title	Authors
1	Assessment of the Potential for Increased Mercury Concentrations.	Tetra Tech Inc. 2008
2	Calculation of Anticipated Consumption Advisory Levels of Fish in the Lower Churchill Area.	Minaskuat Inc. 2008
3	Existing Mercury Concentrations in Osprey and Ecological Risk Assessment.	Minaskuat Inc. 2008
4	Statistical Analysis of Mercury Data from Churchill Falls (Labrador) Corporation Reservoirs.	Jacques Whitford 2006
5	Freshwater Fish Mercury Sampling.	AMEC Earth and Environmental Ltd. 2000

Table 3: Component Studies Reviewed in the Hydrology Theme.

Report #	Title	Authors
1	Bank Stability Study.	AMEC Earth and Environmental Ltd. 2008
2	Salt Water Intrusion 3D Model Study, including Addendum 1.	Hatch 2008
3	Hydraulic Modeling of River.	Hatch 2008
4	Ice Dynamics of the Lower Churchill River.	Hatch 2007
5	Further Clarification and updating of the Ice Dynamics Report.	Hatch 2008
6	Aquatic Environment in the Goose Bay Estuary.	AMEC Earth and Environmental Ltd. 2001
7	Sediment Plume Analysis.	Hatch 2008

Table 4: Component Studies Reviewed in the Water Quality and Quantity Theme.

Report #	Title	Authors
1	Water and Sediment Modeling in the Lower Churchill River.	Minaskuat Inc. 2008
2	Water and Sediment Quality in the Lower Churchill River.	Minaskuat Limited Partnership 2007
3	Sedimentation and Morphodynamics Study.	Northwest Hydraulic Consultants 2008
4	Water and Sediment Quality of the Churchill River.	Jacques Whitford 1999
5	Water Quality and Chlorophyll Study.	Jacques Whitford 2000

Deficiencies

Lake Melville

The exclusion of the area below Muskrat Falls including Lake Melville was highlighted as a deficiency of the EIS by all participants of the meeting. The impoundment of the Churchill River at Gull Island and Muskrat Falls would reasonably be expected to affect the area within the estuary. Potential changes noted by the reviewers were wide ranging but included changes to sediment delivery and transport within this area, which could lead to a change in physical habitat affecting fish resources. Flow patterns, nutrient concentrations and temperature changes could also be possible in the estuary and Lake Melville and these physical changes could affect the overall productivity in the area. Several fish species are known to have important life history stages requiring habitats in Lake Melville. It was also noted that mercury levels could be increased in this receiving environment by downstream passage of food items (both fish and invertebrates) from the reservoirs. The oceanographic and hydrological models provided in the component studies are not adequate to assess responses of the estuary to interruption of freshwater input from the Churchill River or the longer term consequences of changes to water, sediment and dissolved nutrient delivery. Finally, project related socio-economic factors will likely have wide ranging biological consequences by changing the pattern and level of fisheries and marine mammal resource use in the whole region. Since this area was not covered by the current EIS, it was suggested that a through survey of traditional and local knowledge pertaining to fish and fish habitat be conducted for this entire area. This survey should be conducted within both the aboriginal and non-aboriginal communities.

Limitations, assumptions and uncertainty

Section 2.5 of the EIS Guidelines (Governments of Canada and Newfoundland and Labrador 2008) state that this environmental assessment will adhere to the Precautionary Principle. Two of the tenets listed within this section are 1) the project will '*outline assumptions made about the effects of the project and approaches to prevent and minimize these effects*' and 2) will '*identify where scientific uncertainty exists in the predictions of the environmental effects of the project*'. The reviewers within this meeting felt that there were a number of broad statements on potential impacts to fish and fish habitat within the main EIS documents that were not linked to the underlining limitations, uncertainties and assumptions of these predictions. While it was not deemed necessary to list all such information within the EIS overview documents, it was considered essential to supply enough information to allow an informed reader to find this analysis among the Component Studies if such existed.

The following are a number of specific statements that were presented to the meeting regarding limitations, assumptions and uncertainty that pertain to the fish and fish habitat sections of the EIS:

- There is uncertainty that the resultant reservoirs post project will exhibit similar fish habitat usage patterns as is currently observed in Winokapau Lake, especially in the stabilization period. This assumption partly forms the basis of fish usage predictions and needs to be addressed via future monitoring programs which have not been well described in the EIS.

- Sample sizes were low for a number of fish and invertebrate species within the quantification documents. This was also the case for other forms of biological data within these same documents (i.e. aging, length and weight), while diet information, which is particularly important in understanding trophic relationships and interactions, was largely presented in broad categories (e.g. fish, aquatic invertebrates). Additionally a large number of the component studies were very limited in their spatial and temporal coverage. These included baseline analysis of sediment dynamics, water quality, primary production and plankton dynamics as well as macroinvertebrates. These low sample sizes and limited spatial and temporal scope add a heightened level of risk and uncertainty to any predictions or analysis based on these data. This again is an important area to follow through with monitoring programs which hopefully will be started before the project begins to allow for some description of inter-annual variation in these parameters.

- With respect to the use of mean catch-per-unit effort within the fish habitat quantification methodology, the intent of using the upper 95% confidence limit (CL) was understood. However, catch data are usually not normally distributed, as noted in this section. Fish distribution is often contagious, not random. Although the authors 'assumed that the 95% CL estimated for the samples is representative and valid for purposes of calculating catch per unit effort index (CUI) values', this assumption needs to be tested and validated for all habitat types. As it stands, this assumption results in uncertainty. Another possibility would be to use transformed catch data (e.g., log (x+1)). CLs from re-transformed data would be greater than CLs from untransformed data and may supply more confidence.

- There were a number of reservations with using the La Grande hydroelectric system to predict potential changes within the Lower Churchill system. A more robust comparison may have been made by using more than one large reservoir system from north temperate areas. Ideally, these reference systems would have a variety of flushing rates and morphologies, thus a more realistic estimation of post impoundment conditions could be made for the Lower Churchill reservoirs.

- The hydrological regime of the Gull Island reservoir once filled and operating needs to be modeled. This modelling is required to make any predictions regarding future productivity of this area possible. Productivity of this area will be largely affected by the hydrodynamics of the reservoir, including its flushing rate. This flushing rate and where the water will be drawn from within the water column by the turbines will affect nutrient availability, sediment transport, plankton dynamics and ultimately the overall production of this area of the Lower Churchill River. Flushing rate is also one of the key parameters used to predict the elevation of mercury in fish after impoundment.

- Apart from a discussion of the influence of fish mortality through the turbines on downstream mercury levels for low trophic level fish, downstream consequences of reservoir creation for mercury in fish are not considered by the EIS. The creation of the Smallwood Reservoir resulted in elevated mercury levels in fish throughout the Churchill River system and in some important prey species in the estuary. The Lower Churchill project is expected to similarly affect mercury levels in riverine and estuarine fish.

- The salt water intrusion model is only valid as far as the southern part of Lake Melville. From the magnitude of the effects predicted at the river mouth, it is inferred that there will be no significant transient effects in the Lake Melville – Hamilton Inlet system. This appears to be a logically unsound conclusion. In addition to the limited spatial coverage of the model, it is constrained to have temperature and salinity fields identical to their normal (i.e. predevelopment) values. It would thus be impossible for the model to predict any changes outside Goose Bay. Their modelling exercise does not estimate changes in the receiving basins, and is simply not applicable to the question of changes seaward from the river mouth.

- There were questions raised about the validity of the Hatch (2008a) predictions of salinity and temperature within Goose Bay. The model is validated in its barotropic model (i.e. interpretations depth independent) for sea surface elevation against observed levels in the Churchill River. It was apparently not validated in its baroclinic mode (i.e. depth dependent), so its predictions of depth varying distributions of temperature, salinity, and currents, are not scientifically defensible. There exist time series of depth profiles of currents which could be used for validation. Finally, the discussion of model boundary conditions does not indicate what conditions were used to specify velocity.

Additional Fish and Fish Habitat Issues

It was noted by this review that there was an over emphasis on the 'the creation of new fish habitat' within the project area and an under emphasis of the potential implications of 'alterations to fish habitat'. The only habitat loss acknowledged in the EIS is the footprint of the Gull Island Dam, a miniscule amount in relation to that altered. Since the area that will be altered is considerably larger than the actual area that is to be lost, it will have a great impact on the fishes within the river and the application of DFO's No Net Loss Policy (DFO 1986). Accepting that there is still a great deal of uncertainty as to how future fish habitat usage patterns will evolve (see above) this is an area that will require monitoring programs that should be adaptive through time.

Concurrent with the changes in habitat conditions in the future reservoirs, is an expectation that 'certain fish species' will be advantaged over others. These species-specific changes can be predicted using science-based methods. However, with the methods used, there is uncertainty in relative ranking of existing versus predicted species as portrayed in Table 4-16. This uncertainty should be explicit in Tables 4-15 and Table 4-16 of Volume IIA of the EIS. Ranking is not as 'cut and dry' as implied by these tables. This is an area that requires more work and is also an analysis that may inform future fish habitat compensation programs.

Fish passage at Muskrat Falls either through a directed study or other biological indicators of fish movement was not addressed. There may be some data in the Mercury component studies that may be able to indirectly address this issue, but this analysis is currently lacking. Similarly,

there is no assessment of the expected fish mortality that will occur at the two generating stations. This could be accomplished in part by providing fish mortality rates for the individual turbines to be installed, although predicting encounter probability may be difficult. Some fish movement data in the Gull Island area are available. The main objective of this analysis would be to estimate if the expected mortality could be significant from a population perspective.

Mitigation programs

Section 4.6.1 of the EIS guidelines state that mitigation measures shall be described and will include the following:

1. "Fish habitat compensation strategies"
2. "A description of the approach to determine, develop and maintain minimum flow requirements when describing measures for construction, reservoir filling and operation phases of the project".

Neither one of these expected plans were in the EIS and this was agreed to be a major deficiency. There was quite a bit of discussion around the potential effects to fish and fish habitat downstream of the Gull Island dam during reservoir filling and initial commissioning of the generating station during the review meeting. Indeed, it is possible for a substantive recruitment failure to result in this part of the watershed depending upon the final decision as to when flooding will occur and the actual time it will take. While there is no doubt that a number of alternatives exist to complete reservoir filling, it was not possible to evaluate them in the absence of the instream flow methodologies and alternatives.

Monitoring and Follow-up Programs

Section 4.6.4 of the EIS guidelines state that environmental monitoring and follow-up programs will be described within the EIS. Furthermore, it is stated that these programs should adhere to adaptive environmental management principles. Currently, these programs have not been well described for the aquatic environment. This was seen as a major deficiency as it is through these programs that a number of the data gaps and uncertainties associated with spatially and temporally limited studies that have been highlighted in this review may be improved upon.

Cumulative Impacts and Interactions

Cumulative effects within the aquatic environment were not well covered in the EIS. At a minimum, a process that lists foreseeable projects within the Lower Churchill area, including Lake Melville, should be presented in a Geographical Information System (GIS) format. This level of assessment would at least allow an evaluation of any potential hotspots for interactive impacts. It was also noted that any cumulative impact assessment of the Lower Churchill project should describe any residual effects of the Upper Churchill project, as this could be important with respect to fish mercury burdens as well as other physical parameters of the aquatic environment. A G.I.S. analysis could also be completed to map the locations of intra-project activities throughout the construction schedule. This again could be used to locate any hotspots where interactions could occur to produce negative impacts on fish and fish habitat. This type of analysis could also provide insights regarding additional mitigative measures that could be employed to reduce the potential for interactions. With any cumulative impact assessment the potential for climate change over the period of the project should be assessed. There was no such analysis done within the EIS and the application of regional models that are currently in

existence for Labrador should be applied to investigate the potential for extreme events and its potential to affect planned operational regimes.

Interactions and accumulated effects among project activities were not considered in the EIS. For example, the consequences of reservoir filling at Gull Island followed by turbine operation for fish populations between Gull Island and Muskrat Falls may be very significant. Populations decimated by low/no flow conditions may have no potential for recovery without recruitment from elsewhere resulting in a potentially fishless section of the river. A G.I.S. analysis could also be completed to map the locations of intra-project activities throughout the construction schedule. This again could be used to locate any hotspots where interactions could occur to produce negative impacts on fish and fish habitat. This type of analysis could also give insights to mitigative measures that could be employed to reduce the potential for interactions.

CONCLUSIONS

There were a number of deficiencies highlighted with the Lower Churchill EIS from a fish and fish habitat perspective within this scientific review (as listed in the Summary above). The Lower Churchill Hydroelectric Generation Project will impact fish and fish habitat within the Lower Churchill River as well as its estuary and Lake Melville. There remain a number of uncertainties as to how the new reservoir habitat will function as fish habitat and how productive these habitats will be over all.

SOURCES OF INFORMATION

DFO 1986. Policy for the Management of Fish and Fish Habitat. Department of Fisheries and Oceans. Ottawa. 28 p.

Government of Canada and the Government of Newfoundland and Labrador. 2008. Environmental Impact Statement Guidelines, Lower Churchill Hydroelectric Project, Newfoundland and Labrador Hydro. 49 p.

Nalcor Energy 2009. Lower Churchill Hydroelectric Generation Project Environmental Impact Statement, Executive Summary. Nalcor Energy Ltd. St. John’s. 63 p.

FOR MORE INFORMATION

Contact: Keith Clarke
Department of Fisheries and Oceans
Northwest Atlantic Fisheries Centre
P. O. Box 5667
St. John's, NL A1C 5X1
Tel: (709) 772-2907
Fax: (709) 772-5315
E-Mail: keith.clarke@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Newfoundland and Labrador Region
Fisheries and Oceans Canada
Northwest Atlantic Fisheries Centre
P. O. Box 5667
St. John's, NL A1C 5X1
Telephone: (709) 772-8892/2302
Fax: (709) 772-6100
E-Mail: vanessa.sutton-pande@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2009. Science Evaluation of the Environmental Impact Statement for the Lower Churchill Hydroelectric Generation Project to Identify Deficiencies with Respect to Fish and Fish Habitat. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/024.