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JOINT REVIEW PANEL

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IR# JRP.76 to JRP.104

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Volume 3

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IR# JRP.76

Social-economic Impact on Mud Lake

Requesting Organization – Joint Review Panel **Information Request No.: JRP.76**

Subject - Social-economic Impact on Mud Lake

References:

EIS Guidelines, Section 4.4.4.4 (Description of the Existing Environment – Land and Resource Use), Section 4.4.4.6 (Description of the Existing Environment – Communities), Section 4.4.5 (Component Studies), Section 4.5.1 (Environmental Effects – General)

EIS Volume III, Section 5.5.5.2 (Environmental Effects Analysis and Effects Management – Operation and Maintenance)

Hatch Ltd. 2008. *Further Clarification and Updating of the 2007 Ice Dynamics* Report. Prepared for Newfoundland and Labrador Hydro, St. John's, NL

Related Comments / Information Requests:

CEAR # 163 (D. Raeburn)
CEAR # 164 (Unidentified)
CEAR # 174 (V. Kerby)
CEAR # 175 (M. Broomfield)
CEAR # 183 (Central Labrador Environmental Action Network)
CEAR # 193 (Mud Lake United Church Women)
CEAR # 198 (G. Davis)
CEAR # 204 (S. Felsberg)

IR # JRP.71, 96

Rationale:

The EIS Guidelines require the Proponent to describe relevant land and resource use within the study area, including current winter travel patterns on the river. Section 4.5.1 of the guidelines, p.33 states that the Proponent "… shall describe effects on the navigability and the navigation patterns of all waters existing, altered or created by the Project … Particular attention should be paid to traditionally-used patterns to and from Mud lake …" Section 4.4.5 "Component Studies" p.31 indicates that "Component Studies shall be prepared for at least the following VECs: … (k) Socio-economics".

The EIS mentions that, while residents of Mud Lake are particularly dependent upon river ice for winter roads, ice modelling predictions have concluded that adverse environmental effects on river travel are not anticipated and simulations have shown "a potential delay of two weeks for ice formation at the 15 to 20 km mark of the river" (Volume III, p. 5-19). The delay could potentially be longer farther upstream. A number of people commenting on the EIS suggest that the Project will have a significant impact on the timing of ice formation and the structure of the ice formed, which will adversely impact safe winter travel on the ice. The submission suggests that this will result in much longer delays in when residents will be able to safely use the river (ice bridge) for winter travel. Winter travel on the river is critical to the resident's of Mud Lake in their day to day lives, such as work schedules, receiving medical services or more mundane tasks such as grocery shopping.

Throughout the EIS, the community of Mud Lake is grouped with Sheshatshiu when describing the current socio economic circumstances; this is done despite the fact that these two communities are quite different and will be affected differently by the Project. This point was raised by a number of public submissions.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.76**

Information Requested:

The Proponent is asked to provide:

a. **disaggregated baseline socio-economic information for the communities of Mud Lake and Sheshatshiu as described in section 4.4.4.6 of the Guidelines; and**

Response:

Baseline information on Mud Lake from Statistics Canada is only available as aggregated with Sheshatshiu. Please refer to the EIS, Volume III, Section 2.2, page 2-4, which states: "It should be noted that Statistics Canada data combine information for Sheshatshiu (approximately 1,050 people; Newfoundland and Labrador Statistics Agency/Community Accounts 2008, Internet site) with the much smaller community of Mud Lake (approximately 60 people), and few disaggregated data are available; this may mask differences between the communities."

This aggregation of Statistics Canada population, labour and housing Census data for the two communities has no effect on prediction consequences for either of them or for Upper Lake Melville as a whole. It does affect the baseline description for some socio-economic parameters. For other baseline data, Mud Lake is described separately from Sheshatshiu; see, for example, pp 2-28 to 2-32 (regarding municipal and regional infrastructure and services), p. 2-35 (education), 2-43 (health care), 2-59 (hunting), 2-63 (trapping), 2-67 (fishing), 2-70 (travel on the Churchill River), 2-77 (municipal governance) and 2-78 (land and resource use by community).

Because disaggregated baseline data are not available from Statistics Canada, a population and housing census of Mud Lake would be required to establish baseline data specific to that community. This would present other challenges because it would not produce a baseline directly comparable to that for other communities due to timing and methodological differences, and the small sample size would present privacy concerns.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.76**

Information Requested:

The Proponent is asked to provide:

b. **detailed socio-economic assessment of how the Project will affect the residents of Mud Lake, during both construction and operation of the Project; this should include a full description of how the Project will impact the day-to-day lives of the residents (positive and negative, direct and indirect, and short and long term impacts).**

Response:

An assessment, for each of the socio-economic VECs, of how the Project will affect the residents of Mud Lake during construction, and operation and maintenance is provided below. This is followed by a table summarizing the positive and negative, direct and indirect, and short and long term effects. The day-to-day lives of residents of Mud Lake will be affected in much the same way as residents of other communities in the Upper Lake Melville area, although the effects will generally not be as pronounced as those in other communities due to its separation from them and its small size and associated limited range of businesses and services. There will be both positive (e.g., employment and business opportunities) and adverse effects (e.g., reduction in wildlife habitat upstream of Muskrat Falls). Residents of Mud Lake are dependent on the ice for winter roads and on the river for transportation in the ice-free season, but significant adverse environmental effects on river travel by Mud Lake residents are not anticipated. The adverse effects on Land and Resource Use above Muskrat Falls will be similar as the effects that other area residents will experience. There will be little effect to Land and Resource Use downstream of Muskrat Falls, which is the area of the Churchill River that residents of Mud Lake use the most.

Economy, Employment and Business

Some direct, indirect or induced employment benefits to residents of the community of Mud Lake will be experienced. As is described in Volume III, Sections 3.6 and 3.7, the Upper Lake Melville area will experience additional employment and business activity, and some in-migration, during construction and to a lesser extent operation and maintenance. Economic, Employment and Business benefits to Mud Lake will be small given the community's limited range of businesses and services and its relative isolation from the rest of Upper Lake Melville and centres of Project activity (Mud Lake is not directly connected to the local or regional highway network). Its relative separation from the rest of the area also makes it very unlikely that Mud Lake will experience Project-related in-migration, or that it will experience much by way of Project-related spin-off benefits, such as the spending of Project workers.

Physical Infrastructure and Services

The community of Mud Lake will not be directly affected by Project activities at Goose Bay Airport and the Port of Goose Bay, or the resultant increased road traffic within Happy Valley-Goose Bay or on regional highways.

As was noted above, it is very unlikely that Mud Lake will experience Project-related in-migration with the associated demands for local roads, water, sewerage, landfill, power and communications infrastructure and services. Given the relative isolation of Mud Lake, it is very unlikely there will be new Project-related demands for commercial industrial land within the community. The use of the river for access by boat and snowmobile is discussed in the Land and Resource Use section below.

Social Infrastructure and Services

In-migration is likely to be the principal driver of any socio-economic effects resulting on Social Infrastructure and Services. As it is very unlikely that Mud Lake will experience Project-related in-migration, there will be very few or no effects on the demand for education infrastructure and services, on housing and accommodations, or on any other community Social Infrastructure and Services within the community. In those cases where Mud Lake residents use Social Infrastructure and Services elsewhere in Upper Lake Melville, they will experience the same effects as the residents of other communities.

Community Health

The main Project driver with the potential to affect Community Health in the Upper Lake Melville area is employment, either that associated with the Project itself or generated by Project expenditures. The potential socio-economic effects will be experienced by local residents involved in the Project, or as a result of in-migration and worker-community interactions. Only a small number of Mud Lake residents are likely to realize indirect benefits, given the community's relative isolation from the rest of Upper Lake Melville and centres of Project activity. It is very unlikely that Mud Lake will experience Project-related in-migration. Mud Lake's relative isolation also makes it unlikely that there will be negative worker-community interactions in Mud Lake. As such, the Project should have few or no effects on Community Health in Mud Lake, through any effects on: income, employment and social status; health services; personal health practices and coping skills; healthy child development or social environments and social support networks.

In the case of Physical Environment, residual adverse effects to human health resulting from elevated mercury levels will be mitigated through the effective development and posting of consumption advisories for fish caught in the lower section of the Churchill River. Please refer to the response to IR# JRP.78 and IR# JRP.79.

Land and Resource Use

Land and resource use is an important component of the day-to-day lives of most residents of Mud Lake, and includes hunting, fishing, trapping and support activities such as snowmobile and boating. Residents of Mud Lake use land and resources in and along the lower Churchill River primarily from the mouth of the river to Muskrat Falls in the winter and early spring. Primary activities include small game and waterfowl hunting, trapping, and fishing. Geese and duck are hunted along the shoreline of the Churchill River, using boats from the mouth up as far as Muskrat Falls. Trout, smelt and occasionally pike are angled from the mouth of the river to Muskrat Falls. Land and resource use activities outside of the lower Churchill River are conducted throughout the year; hunting and trapping activities mostly occur between October and June, and other activities (fishing, cabin use, boating, berry picking, wood cutting) occur during the remainder of the year. Some activities, such as small game hunting, are practised in areas that were made accessible by the Trans Labrador Highway (TLH) Phase I (grouse, ptarmigan, snowshoe hare). Caribou hunting occurs between Metchin River and Churchill Falls. Access to trout and pike angling areas is facilitated by the TLH Phase I as those species can be fished from several brooks and rivers intersected by the road between Muskrat Falls and Churchill Falls. The Traverspine River, outside the Churchill River valley is also a popular fishing area. The Churchill River downstream of Muskrat Falls is popular for boating, and is used by residents of Mud Lake to access Happy Valley-Goose Bay and other communities in the Upper Lake Melville area.

Navigation/Winter Travel

Residents of Mud Lake are dependent on the ice for winter roads and on the river for transportation in the ice-free season. Because Mud Lake is not directly connected to the regional road network, its residents must cross the river by boat in the ice-free season and by snowmobile during ice-cover. Travel on the river is dangerous during periods of ice formation and ice break-up. Passage between Mud Lake and Happy Valley-Goose Bay is therefore restricted during these periods. An ice model based on median conditions over a five-year simulation shows a potential delay of two weeks for ice formation downstream of Muskrat Falls. Although ice formation will be delayed, the duration of the ice formation period will remain approximately the same as currently exists (Hatch 2007) and adverse environmental effects on river travel by residents of Mud Lake are not anticipated.

Hunting/trapping

The impoundment of the reservoirs will result in the loss or disturbance of approximately 126 km^2 of land upstream of Muskrat Falls. The shoreline downstream of Muskrat Falls will not be affected and therefore hunting and trapping activities in this section will not be affected. The loss and alteration of wildlife habitat upstream of Muskrat Falls could result in a reduced opportunity for hunting and trapping along the Churchill River in those areas, or along the interconnecting transmission line corridor. The sustainability of game species will not be threatened and the residents of Mud Lake will be able to continue hunting and trapping activities.

As a mitigation measure for the loss of habitat due to inundation upstream of Muskrat Falls, Nalcor Energy (Nalcor) will prepare the riparian zone in each reservoir to encourage rapid development of shrubs and vegetation reflecting a natural near-shore zone, where hunting and trapping can occur. Trappers with a demonstrated continuous and successional use of a trap line will be compensated if they lose an established trap line in the reservoir (refer to the response to IR# JRP.110). It is not known if a Mud Lake resident or residents have established trap lines in the area that will be impounded.

Increased competition for resources resulting from new roads will be limited because they will be only 15 to 30 km in length as most of the 375 km of road developed for reservoir clearing purposes will be flooded during the construction phase.

Fishing

The change in fish habitat as a result of Project facilities will occur upstream of Muskrat Falls. Fish habitat downstream of Muskrat Falls, where the angling activities of Mud Lake residents are concentrated, will not be affected.

The creation of the reservoirs will lead to a net total increase in habitat available for angled species. This will comprise suitable and productive habitats for brook trout, lake trout and ouananiche. Although the construction of the Project infrastructure will represent a loss of 26 ha of fish habitat, there will be an overall creation of over 11,000 ha of fish habitat due to inundation.

Local consumption of fish could decline if there is the perception that the Project has compromised the taste or nutritional quality of fish. During operation and maintenance, mercury levels in fish are expected to increase. The mercury levels are expected to peak in 10 to 15 years, after which they will decline, approaching baseline levels within 35 years. Consumption advisories will be updated as required. The consumption advisory will be limited to the section of the river downstream from the Churchill Falls tailrace. Nalcor is currently conducting a Human Health Risk Assessment for methylmercury exposure to fish, and will make the results available upon its completion (please refer to the response to IR# JRP.78 and IR# JRP.79).

Historic and Archaeological Resources

There will be no physical disturbance in or around the community of Mud Lake, and therefore Historic and Archaeological Resources in that area will not be disturbed.

Summary

The positive and negative, direct and indirect, and short and long term effects to residents of Mud Lake are summarized in Table 1.

Table 1 Summary of Socio-economic Effects Analysis for Mud Lake

		Direct Effects[1] (Positive/Negative/ Neutral)	Indirect Effects[2] (Positive/Negative/ Neutral)	Short-term Impacts[3]	Long-term Impacts[4]
Economy		Neutral	Neutral	Neutral	Neutral
Employment		Positive: Small Increase	Neutral	Positive: Small increase	Negligible increase
Business		Neutral	Neutral	Neutral	Neutral
Physical Infrastructure and Services		Positive: Increase in access to physical infrastructure when outside of the community	Not Applicable	Neutral	Positive: Increase in access to physical infrastructure when outside of the community
Social Infrastructure and Services		Adverse/Positive	Not Applicable	Adverse/ Positive	Neutral
Community Health	**Methyl-mercury in Fish**	Not Applicable	Negative: Potential reduction in consumption	Not Applicable	Negative: Potential reduction in consumption
Community Health	**Income, employment and social status; health services; personal health practices and coping skills; healthy child development; social environment and social support networks**	Adverse/Positive	Not Applicable	Adverse/ Positive	Neutral
Land and Resource Use	**Navigation and Winter Travel**	Neutral	Not Applicable	Neutral	Neutral
Land and Resource Use	**Access to Hunting/Gathering Sites**	Positive: Increase in access to resources	Not Applicable	Positive: Increase in access to resources	Positive: Continuation of short-term impacts
Land and Resource Use	**Access to Hunting/Gathering Sites**	Negative: Reduction in natural habitat above Muskrat Falls	Not Applicable	Negative: Reduction in natural habitat above Muskrat Falls	Negative: Continuation of short-term impacts
Land and Resource Use	**Competition for resources**	Negative: Increase in competition for resources resulting from increased access	Not Applicable	Negative: Increase in competition for resources	Negative: Continuation of short-term impacts
Land and Resource Use	**Fishing**	Positive: Increase in fishing area above Muskrat Falls	Not Applicable	Positive: Increase in fishing area above Muskrat Falls	Positive: Continuation of short-term impacts
Historic and Archaeological Resources		Historic and archaeological resources will not be affected downstream of Muskrat Falls			

Notes: [1]Direct effects of Project on the community of Mud Lake.
[2]Indirect effects are the spin off or multiplier effect.
[3]Short term effects are the ones occurring during the construction phase.
[4]Long term effects are the ones occurring during the operation and maintenance phase.

Reference:

Hatch Ltd. 2007. Ice Dynamics of the Lower Churchill River. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

IR# JRP.77

Drinking Water Quality

Requesting Organization – Joint Review Panel **Information Request No.: JRP.77**

Subject - Drinking Water Quality

References:

Final EIS Guidelines – Section 4.4.4.6 – Communities

Aura Environmental Research (2008) Community Health Study

EIS – Volume III Section 2.5.3.5 – Water

Related Comments I Information Requests:

CEAR # 164 (Unidentified)
CEAR # 174 (V. Kerby)
CEAR # 198 (G. Davis)
CEAR # 171 (Health Canada)

Rationale

The EIS Guidelines indicate that the EIS should contain a discussion of drinking water sources and quality. Aura Environmental Research (2008) Community Health Study and Section 2.5.3.5 of Volume III for the EIS indicates that some communities have treated municipal water supplies and others have private wells for their drinking water.

There is no discussion about whether the surface water from the Churchill River is used or may potentially be used in the future as a drinking water supply. If it is or may be in the foreseeable future, there is no discussion about the effect the Project may have on drinking water quality.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.77**

Information Requested:

The Proponent is asked to provide information on whether the water from the Churchill River is currently used, or in the future may be used, as a drinking water supply and whether the Project would have an impact on drinking water quality (as applicable).

Response:

The surface water of the Churchill River is currently not used as a direct drinking water supply and it is unlikely that it will be used by local communities as a future source of drinking water. The Project is predicted to have no measurable effect on existing drinking water quality.

Happy Valley-Goose Bay, North West River and Sheshatshiu have piped water systems for drinking water supply. Most Mud Lake residents have ground wells that are fed by seepage from the Churchill River; however at least five residences use surface water directly from a channel in Mud Lake. Recent testing of residential drinking water in Mud Lake indicates that Mud Lake surface water sources are currently below drinking water quality standards (AMEC unpublished data).

As with other parameters such as water flow and water temperature, water quality of inflowing tributary rivers and streams of the lower Churchill River are not expected to be affected by the Project. In this respect, water quality of sources used by people who are on the land (e.g., cabins, hunting and snowmobiling) are not expected to be measurably affected.

Correspondence received from Mayor Leo Abbass indicated that the Town of Happy-Valley Goose Bay presently has no plans to use the river water as a source for drinking water. The Town currently provides water to residents from two sources; a series of five wells about 7 km up the Trans Labrador Highway (TLH) at the site of its water treatment plant and the second source coming from Spring Gulch which is on the base. Both of these sources provide the Town with more than ample supply of water. Mayor Abbass did indicate that this does not preclude the Town from revisiting its water supply sources in the future, but at this time the Town has no plans for using the water from the river for human consumption. In addition, the aquifer that is supplying fresh groundwater to the Happy Valley-Goose Bay well field is described as a leaky confined aquifer, which means that it is not directly connected to the immediate surface water system (i.e., Churchill River). The groundwater source is considered to be non-GUDI (Groundwater Under Direct Influence from Surface Water). In other words, it is not considered to be vulnerable to direct surface water influence in the immediate area of the wells that form the well field.

Happy Valley-Goose Bay, Churchill Falls and North West River also have piped sewage systems serving all dwellings and discharging untreated effluent into the Churchill River and Lake Melville. The current provincial Water Quality Index (WQI) of the lower Churchill River for drinking is ranked as "marginal" (see Newfoundland and Labrador Department of Environment and Conservation, no date). Accordingly, it is highly unlikely that the Churchill River or Lake Melville will be a future source of safe drinking water for the communities of Happy-Valley Goose Bay, North West River, Sheshatshiu and Mud Lake.

The response to IR# JRP.63 provides further discussion of the potential for Mud Lake groundwater to become contaminated with mercury as a result of the Project as well as saltwater intrusion during reservoir filling.

References:

Personal Communication:

Mayor Leo Abbass Mayor of Happy Valley-Goose Bay.

Literature Cited:

Newfoundland and Labrador department of Environment and Conservation. No date. http://www.canal.gov.nl.ca/canal/root/main/station_details_e.asp?envirodat=NF03OE0001.

IR# JRP.78

Baseline Methylmercury Exposure

Requesting Organization – Joint Review Panel **Information Request No.: JRP.78**

Subject– Baseline methylmercury exposure

References:

EIS Guidelines, Section 4.4.4.6 (Communities)

EIS Guidelines, Section 4.6.4 (Monitoring and Follow-up Programs)

EIS Volume III, Section 4.8.3 (Community Health), Section 4.9.3 (Community Health)

Related Comments / Information Requests:

CEAR # 171 (Health Canada)
CEAR # 189 (J. Airhart)
CEAR # 203 (Hydro-Québec)

IRs # JRP. 20, 21, 33, 43, 63, 66, 70, 74, 81, 82, 107

Rationale:

The EIS Guidelines indicate that baseline data of methylmercury exposure from country foods of the local human population should be completed, including a review by Aboriginal groups and appropriate government agencies, before the Proponent changes the conditions of the Churchill River in any way that could affect mercury concentrations. The Guidelines state that the Proponent shall "develop a baseline of methylmercury exposure of the local human population in general and of groups at risk, in particular children and toddlers, and women of childbearing age, which can be accomplished through dietary surveys and human hair sampling".

In Section 4.9.3 of Volume III on the follow-up of community health, the Proponent states that it will collect data from local residents (without further details) in order to establish a mercury exposure baseline for local residents. This study will be carried out prior to Project commencement. Table 4-18 presents an outline of the mercury monitoring and follow-up program, which calls for mercury levels to be verified only in fish, on an annual basis for the first 10 years following reservoir impoundment and thereafter at a frequency to be determined pending results.

Requesting Organization – Joint Review Panel **Information Request No: JRP.78**

Information Requested:

The Proponent is asked to:

a. **define the detailed program, scope, methodology, and timeframe for completion of baseline collection of mercury concentrations in local residents, indicating which communities will be part of this study;**

Response:

Nalcor Energy (Nalcor) has initiated a Human Health Risk Assessment (HHRA) to assess the potential human health risk associated with mercury exposure. The overall approach of the HHRA is to use available baseline mercury data from previous studies and to collect additional baseline mercury data by conducting a food consumption survey and hair sampling in the communities of Mud Lake, North West River, Happy Valley-Goose Bay, Churchill Falls and Sheshatshiu.

The HHRA will include the following scope of work:

- Phase 1: Review and Consultation by Government Agencies and Aboriginal groups
- Phase 2: Review and Compilation of Existing Human Mercury and Dietary Data
- Phase 3: Review, Compilation and Synthesis of Available Mercury Data as Related to the Lower Churchill Hydroelectric Generation Project
- Phase 4: Community Views Analysis
- Phase 5: Mercury Baseline Sampling
- Phase 6: Completion of Human Health Risk Assessment

Phase 1 of the HHRA involves Nalcor consulting with regulatory agencies and aboriginal communities regarding the HHRA approach and methodology. Nalcor plans to meet with representatives from Health Canada (HC), Environment Canada (EC), the Department of Fisheries and Oceans (DFO) and the government of Newfoundland and Labrador to ensure that the data to be used in support of the HHRA and the approach and methodology of the HHRA is adequate to satisfy the requirements of the EIS Guidelines. Nalcor will also lead consultations with the potentially affected Aboriginal groups to provide them with details of the study, and appropriate protocols to be followed in the collection of data within the aboriginal communities. Both government and Aboriginal groups will be provided an opportunity to comment on the study plan; updates on study activities will be provided as well over the course of the study and the resulting report will also be provided for review.

Phase 2 of the HHRA will consist of a review of all available reports and studies to extract existing information about hair mercury results and relevant exposure data related to dietary patterns and characteristics of Innu and/or non-Innu communities for use as input into the HHRA. Hair samples were collected from the Innu in Sheshatshiu in 2002 and 2003 by the Collaborative Mercury Research Network (COMERN). Nalcor hopes that Innu Nation will provide access to the results of data collected as part of this initiative. If available, this data will be reviewed and if appropriate, used in the HHRA.

In addition to the COMERN data, the following existing information will be extracted from the Lower Churchill River Fish Consumption and Angling Survey (Minaskuat 2009a) and the Current Land and Resource Use Study (Minaskuat 2009b):

- fish consumption patterns and rates;
- traditional food consumption including frequency of consumption and portions, pattern of consumption (including fish and wildlife such as caribou, seals, waterfowl); and
- variability of consumption between and within communities.

The data will be analysed, where possible, to determine whether there are any substantial differences between communities. Data from the COMERN Project will also be examined to determine whether there are differences in consumption patterns between residents of Sheshatshiu and the surrounding communities. Data permitting, data will be analyzed to identify potential gender variances in dietary patterns, and knowledge and experiences of traditional food consumption patterns.

Consumption data collected and reported by Nalcor will also be examined to characterize dietary habits of the sampled population to confirm that there are no substantial differences between communities.

If no substantial differences in dietary habits and consumption patterns are confirmed, then the populations of the five communities (Sheshatshiu, Mud Lake, North West River, Happy Valley-Goose Bay and Churchill Falls) will be treated as one population in terms of diet and consumption patterns. A sample of 300 individuals from this population will be selected as identified in Table 1. The sampling effort is roughly scaled to total population size (N). Following completion of Phase 2 of the HHRA the findings will be summarized and the sufficiency of existing data will be determined.

Table 1 Population from which Human Mercury and Dietary Data will be Sampled

Population Group	Community					
	Churchill Falls	North West River	Happy Valley - Goose Bay	Mud Lake	Sheshatshiu	Total
Total N	700	490	8000	75	1200	10465
Toddlers (1 - 4 yrs old)	10	10	20	5	15	60
Children (4 - 11 yrs old)	10	10	20	5	15	60
Teens (12-19 yrs old)	10	10	20	5	15	60
Adults (> 19 yrs old)	10	10	20	5	15	60
Childbearing	10	10	20	5	15	60
Total n	50	50	100	25	75	300
n/N	7%	10%	1%	33%	6%	3%

Notes: N = population size
n = sample size

Phase 3 of the HHRA will consist of a thorough inventory and review of all available information on mercury in the atmospheric, aquatic and terrestrial environments of Labrador as they relate to the Project. This will include a detailed review of documents related to the Lower Churchill Hydroelectric Generation Project, EIS and associated Component Studies. Additionally, historical material (published and unpublished reports, datasets) will be reviewed and included in the compilation/synthesis if they provide additional or complementary information to that included in the EIS. Other publications including those by the DFO scientists related to the project (e.g., Anderson et al. 1995, Anderson and Scruton 1997) and results of studies conducted under COMERN, the NSERC Collaborative Research Mercury Network (e.g., Canual et al. 2006) will also be integrated into the review if they are deemed relevant to the project. Baseline levels on mercury in fish tissue have also been collected as part of other environmental assessments (e.g., Voisey's Bay Mine/Mill, proposed Michelin

Uranium Mine/Mill, and others) and it will be determined if these data may be available to include in the Project.

Phase 4 of the HHRA involves gaining access to the Nalcor Issues database to review the results of past and ongoing community consultations. This information will be used to compile the views of local populations regarding mercury and its influence on the changes observed in their diet and consequently in their health in general. Issues related to foreseeable changes to resource use and consumption, cultural traditions and values due to the potential for an increase in mercury levels resulting from the Project will also be identified and discussed in the final report. It is anticipated that adequate information is available in the existing database and directed surveys will not be required.

Phase 5 of the HHRA includes a dietary survey and hair sampling from the above noted communities. The HHRA will apply the dietary survey used by researchers at the Universite de Quebec a Montreal (UQAM) as part of the COMERN study. The use of the COMERN dietary survey ensures consistency in the data collection and allows for comparability. This dietary survey will collect information on the following:

- normal dietary patterns; and
- traditional food consumption including frequency of consumption and portions, pattern of consumption (including fish and wildlife such as caribou, seals and waterfowl).

Hair samples will also be collected from each participant using same standard protocols applied during the COMERN project. Three centimetre long hair samples will be collected from each participant and will be analysed in whole for methylmercury.

After the community surveys and the analysis for hair samples have been completed, all existing and newly collected baseline mercury data will be compiled for the purposes of statistical analysis. Statistical analysis will be used to characterize the human exposure to dietary mercury using the outcomes of the dietary and angling surveys and performing the following analyses:

1. Statistical analysis of existing fish data to derive relationships between mercury concentration in fish and fish length for species of interest for human consumption;
2. Statistical analysis of diet survey data to characterize fish consumption patterns;
3. Combination of relationships between mercury content in fish with fish consumption information to determine dietary mercury intake from fish; and
4. Combination of fish-derived mercury intake with other sources to determine total dietary mercury intake.

Additional detail on these analyses is provided in IR# JRP.81b and (c).

Finally, a quantitative Human Health Risk Assessment will be completed using the findings of the above noted phases as input. The HHRA framework will include the following four basic elements: Problem Formulation, Exposure Assessment, Toxicity Assessment and Risk Characterization.

- **Problem Formulation** – This section will incorporate the findings of Phases 1 through 5 into the human health Conceptual Site Model (CSM) which explains how the study area characterization information provided was incorporated into the human health CSM and was relied upon in the preparation of the HHRA.
- **Exposure Assessment** – This is a quantitative assessment of the amount of mercury that local residents in Innu and non-Innu communities may be exposed. These communities include

Sheshatshiu, Mud Lake, North West River, Happy Valley-Goose Bay and Churchill Falls. The general routes of exposure by which receptors may become exposed to mercury include ingestion of fish and wildlife such as caribou, seals and waterfowl. Other routes of exposure, e.g. transfers through breast milk, may also be relevant as well as the cumulative effects of the contribution of these other sources will be discussed.

A baseline of methylmercury exposure will be developed of the local human population in general and of groups at risk, in particular women of childbearing age. Receptors and relevant routes of exposure will be further characterized and addressed in the HHRA, based upon the Site-specific information collected during the data review (Phases 2, 3 and 4) and hair survey analysis (Phase 5). The period deemed adequate to reduce the quantity of mercury ingested will be presented and justified and the toxicological risk, on sensitive human populations associated with the consumption of large quantities of fish considered (e.g., during a weekend of fishing).

The exposure assessment will incorporate site-specific information, where available, and will consider and utilize published exposure information obtained from the Canadian Council of Ministers of the Environment (CCME), Health Canada, U.S. Environmental Protection Agency as well as other appropriate and applicable regulations and guidelines.

- **Toxicity Assessment** – This section will identify the potential adverse effects in humans associated with mercury, and will determine the quantitative relationship between the magnitude of exposure and the probability of occurrence of a particular adverse effect, as well as the uncertainties associated with the determination. This information will provide a rationale for appropriate exposure limits based on the protection of sensitive individuals who may be exposed for long periods of time. The toxicity assessment will incorporate exposure limits and toxicity reference values obtained from Health Canada, U.S. Environmental Protection Agency and other regulatory agencies, as appropriate.
- **Risk Characterization** – This section will integrate the results of the exposure and toxicity assessments and provide an indication of the magnitude and nature of the risk, if any, associated with potential exposures to mercury. The risk characterization will also discuss the uncertainties associated with the HHRA and will help to identify other issues that may warrant further study.

  The risk characterization will include an evaluation of the contribution from different exposure routes and media to the overall risk, including a description of the nature and magnitude of the risk from each route of exposure; whether current or future levels of mercury are of potential concern to receptors; the populations and sub-populations at greatest risk; and the uncertainties associated with the overall analysis.

The timeframe for the completion of the HHRA is May 2010 assuming that community consultations with Aboriginal and non-aboriginal communities have been completed and surveys can be initiated by September 2009.

References:

Anderson, M.R., D.A. Scruton, U.P. Williams, and J.F. Payne. 1995. Mercury in fish in the Smallwood Reservoir, Labrador, twenty-one years after impoundment. Water Air Soil Pollut. 80:927-930.

Anderson, M.R. and D.A. Scruton. 1997. Return time for mercury in the Smallwood Reservoir, Labrador; trophic level versus species specific response. Pg. 22, in: Pierce, R.C. and D. Williams. Book of Abstracts: Department of Fisheries and Oceans, Green Plan Toxic Chemicals program, Wrap-up Conference, Government Conference Centre, Ottawa, Ontario, January 28-31, 1997. Can. Tech. Rep. Fish. Aquat. Sci. 2163: xiv + 93 p.

Canuel, R., S. De Grosbois, L. Atikesse, M. Lucotte, P. Arp, C. Ritchie, D. Mergler, H-M Chan, M. Amyot and R. Anderson. 2006. New Evidence on Variations of Human Body Burden of Methylmercury from fish consumption. Environmental Health Perspectives. Vol. 114, No. 2.

Minaskuat Inc. 2009a. Lower Churchill River Fish Consumption and Angling Survey. Report prepared for the Lower Churchill Hydroelectric Generation Project. St. John's, NL.

Minaskuat Inc. 2009b. Current Land and Resource Use Study. Report prepared for the Lower Churchill Hydroelectric Generation Project. St. John's, NL.

Requesting Organization – Joint Review Panel **Information Request No: JRP.78**

Information Requested:

The Proponent is asked to:

b. **provide detail on how the risks related to future mercury exposure for residents would be evaluated;**

Response:

In order to evaluate the risk related to potential future exposure to mercury by residents, it is necessary to predict/model how fish mercury levels will evolve as a result of the Project. There are two components to this task. Firstly, it is necessary to determine how the fish community may change due to flooding. This would include changes in distribution, relative abundance, size, feeding habits, and other characteristics in response to the changes in habitat quantity and quality due to impoundment. These issues have been dealt with in some depth in the EIS (Volume IIA, Sections 4.11, 4.12 and 4.13). Overall, it was predicted that there would be a net increase in overall use of available habitat, and hence in fish production, and the only species predicted to have a decrease in habitat was lake chub. The fish community was also predicted to change with, for example, whitefish predicted to become a more important part of the fish community while white sucker and northern pike were expected to become less important. This is useful information with respect to the HHRA as it provides some perspective on the future availability of fish for human consumption.

In order to predict future mercury levels in fish after impoundment, a combination of screening level regression models and assessment of trends in existing reservoirs was used (Tetra Tech 2008). Increase factors were predicted for fish mercury in the future Gull Island and Muskrat Falls Reservoirs and a number of very conservative assumptions were made. Increase factors were predicted to range from 1.12 to 1.7 (i.e. a 10 to 70 percent increase from background levels). Additional analysis in response to the IR# JRP.21 indicated that increasing peak increase factors and peak estimated fish mercury concentrations for Smallwood Reservoir to a value of 3 did not result in higher predicted fish mercury concentrations for the Project, using the regression approach presented in the EIS. The response to IR# JRP.20c evaluated available data, albeit limited, for three reservoirs that represent higher flow, lower flooding scenarios more relevant to the Project. Including data from two of three reservoirs did not result in higher predicted peak increase factors or peak fish mercury concentrations for the Project. These data provide a conservative perspective on potential increases in mercury exposure to humans in relation to fish consumption after impoundment

Nalcor plans to monitor increased levels of methylmercury in fish on an annual basis for the first 10 years following reservoir impoundment (EIS, Volume III, Section 4.9.3). In addition, methylmercury exposure of residents of Sheshatshiu, Mud Lake, North West River, Happy Valley-Goose Bay and Churchill Falls will be monitored through dietary surveys and hair sampling. The risks to future mercury exposure by residents will be evaluated by updating the HHRA using the monitoring data as input. Nalcor will work with government authorities to develop fish consumption advisories, as required.

See response to part (a) of this IR for details on the HHRA approach and methodology.

Risks related to potential future exposures to methylmercury by residents are estimated based on comparisons of probable daily intakes (based on dietary survey results) to Tolerable Daily Intakes (TDIs) developed by Health Canada. A TDI is defined as the amount of a chemical that a person can be exposed to on a daily basis over a lifetime without appreciable risk of adverse health effects. Health Canada developed a TDI for methylmercury for women of childbearing age, pregnant women, and young children of 0.2 micrograms per kilogram body weight per day (0.2 µg/kg bw/day). Health Canada employs the methylmercury TDI for adults of the general population that was developed by the Joint FAO/WHO Committee on Food Additives, which is 0.47 micrograms per kilogram body weight per day (0.47 µg/kg bw/day).

The ratio of the probable daily intakes to the TDI (expressed as a percentage) provides an indication of increased risk of adverse health effects from methylmercury exposure. Values approaching or exceeding 100 percent identify those exposure scenarios where the TDI may be exceeded and that require more careful evaluation. Other considerations that must be assessed in evaluating the risk and the degree of confidence in the assessment conclusions include the quality of the methylmercury concentration data, uncertainties in predictive modelling, if relevant, and the likelihood of possible long-term exposure to the particular source of fish, etc.

Reference:

Tetra Tech Inc. 2008. Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Assessment of the Potential for Increased Mercury Concentrations.

Requesting Organization – Joint Review Panel **Information Request No: JRP.78**

Information Requested:

The Proponent is asked to:

c. **outline how the Proponent will respond to the various possible outcomes of baseline mercury in terms of mitigation, adaptive management, changes to Project design; and**

Response:

Nalcor is not aware of any practical Project design or mitigation technique that could reduce the Project's influence on methylmercury levels in fish. Therefore, the approach to preventing unacceptable risk to human health as a result of fish consumption relates to determination and implementation of fish consumption advisories. These advisories will result from an examination of baseline methylmercury exposure and the contribution of the Project.

Requesting Organization – Joint Review Panel **Information Request No: JRP.78**

Information Requested:

The Proponent is asked to:

d. **indicate whether the Proponent plans to monitor changes in mercury concentrations in the local population within the study area and to measure changes in community health related to mercury exposure.**

Response:

Nalcor plans to monitor methylmercury levels in fish as the Project becomes operational. Findings from community health authorities and Nalcor-sponsored follow-up (e.g., mercury level monitoring) will contribute to ongoing evaluation and, as necessary, the modification of strategies designed to reduce any adverse effects the Project might have on Community Health, and the further promotion of strategies that have beneficial effects. Proposed monitoring and follow-up programs for mercury concentrations in the local population are:

- establish baseline exposure of humans to mercury; and
- verify mercury levels in fish.

IR# JRP.79

Fish Consumption Survey Results

Requesting Organization – Joint Review Panel **Information Request No.: JRP.79**

Subject - Fish Consumption Survey Results

References:

EIS Guidelines, Section 4.4.4.6 (Communities)

Minaskuat Inc (2009) Component Studies Aquatic Environment (1). Fish and Fish Habitat. Report 11 of 11: Lower Churchill River Fish Consumption and Angling Survey. p. 4-1 and p. 4-6

Related Comments / Information Requests:

CEAR # 171 (Health Canada)

IR # JRP.73, 80

Rationale:

Section 4.4.4.6 (Communities) of the EIS Guidelines state that "the Proponent shall characterize the current fishing patterns, including fishing location, frequency, and variability in consumption between communities and within a single community".

On page 4-1 of Minaskuat Inc. (2009), the document states that the Innu community of Sheshatshiu was not included in the telephone survey at their request.

On page 4-6 of Minaskuat Inc. (2009) -With respect to the survey, advertising was undertaken in two news papers, on the Project website, and on radio and television. It was not stated whether the survey was in English only or also offered in other local languages. If the survey was only in English, this may have impacted results. In addition, the advertising and the survey itself were focused on people with computers, radios, televisions and/or telephones. It was unclear what percentage of people in Central Labrador would have access to these technologies.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.79**

Information Requested:

The Proponent is asked to provide:

a. **a discussion of how the absence of information from Sheshatshiu may have affected the consumption and angling survey, and how this information will be acquired and/or accounted for when determining consumption and angling patterns on the Churchill River, Lower Churchill River and its tributaries;**

Response:

Residents of Upper Lake Melville, including the residents of Sheshatshiu, are all subject to the same angling season, limit, size and other fisheries management initiatives. Aside from a three metric tonne allocation of Atlantic salmon, no other fish quota (e.g., trout, smelt, pike and cod) is allocated to residents of Sheshatshiu as members of Innu Nation. Therefore, the absence of this specific information does not measurably affect the outcome of the consumption and angling survey.

Although this information is not required for the purposes of the survey, Nalcor Energy (Nalcor) will seek to acquire angling and consumption information for the residents of Sheshatshiu, in consultation with Innu Nation, and in accordance with the IBA currently being negotiated with Innu Nation for the purpose of characterizing current angling patterns in the lower Churchill River.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.79**

Information Requested:

The Proponent is asked to provide:

b. **information about whether the survey was offered only in English, and if so, whether this may have affected the results of the survey; and**

Response:

The survey was offered in English only. Experience with harvesting surveys in the greater Happy Valley-Goose Bay area indicates this would not substantially alter the distribution of results and its associated variation, and therefore is unlikely to result in sampling bias or error (Natcher and Felt 2008; 2009 ongoing).

References:

Natcher, David and Lawrence Felt. 2008. Atlantic salmon and arctic char harvesting patterns in Upper Lake Melville. Poster prepared for Government of Nunatsiavut.

Natcher, David and Lawrence Felt. 2009 ongoing. Resurvey of topics covered in 2007.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.79**

Information Requested:

The Proponent is asked to provide:

c. **information about the percentage of people in the survey area that would be expected to have access to electronic media (television, computer, radio) and/or would be expected to have a telephone, and whether this may have affected the results of the survey.**

Response:

The following provides a summary of known usage of television, computer, radio, and telephone by residents in the survey area.

Television

Television is available to practically all residents of the Upper Lake Melville area through either cable companies or satellite vendors. Information regarding household television ownership is not available. Television usage is estimated to be slightly lower than the island of Newfoundland for cable, but the same or slightly higher for satellite dish use. The overall gap (level of subscription for cable services) is closing on an annual basis and current estimates by marketing personnel in local cable companies place it at 10 percent. Alternate sites to households, such as community centres, schools, etc. are available along with internet access through the Smart Labrador internet initiative of both provincial and federal governments.

The access to television by residents of central Labrador would not affect the results found in the angling and fish consumption components of the survey.

Computer

In recent years a 'Smart Labrador' initiative funded by Provincial and Federal levels of government has greatly extended infrastructure available for internet usage to residents of Labrador. All areas covered by the survey have internet usage rates consistent with those of the island portion of the province, though not all are necessarily of similar bandwidth/speed (dial up contrasted with cable or DSL).

Two service providers offer dial up and high speed internet access in the Upper Lake Melville area, of which one (Eastlink) does not provide services to either North West River or Sheshatshiu , and the other (Aliant) does not provide service to Sheshatshiu. If information and contact were limited exclusively to the internet at the household level, there would likely have been some skewing of the sample. However, multiple forms of media were used for advertising.

Access to computers by residents of central Labrador would therefore not affect the results found in the angling and fish consumption components of the survey.

Radio

Due to low purchase cost and free wavelength access, radios are the most common form of electronic information reception throughout the world as indicated in virtually every survey of consumer durables. Of all forms of electronic media, this is most likely to be consistent in access among communities in the area of interest.

Access to radio by residents of central Labrador is not expected to affect the results found in the angling and fish consumption components of the survey.

Telephone

Along with radio, the telephone is likely to be most widely distributed electric media due to cost of purchase and ongoing charges, as well as relative ease of use. There is no evidence that the proportion of the adult population without telephone access is any lower in the survey area than in other municipalities of similar size on the island or elsewhere in Canada.

As with other telephone surveys, an unknown number of individuals and households were probably missed during the survey due to lack of a listed telephone in the exchanges covered by the survey, or as a result of alternate accommodations (e.g., boarding houses, institutionalization of various forms, multiple households). The number of those under-represented in the present survey is not expected to be any larger than in any other telephone-based survey. Moreover, geographic location and isolation of central Labrador is not expected to provide any additional source of sampling error beyond that referenced above.

Access to telephone by residents of central Labrador would therefore not affect the results found in the angling and fish consumption components of the survey.

IR# JRP.80

Change in Fishing Patterns, Locations, Frequency and Variability

Requesting Organization – Joint Review Panel **Information Request No.: JRP.80**

Subject - Change in Fishing Patterns, Locations, Frequency and Variability

References:

EIS Guidelines 4.4.4.6 (Communities)

EIS Volume III, Sections 2.8.5 (Land and Resource Use – Fishing) and 5.5.5 (Environmental Effects Analysis and Effects Management – Land and Resource Use)

Related Comments / Information Requests:

CEAR # 170 (Fisheries and Oceans Canada)

IR# JRP.73, 79

Rationale:

Section 4.4.4.6 Communities, of the EIS Guidelines (a) directs the Proponent to “characterize the current fishing patterns, including fishing location, frequency and variability in consumption between communities and within a single community and determine whether this pattern may change following the construction of the dams”.

This element of the Guidelines is relevant to the assessment of the environmental effects of the Project as it describes the existing environment and helps to identify components of the biophysical and socioeconomic environment that are most valued and / or sensitive and have meaningful potential to be affected by the Project.

Sections “Change in Access” and “Wage-related Change in opportunity for Hunting/Fishing/Trapping” in Volume III, Section 5.5.5.1 of the EIS emphasizes hunting and trapping (e.g. references fear of provincial hunting regulations being ignored), with little reference to fishing (the same concern regarding fishing and the associated regulations is not given).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.80**

Information Requested:

The Proponent is asked to review Section 4.4.4.6 (Communities) of the EIS Guidelines and EIS Volume III, Section 5.5.5.1 and provide an analysis of the impacts on fishing patterns, locations, frequency and variability including changes that will be caused by increased access to fishing sites.

Response:

The Lower Churchill River Fish Consumption and Angling Survey (Minaskuat 2009a) and interviews conducted as part of the Land and Resource Baseline Report (Minaskuat 2009b) provides a description of the angling practices for the communities of Happy Valley-Goose Bay, Mud Lake, North West River and Churchill Falls, with respect to the lower Churchill River (defined as that section of the river between Muskrat Falls and the Churchill Falls tailrace and the mouths of any streams flowing into this area). Both of these reports were included as part of the EIS submission. The results of the survey estimate that 9.8 percent of the overall Central Labrador population conducted some angling on the lower Churchill River in the past 12 months (October/November, 2006 to October/November, 2007), with as many as 13.7 percent in a "typical year". Regionally, Happy Valley-Goose Bay and Mud Lake anglers' use of the lower Churchill River is the most similar to the overall results, while North West River anglers use the lower Churchill River less, and Churchill Falls anglers use the lower Churchill River considerably more often than the other three communities.

When asked about preferred locations, the responses suggest that the Churchill Falls tailrace, Muskrat Falls and Gull Island were the preferred areas fished by Central Labrador anglers in the lower Churchill River from October/November 2006 to October/November, 2007. The remaining locations consisted of various rivers and lakes, such as Minipi and Winokapau Lakes and the Cache and McKenzie Rivers.

As stated in the EIS, there are a number of Project-related effects that could affect hunting, trapping and fishing, including wage-related change in opportunity, physical changes in habitat, and changes in access. For some of these effects, there may be both adverse and positive effects on any one of these harvesting activities. For instance, wage-related change in opportunity will have both positive and adverse effects for all harvesting activities, including fishing. As stated in the EIS (Volume III, Section 5.5.5.1, page 5-12), working shifts during construction will limit the time available for workers to hunt and/or fish while they are employed by the Project. However, employment will also provide financial resources that may support hunting and/or fishing activities during off-duty hours. The assessment of this issue is fully applicable to fishing.

While the creation of the Muskrat Falls and Gull Island Reservoirs will lead to a net total increase in habitat and use for angled species, access to preferred angling locations such as upriver of Muskrat Falls and Gull Island may be affected. Fishing locations below Muskrat Falls are expected to be accessible below the tailrace. At Gull Island, the dam location and infrastructure will be unavailable; however, the tailrace and downriver will most likely be accessible to anglers. The habitat velocities as the water enters the upper, shallow end of Gull Lake will be suitable for salmonids and anglers. The mean water velocities will be reduced from approximately 1.5 to 3.6 m/s to 0.3 to 1.3m/s in the 4 km stretch below the dam.

As shown from the survey results, anglers from Churchill Falls use the lower Churchill River considerably more often than other communities and their preferred location is the Churchill Falls tailrace. The Project should not interfere with angling in this region. Angling practices outside of the lower Churchill River are also not expected to be affected.

While construction and inundation will affect shoreline access and boat launching points, this will be mitigated by replacing the lost access points with new boat launches (please refer to the response for IR# JRP.34(d)). Also, the areas below the dams may be inaccessible as they are immediately below the facilities. Therefore, while access points for angling will change as a result of the Project, there should be no net loss in access. With respect to the potential for increased access and therefore increased competition for resources, the mitigation in place to limit adverse effects on other types of harvesting are also applicable to fishing (i.e., restricted access to Project roads and work areas during construction; removal of stream crossings along access roads as construction and reservoir preparation is completed; a no-harvesting policy will be in effect for all Project employees, as described in IR# JRP.38). While there may be some changes in angling patterns as a result of the Project, there are also several non-Project factors to moderate these effects. Fish stocks are managed by both the provincial and federal levels of government including seasonal restrictions in place to manage fish resources and it is understood that the majority of anglers comply with these restrictions. As well, respondents from the survey who did not fish the lower Churchill River were asked why they did not fish the area. Of the overall Central Labrador population, only 4.4 percent reported their reason as “Lack of access/ability/health, not practical given the distance”. This response would imply that for the majority of anglers, their preferred fishing locations may be influenced by factors other than access.

References:

Minaskuat Inc. 2009a. Lower Churchill River Fish Consumption and Angling Survey. Report prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2009b. Current Land and Resource Use in the Lower Churchill River Area. Report prepared for the Lower Churchill Hydroelectric Generation Project.

IR# JRP.81

Sheshatshiu Innu Fish Consumption

Requesting Organization – Joint Review Panel **Information Request No.: JRP.81**

Subject – Sheshatshiu Innu fish consumption

References:

EIS Guidelines, Section 4.4.4.6 (Communities)

EIS, Volume III, Section 2.8.5 (Fishing)

EIS, Volume III, Section 5.5.5.2 (Environmental Effects Analysis and Effects Management)

Related Comments / Information Requests:

CEAR # 171 (Health Canada)
CEAR # 203 (Hydro-Québec)

IRs # JRP.20, 21, 33, 43, 63, 66, 70, 78, 82, 74, 79, 82, 107

Rationale:

The EIS Guidelines require the Proponent identify the species of fish and specific portions of the fish that are consumed by humans. As the Project is likely to result in an increase in methylmercury concentrations in fish, the Proponent shall assess the human health risk associated with mercury exposure.

Health Canada indicates that the total edible food weights for fish species presented in Table 2-12 (Sheshatshiu Innu Fishing Activities, 1987) are inadequate for the conduct of a human health risk assessment of country foods for the Sheshatshiu Innu, with respect to methylmercury exposure as they are dated and may not reflect current consumption patterns. No discussion has been provided about the appropriateness of the 1987 data with respect to current consumption patterns. In addition, there is no information regarding the number of fish meals per week/day by species for each age category for the Sheshatshiu Innu.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.81**

Information Requested:

The Proponent is asked to provide:

a. a rationale to support the contention that Innu consumption patterns are expected to be similar to those surveyed in 1987 or supply more recent daily/weekly fish consumption rates by species for each age category for the Sheshatshiu Innu;

Response:

Consumption Patterns in 1987 and Today

There are two sources of information regarding whether Innu fish consumption patterns today are likely to be similar to those surveyed in 1987: Samson and Pretty (2005); and a series of reports produced under the auspices of the Collaborative Mercury Research Network (Mergler et al. 2004; de Grosbois et al. 2004; Lucotte et al. 2005; and Canuel et al. 2006).

Samson and Pretty (2005) argue that there has been a significant decline in the quantity of country food consumed by the Labrador Innu since 1987, as a result of the cancellation of the Outpost Program. They note, however, that there are few data on changes in consumption of country foods by the Innu over time (Samson and Pretty 2005). They cite Mackey (1987) to the effect that 30 to 65 percent of the Innu in Labrador continued at that time to spend the autumn or the spring hunting, fishing, trapping and gathering in the interior. They then state that "This has fallen dramatically since the withdrawal of funding for the Outpost Program, which enabled Innu families to spend several months a year in the country." They do not, however, cite any evidence to support their assertion.

Lucotte et al. (2005: Table 2) reported that a sample of adult Innu from Sheshatshiu that was selected to represent the gender and age structure of the 1,200 members of that community in 2002 (de Grosbois et al. 2004) consumed an average of 127.1 meals of fish in that year. Health Canada (no date) states the average portion size for a fish meal is 0.075 kg, although the extent to which that figure is applicable to the Innu of Sheshatshui is unknown. Assuming that each of the 1,200 members of the population of Sheshatshui in 2002 ate 127.1 meals of fish in that year and that the average portion weighed 0.075 kg, the total edible food weight of fish harvested in that year would have been roughly 11,400 kg.

Armitage (1990) calculated that the 740 Innu of Sheshatshit (Sheshatshiu) consumed a total of approximately 5,000 kg of fish in 1987.

The preceding calculations yield a per-person average consumption of 7.0 kg in 1987 and of 9.5 kg in 2002. Given the uncertainty surrounding the applicability to the Innu of Health Canada's estimate of the average portion size for a fish meal, the most that can be said is that this line of evidence is consistent with the contention that Innu consumption patterns of fish today are similar to those in 1987.

Daily/Weekly Fish Consumption Rates

Information on the daily and weekly fish consumption rates by species for the Sheshatshiu Innu was not found. Data that have been disaggregated by age or gender have not been published, although it is clear from de Grosbois et al. (2004) that such data were collected.

Table 1 summarizes the only recent data on fish consumption patterns by the Innu of Sheshatshiu. They reflect information provided by 118 Sheshatshiu Innu adults in 2002.

Table 1 Number of Fish Meals, by Species, Eaten by Sheshatshiu Innu in 2002

Fish Species	118 participants			
	Fish Meals[1]	Standard Deviation	Minimum	Maximum
Fish meals/year				
Salmon	29.1	57.5	1	336
Lake trout	40.7	117.0	1	1,008
Arctic char	44.7	102.6	1	536
Northern pike	12.6	28.3	1	120
Fish meals/spring season (three months)				
Salmon	3.2	11.9	0	84
Lake trout	11.9	34.7	0	252
Arctic char	9.9	41.0	0	252
Northern pike	3.8	12.4	0	60
Smelt	7.9	15.9	0	84
Brook trout	10.0	21.8	0	168

[1] Not defined.
Source: Lucotte et al. (2005)

To increase the level of understanding of current consumption patterns, Nalcor Energy (Nalcor) has initiated a Human Health Risk Assessment (HHRA).

References:

Armitage, P. 1990. Contemporary Land Use and Occupancy among the Innu of Utshimassit and Sheshatshit. Preliminary Report. Innu Nation (Naskapi-Montagnais Innu Association) and Sheshatshit and Utshimassit Nitassinan(Labrador-Québec).

Canuel, R., S. Boucher de Grosbois, L. Atikessé, M. Lucotte, P. Arp, C. Ritchie, D. Mergler, H–M. Chan, M. Amyot and R. Anderson. 2006. New Evidence on Variations of Human Body Burden of Methylmercury from Fish Consumption. Environmental Health Perspectives 114(2): 302-306.

De Grosbois, S., L. Atikessé, N. Bourbonnais-Spear, M. St-Jean, J. Charron, M. Amyot, R. Anderson, M. Penashue, N. Rich and M. Benuen. 2004. Ecosystem and health: Community involvement in a transdisciplinary project on mercury exposure with an Innu community of Labrador. RMZ-Materials and Geoenvironment 51(1): 384-387.

Health Canada. no date. Eating Well with Canada's Food Guide. Available at: http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang-eng.pdf. Accessed 24 July, 2009.

Lucotte, M., R. Canuel, S. Boucher de Grosbois, M. Amyot, R. Anderson, P. Arp, L. Atikesse, J. Carreau, H-M. Chan, S. Garceau, D. Mergler, C. Ritchie, M.J. Robertson and C. Vanier. 2005. An Ecosystem Approach to Describe the Mercury Issue in Canada : From Mercury Sources to Human Health. In N. Pirrone et al. (ed.). Harmonization of Mercury Measurements Methods and Models to Assess Source-Receptor Impact on Air-Quality and Human Health. Kluwer Publisher. 451-465

Mergler, D., S. de Grosbois, L. Chan, C. Vanier, M. Legrand, L. Atikesse, M. St-Jean, J. Charron, N. Abdelouahad, G. Beauchamp, A. Pull, I. Rheault and M. Lucotte. 2004. Maximizing nutrition from fish consumption and minimizing toxic risk: an ecosystem approach to mercury in Canadian communities. RMZ-Materials and Geoenvironment 51(1): 472-475.

Samson, C. and J. Pretty. 2005. Environmental and Health Benefits of Hunting Lifestyles and Diets for the Innu of Labrador. Presented at British Association of Canadian Studies, First Nations, First Thoughts Conference, Edinburgh, Scotland, 6 May, 2005.

Requesting Organization – Joint Review Panel **Information Request No: JRP.81**

Information Requested:

The Proponent is asked to provide:

b. **a discussion of whether the Proponent and Innu Nation representatives established a new approach or method for obtaining the information required to properly evaluate fishing and fish consumption patterns in order to adequately evaluate the risks inherent in future exposure to mercury in the community; and**

c. **if so, a description of the chosen method if applicable and provide examples of its effectiveness.**

Response:

Nalcor has met with representatives from government agencies (Health Canada, DFO) to ensure that the data to support the HHRA and the approach and methodology of the HHRA is adequate to satisfy the requirements of the EIS Guidelines. In addition, Nalcor will lead consultations with the potentially affected Aboriginal groups to ensure that they have a full understanding of the study, and that appropriate protocols are followed in the collection of data within the Aboriginal communities. Both government and Aboriginal groups will be provided an opportunity to comment on the study plan; updates on study activities will be provided as well over the course of the study and the resulting report will also be provided for review.

The HHRA will apply the dietary survey utilized by researchers at the Université de Quebec à Montreal (UQAM) as part of the COMERN study. To the extent possible, Nalcor will develop a data sharing agreement with Innu Nation to obtain access to the COMERN data. The use of the COMERN dietary survey ensures consistency in the data collection and allows for comparability. This dietary survey will be delivered to the participants to collect information on:

- fish consumption patterns and rates; and
- traditional food consumption including frequency of consumption and portions, pattern of consumption (including fish and wildlife such as caribou, seals and waterfowl).

After the community surveys and the analysis for hair samples have been completed, all existing and newly collected baseline mercury data will be compiled for the purposes of statistical analysis. Statistical analysis will be used to characterize the human exposure to dietary mercury using the outcomes of the dietary and angling surveys and performing the following analyses:

1. Statistical analysis of existing fish data to derive relationships between mercury concentration in fish and fish length for species of interest for human consumption;
2. Statistical analysis of diet survey data to characterize fish consumption patterns;
3. Combination of relationships between mercury content in fish with fish consumption information to determine dietary mercury intake from fish; and
4. Combination of fish-derived mercury intake with other sources to determine total dietary mercury intake.

To the extent possible and appropriate, the above analyses will be conducted using probabilistic methods. That is, the outcome will be a range of mercury exposures (or, more precisely, a statistical distribution of values) for various subgroups of the study population, rather than simply an evaluation of a hypothetical 'average' person. This approach will permit an evaluation of the potential risks of mercury in terms of the types of effects that might occur, which subgroups of the population might experience these effects, and the proportion of people in each group that are potentially at risk. A probabilistic approach is warranted for this analysis because of the high variability that exists among people in terms of how much fish is consumed, where fish are caught and which species are preferred, and the resulting potential for exposure to mercury (Minaskuat 2009). The following details the statistical analyses to be completed for the HHRA:

1. Statistical analysis of existing fish data. The existing fish data will be analyzed to derive relationships between baseline mercury and fish length that account for any significant differences among species and among locations. The primary statistical tools for this analysis will be General Linear Model (GLM) analysis and polynomial regression (Tremblay et al. 1998, as employed in previous analyses of fish mercury data from the Project area). These relationships will describe not only mean mercury concentrations for any given fish, but also the range of mercury concentrations that would be expected for fish of this type. This information is relevant to HHRA because it describes the likely range of baseline mercury concentrations that will be encountered in any given meal of fish, and therefore, permits an evaluation of the range of mercury exposures in people consuming these fish.

   The baseline fish mercury relationships will also serve as the basis for Project-case (i.e., post-construction) relationships. For all locations that are expected to be affected by Project activities, fish mercury relationships will be adjusted to account for the predicted factor increase in mercury concentration. It is assumed that predicted increases in fish mercury concentration (e.g., as in TetraTech 2008) will be available for all relevant locations. For locations that are not expected to be affected by Project activities, project-case mercury relationships will be identical to baseline mercury relationships.

2. Statistical analysis of diet survey data. The diet survey results will characterize fish consumption patterns in terms of frequency of fish consumption, meal size, species and size of fish consumed, and harvesting locations. This information will be summarized as statistical distributions describing the variability among individuals. As appropriate, the distribution of each variable will be derived separately for the various subgroups of the population.
3. Calculation of dietary mercury intake from fish. The fish-derived component of dietary mercury intake will be calculated by combining the consumption survey data with the fish mercury relationships. For each type of fish consumed (e.g., 500 mm lake trout from Gull Island Reservoir), the fish-mercury relationships will be used to determine a distribution of mercury concentrations in tissue. These mercury concentrations will then be multiplied by the size of the meal consumed and frequency with which such a meal is consumed to give an intake rate of mercury from that source. This calculation will be performed for every type of fish consumed, and these values will be summed for each subgroup of the study population to give a total dietary mercury intake rate from fish.

4. Calculation of total dietary mercury intake. The consumption survey results will also characterize non-fish diet items that have the potential to represent a dietary mercury source, including other country foods (e.g., wild birds, caribou, and seals) and store-bought foods (e.g., canned fish). Mercury intake rates will be calculated from meal size and consumption frequency (from the consumption survey) and estimated mercury concentrations (obtained from the literature). These values will be added to the distribution of fish-derived dietary mercury to give total dietary mercury intake rates in each subgroup of the study population. Calculations will be performed to characterize both a baseline distribution (i.e., based on existing data) and a project-case distribution (i.e., with fish mercury- relationships adjusted to account for predicted project-related changes in mercury concentration).

   The estimated baseline mercury intake rates will be evaluated by comparison to hair mercury measurements. Hair mercury data will be summarized for the same subgroups of the study population identified in the fish consumption analysis. Statistical analysis and comparison to published diet-hair relationships will be used to evaluate the degree to which baseline Hg intake rates correspond to measured hair mercury concentrations.

References:

Minaskuat Inc. 2009. Lower Churchill River Fish Consumption and Angling Survey. Report prepared for the Lower Churchill Hydroelectric Generation Project.

Tetra Tech Inc. (2008) Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Assessment of the Potential for Increased Mercury Concentrations.

Tremblay, G., P. Legendre, J-F Doyon, R. Verdon and R. Schetagne. 1998. The use of polynomial analysis with indicator variables for interpretation of mercury in fish data. Biogeochemistry 40: 189-201, 1998.

IR# JRP.82

Fish Consumption, Mercury Exposure and Advisories

Requesting Organization – Joint Review Panel **Information Request No.: JRP.82**

Subject - Fish Consumption, Mercury Exposure and Advisories

References:

EIS Guidelines, Section 4.4.4.6 (Communities)

Minaskuat Inc. (2009) Component Studies Aquatic Environment (1). Fish and Fish Habitat. Report 11 of 11: Lower Churchill River Fish Consumption and Angling Survey. p. 5-19

Minaskuat Inc. (2008). Component Studies Aquatic Environment (2). Mercury. Report 2 of 5: Calculations of Anticipated Consumption Advisory Levels of Fish in the Lower Churchill Area. Table 6-3

Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch

Related Comments / Information Requests:

CEAR # 171 (Health Canada)
CEAR # 203 (Hydro-Québec)

IRs # JRP. 20, 21, 33, 43, 63, 66, 78, 81, 107

Rationale:

Section 4.4.4.6 (Communities) of the EIS Guidelines states that "the Proponent shall characterize the current fishing patterns… and determine whether this pattern may change following the construction of the dams".

On page 5-19, of Minaskuat (2009), the report indicates that with respect to the Lower Churchill River, the Gull Island and Muskrat Falls areas are important fishing areas (28.4 percent indicated Muskrat Falls and 10.7 percent indicated the Gull Island area). These are the same areas where reservoirs will be created and these reservoirs (and dams) are expected to have an impact on fish and fish habitat.

Health Canada has indicated that, based on current consumption rates from the Lower Churchill River (Minaskuat, 2009), if these rates remain the same or increase following dam construction, fish ingestion rates may exceed the HC provisional tolerable daily intake of methylmercury (Health Canada, 2007) for average and above-average consumers of fish for some potentially sensitive receptors, such as pregnant teens and women of child-bearing age. This statement is based on the following:

- assuming an average consumption rate of 1.1 fish/week (4.4 fish/month) from the Lower Churchill River (averages for Northwest River and Churchill Falls were 1.7 and 1.1 meals/week (Minaskuat, 2009));
- assuming the preferred species include Lake Trout (trout was rated as the most preferred species in Table 5-7 of Minaskuat, 2009);
- assuming current consumption patterns continue following dam construction; and
- based on the anticipated recommended fish consumption for people eating fish from the Lower Churchill River - Tables 6-3 to 6.9 from Minaskuat (2008).

For example, for the teenage mother or the woman of childbearing age, consuming more than one meal/month of Lake Trout (food unit value of 33.4 (from Minaskuat, 2008)) from the Lower Churchill River would result in an exceedence of the calculated allowable food units/month of 36 for the teenage mother (Table 6-7 from Minaskuat, 2008) and 38 for the woman of childbearing age (Table 6-5 from Minaskuat, 2008).

Moreover, there are no specific statements in the EIS and/or supporting documentation about potential changes in the fishing pattern on the Churchill River, the Lower Churchill River and its tributaries following the construction of the dams.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.82**

Information Requested:

The Proponent is asked to provide:

a. **a discussion about whether or not fishing patterns and fish consumption from potentially affected areas are expected to change as a result of the Project and how this would impact individual's (including average and above-average consumers) potential exposure to methylmercury in Project-related methylmercury -impacted fish. In doing so, factor in the results of the reconsideration of baseline mercury levels in fish (as requested in JRP.20);**

Response:

A change in fishing patterns is expected in some areas. As described in the response to IR# JRP.80, a number of Project-related effects could affect fishing, including wage-related change in opportunity, physical changes in habitat, and changes in access:

- working shifts during construction will limit the time available for workers to fish while they are employed by the Project. However, employment will also provide financial resources that may support fishing activities during off duty hours, which may result in an increase in fishing activity.
- the creation of the Muskrat Falls and Gull Island Reservoirs will lead to a net total increase in habitat and use for angled species.
- access to preferred angling locations such as upriver of Muskrat Falls and Gull Island may be affected.
- fishing locations below Muskrat Falls should still be accessible below the tailrace.
- the dam and infrastructure locations at Gull Island and Muskrat Falls will be unavailable for angling; however, the tailrace area and downriver will most likely be accessible to anglers.
- the habitat velocities as the water enters the upper, shallow end of Gull Lake will be suitable for salmonids and anglers.
- the Project should not interfere with angling in the area around the Churchill Falls tailrace.
- angling practices outside of the lower Churchill River should not be affected.
- there should be no net loss in access (boat launch points will be replaced with new boat launches (please refer to the response for IR# JRP.34d).

Please refer to the response to part (c) of this IR for a discussion of potential effects to fish consumption.

Nalcor Energy (Nalcor) is currently conducting a Human Health Risk Assessment (HHRA). The results will be made available to the JRP upon its completion. The HHRA is addressing, among other things, changes to fishing patterns and fish consumption that may result from the Project, as well as how this would affect individual's (including average and above-average consumers) potential exposure to methylmercury in Project-related methylmercury-affected fish. As requested in IR# JRP.20, Nalcor has reconsidered baseline mercury levels in fish. As described in that response, the levels as presented in the EIS are higher than the re-calculated values and therefore represent a conservative, worst-case scenario.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.82**

Information Requested:

The Proponent is asked to provide:

b. **combine the current consumption information from Minaskuat (2009) with the information regarding increased levels resulting from the Project from Minaskuat (2008) and recalculations of fish mercury levels (as requested in JRP.20); in order to better understand how current and potential future fish consumption patterns may need to be altered, what types of advisories may need to be issued, and potential target audiences for these consumption advisories using the recalculations of consumption advisories in JRP.21; and**

Response:

Please refer to IR# JRP.20 and IR# JRP.21 for a detailed response. A summary of the response is presented below.

In the response to IR# JRP.20, the additional analysis indicated that increasing peak increase factors and peak estimated fish mercury concentrations for the Smallwood Reservoir to a value of 3, or including three reservoirs more relevant to the proposed Lower Churchill development did not result in higher predicted fish mercury concentrations for the proposed Lower Churchill development, than those using the regression approach presented in the EIS.

In the response to IR# JRP 21, combining a higher peak increase factor for Smallwood Reservoir (3.2) and using data from additional sites more representative of high flow, low flooding environments did not result in higher predicted peak increase factors or peak fish mercury concentrations for the Lower Churchill development than those presented in the EIS.

Therefore, higher peak fish mercury concentrations were not predicted using those parameters and accordingly, there is no need to recalculate consumption advisories. There is no change with respect to the consumption advisories, above and beyond the results presented in the EIS. Therefore, there is no need at this time to change the consumption advisory target audience or strategy as presented in the EIS. Fish mercury concentrations will be monitored after the river is altered (post-development), and consumption advisories will be finalized in accordance with the monitoring results.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.82**

Information Requested:

The Proponent is asked to provide:

c. **the results of any relevant research (in Labrador or elsewhere) that explores the impacts of country food consumption advisories with respect to compliance, broader changes in diet, or loss of confidence in country foods.**

Response:

A review of relevant sources (e.g., primary scientific literature, government and industry reports) was conducted to obtain information regarding the impacts of country food consumption advisories with respect to compliance, broader changes in diet, or loss of confidence in country foods. The information sources are provided in the "References" section at the end of this response.

Impacts of country food consumption advisories with respect to compliance

Jardine (2007) completed a study of health perceptions in northern aboriginal communities from Northwest Territories and Labrador, and determined that participants appeared to understand the nature and magnitude of the risks to their health associated with lifestyle and basic physical and environmental risks, they also showed indication of having received, comprehended and accepted information on these risks. They have however, not modified or changed their behaviours as a result of this health messaging. There have not been notable changes in diet to minimize contaminant exposure through the consumption of country food species higher in some organochlorine and metal contaminants potentially due to the ineffective nature of the current messaging strategy. It is perceived that much of the current messaging is "fear based" health messaging and in all communities federal government agencies were not identified as being a key source of health information, and were also rated low in terms of trust. Elders were rated as a trusted source of information, however, many elders are often not sufficiently informed to be able to provide this information and the advent of new communication technology is making this knowledge gap even more acute (Jardine 2007).

In a point of view memo written by the Contaminants Committee, Public Health Department, Cree Board of Health and Social Services of James Bay (CBHSSJB) in response to hearings regarding the EM1A/Rupert River Diversion Project Environmental Review, it was suggested that fish consumption advisories recommend a pattern of fish consumption that is very different than traditional consumption patterns and that it is not necessarily feasible to follow suggested advisories. Moreover, it was suggested that advisories can lead to cultural loss since many family activities are organized around fishing and fish eating. The CBHSSJB acknowledged that contaminants are a problem but suggest that the most important problem facing the Miyupimaatisiiwin of the Liyiyiu Aschii population are obesity, dependencies and psychosocial problems, all of which can be managed by promoting traditional activities without sending the double and ambiguous message that it may be dangerous to eat fish. CBHSSJB would like to promote traditional activities rather than impose advisories and suggested that monitoring susceptible receptors (i.e., pregnant women) who consume fish will give require information to make appropriate decisions. CBHSSJB notes that the state of Alaska has decided not to implement fish consumption advisories suggested for national application by the US EPA since the most commonly consumed fish in Alaska is low in mercury.

Studies of Native communities affected primarily by contaminants in fish focusing exclusively on a series of exposure assessment studies conducted on PCB contamination in fish in the Mohawk Nation of Akwesasne from 1995 to 1999 yielded valuable information on the integration of First Nation participants and collaboration in the communication and participation in exposure assessments. Studies conducted in 1995 (to assess exposure to PCBs for nursing Mohawk women), in 1996 (to assess dietary, residential and occupational exposures to PCBs and DDE and body burden in Mohawk men) and in 1998 (to assess the relationship between the consumption of contaminated fish and concentrations of the PCBs and the PCB cogeners in the milk of nursing mothers at Akwesasne) yielded results showing significantly higher body burdens, blood levels and milk levels of organochlorines than in Caucasian control populations. It was determined that the fish were contaminated with PCBs and a higher rate of fish consumption was prevalent among the Mohawk population. The establishment of fish consumption advisories and the effectiveness of these advisories are attributed to the involvement of Native researchers in these studies. These fish advisories implemented over the past years have reduced the body burdens of PCBs for Akwesasne community members. These studies had First Nation researchers as an integral part of the research team and these Native community researchers implemented the studies' interviews and assisted in the questionnaire development and the identification and recruitment of participants. It was acknowledged by the researchers that the success of the sampling was due to the Mohawk's willingness to cooperate with the sampling efforts which was attributable to the field staff being of Mohawk heritage and the genuine concern of the Mohawk people for their environment (Quigley 2001).

Fish consumption advisories in the Great Lakes area have been generated as a result of concerns about the health effects of ingesting fish contaminated by pollutants (e.g., mercury, PCBs). Imm et al. (2005) completed a survey of anglers in the Great Lakes area of the United States and reported that approximately half of adults who consumed fish from the Great Lakes were aware of the health advisories that had been issued by the health department in their home state and that advisory awareness was associated with annual fish consumption rates. Historical confusion regarding consumption advisories in the Great Lakes area stemmed from the fact that until the early 1990s, sport-fish consumption advisories were state-specific and this led to confusion because neighboring states often provided different advice for the same shared waterbody. With consistent communication of the advisories, compliance increased; however, the least popular recommendation, the restriction on the amount of fish that should be eaten in a given time period, only had a compliance level of 52 percent.

Despite an outreach program designed to inform pregnant women of the local fish consumption advisories in Wisconsin, of the 20 percent of the survey population who consumed sport fish, very few of the individuals were aware of any advisories and 67 percent were completely unaware. However, once made aware of the advisory, 15 percent ate less fish and 11 percent ate different types of fish (Gliori et al. 2006).

In order to assess the probability of fish consumption in instances when anglers were aware of consumption advisories, Jakus et al. (2002) completed a Bayesian statistical analysis on data from 20 advisories in the Chesapeake Bay area of the United States. The mean probability that people aware of advisories but still likely to consume fish (called *P(Consume|Aware)*by Jakus et al.) was roughly 49 percent. The mean probability that people not aware of advisories but still likely to consume fish (*P(Consume|Not Aware)*)was 67 percent. Once made aware of the fish consumption advisories, between 13 percent and 25 percent of those surveyed reported not eating any fish from contaminated waters; 23 to 26 percent reported changing the species targeted for consumption; and 15 to 54 percent reported adjusting overall fish consumption. The data and the findings presented in the report supported that fish consumption advisories cause anglers to choose other locations to fish and take fewer overall fishing trips during any given time period and Jakus' statistics correspond to compliance rates with fish consumption advisories as seen in the Great Lakes.

Impacts of Country Food Consumption Advisories With Respect to Broader Changes in Diet

Jakus et al. (2002) reported that once aware of the fish consumption advisories between 13 and 25 percent of those surveyed reported not eating any fish from contaminated waters; 23 to 26 percent reported changing the species targeted for consumption; and 15 to 54 percent reported adjusting overall fish consumption. The data and the findings presented in the report supported that fish consumption advisories cause anglers to choose other locations to fish and take fewer overall fishing trips during any given time period.

The position paper of the Dietitians of Canada confirms that a diet rich in traditional foods has been demonstrated to be more nutritious than one of "market foods" available in the North, especially in isolated First Nations' communities. Food security, however, is undermined by concerns about concentrations of contaminants, including metals and organochlorines in fish, marine mammals and game. Additionally, the loss or decline in traditional land use including hunting, gathering, and fishing in many northern aboriginal communities has perpetuated further increased dependence on foods shipped from the South (Dieticians 2007).

Concerns about the safety of food sources and the precipitated changes in diet are further demonstrated by the Coast Salish Community on Vancouver Island. These communities, when questioned about food security, listed environmental concerns and food safety as reasons for food insecurity. Historically the Coast Salish collected abundant supplies of shellfish from the coastal and inlet areas (up to 16 species of fish were consumed by the communities). The "red tide" and algal blooms contributing to paralytic shellfish poisoning (PSP) and the advisories against inlet shellfish collection have significantly reduced the abundance of shellfish available for these communities (Fediuk 2003). The acute effects of PSP ensure compliance with consumption advisories.

While the contamination of the Arctic marine food chain is a known scientific phenomenon, few people have altered their lifestyle even after having heard about the risk of the presence of PCBs in the food chain, and in the breast milk of Inuit women. Indeed, only 14 percent reported changing their habits upon becoming aware of the contamination (Duhaime et al. 2004). This resistance to change is reflective of the integration of country foods into the social, cultural, and economic life of the Inuit of the Canadian North. Country food is typically preferred over imported meats and foods which are very costly and represent a poor quality alternative to country fish and game known to be rich in micronutrients and protein (Kuhnlein and Chan 2000).

Duhaime et al. (2004) examined the economic impact of the Nunavik health authorities' objective to encourage consumption advisories in order to reduce the intake of PCBs in certain foods. The Nunavik health authority suggested that people either substitute contaminated food with foods with lower levels of contamination or to increase consumption of other foods with special health properties (e.g., foods high in key nutrients like omega-3-fatty acids). Results of the Duhaime et al. (2004) study suggest that household budgets (Inuit in Nunavik) and the regional economy are not expected to be dramatically affected by the replacement of contaminated food with the purchase of store-bought meat and even less so when contaminated country food is replaced with other country food less contaminated. The conclusion of the study is that the Nunavik health authorities' suggestions of substitute contaminated food with foods with lower levels of contamination or to increase consumption of other foods with special health properties would not result in economic constraints for Inuit. However, Duhaime et al. highlight two detractors from consumption advisories, even in light of exposure to contaminants; 1) country foods are a vital source of essential nutrients and provide health benefits despite the level of contaminants they contain and 2) country foods are integral to the social, cultural and economic life of populations in the North since harvesting, sharing processing and eating country meat are key components to spiritual and social life.

Impacts of Country Food Consumption Advisories With Respect to Loss of Confidence in Country Foods

Fall and Field (1996) report that in the year after the oil spill from the Exxon Valdez, subsistence harvests declined by as much as 77 percent compared to pre-spill values in 10 of 15 Alaska native communities primarily because of concerns regarding food safety. Three years after the spill the harvest quantities had rebounded but were still lower than pre-spill values as there were continued concerns in some communities but some households had return to subsistence consumption for economic and food security reasons.

Prior to the spill subsistence harvesting by First Nations along the west coast use was widespread with almost every household using, harvesting and participating in the non-commercial exchange of wild foods. Although harvests were seasonal and based on resource availability the subsistence harvests were diverse and subsistence activities were organized as kinship or family activities with foods being shared with relatives and elders and others in need. Typical use values ranged from 70-275 kg/year with up to 19 species harvested; after the spill subsistence harvesting declined in 10 of 15 Coastal Alaskan First Nation communities between 31 and 77 percent. Moreover, resource sharing patterns also changed and the number of species harvested declined from 19 to 10. Subsistence harvesters reported acting with caution and refraining from harvesting or using traditional foods for fear that the resource had been poisoned. In the years after the spill the subsistence use numbers have increased higher than the first post spill year but still remained lower than pre-spill values. Differences in harvest composition also occurred after the spill: prior to the spill marine mammals comprised 37 percent of the harvest but only 6 percent after the spill. The values for fish were 38 percent pre-spill and 74 percent post-spill. The differences in fish consumption patterns were largely linked to the finding that fish were advised to be generally free of oil contamination and were safe to eat. First Nation communities expressed concern about long term effects of using subsistence food and had a perception of continued low populations of some resources; they also continued to travel outside of the Prince William Sound area to harvest for the purpose of either to avoiding the oiled areas or because of scarce resources.

In December 1996 the Alberta Provincial Health Officer issued a public health notice advising against eating wild game taken from the Swan Hills area after an uncontrolled release from the Special Waste Treatment Centre in Swan Hills, Alberta. Precautionary measures included a consumption advisory to refrain from eating wild game caught from within a 30 km radius of the plant. This advisory was downgraded in May, 1997 to limit the quantity of wild game consumed from within 30 km of the plant to 370 grams per month (Alberta Health 1997). As a result of the wild game consumption advisory, First Nations local to the Swan Hills area have lost confidence in the quality of moose harvested in the area. Roughly 80 percent of the First Nation hunters changed their harvesting locations to avoid the Swan Hills area, 10 percent stopped hunting and eating moose altogether and 10 percent did not change their hunting practices. Still today when moose is offered at community gatherings, the source is often questioned prior to acceptance (Dersch 2009).

In the 2006 dietary study conducted by Myers and Furgal to determine the effectiveness of risk communication messaging in informing Arctic residents of the potential presence of contaminants in their food, the majority of respondents said that they had heard about contaminants in their region. However, when country food was not eaten, safety and food contamination were virtually never given as the reasons people did not eat, or had not eaten, some country foods. In general, most people indicated that they knew of no specific groups who should avoid certain county foods and no one reported that women of child-bearing age or children should avoid country foods. Of the demographic groups included in the survey, hunters were the most likely to report having been informed, while women of childbearing age who choose foods for their families and who theoretically should have the most information about contaminant levels in different country foods and the need to avoid certain foods, seemed to have the least awareness of these concerns. More than half the respondents indicated that if their country food were contaminated, they would not change their food habits, assuming that they could avoid any problems by visual checking, extra cooking, or hospital check-ups.

Boulet (2004) examined food insecurity in Arctic communities and established that a number of factors have influenced both harvesting practices and the consumption of country food as the study indicated a general drop in the amount of country food that was included in the local diet. While climate change has been cited as having a substantial negative impact on harvesting activities, concerns about environmental pollutants and the contamination of the Arctic food chain, have also raised a number of concerns relating to the consumption of country foods (Boulet 2004).

Summary

Studies have shown that when communicated effectively and clearly, and when community members are involved in the process, consumption advisories can result in a decrease in contaminant load in people. However, it appears that country food consumption advisories have the potential to lead to cultural loss of the peoples for which the advisories were developed in the first place. Country food consumption advisories have been linked to a certain amount of social, psychological, economic and lifestyle disruption. In some cases, communities have decided to ignore country food consumption advisories opting to continue with traditional lifestyles believing that the benefits of doing so (e.g., health benefits, cultural benefits) outweigh the risk of following advisories.

References:

Alberta Health. 1997. Swan Hills Special Waste Treatment Centre Human Health Impact Assessment.

Boulet, D. 2004. Hunger in the Arctic – Food (In) Security in Inuit Communities. A Discussion Paper. Ajunnginiq Centre. National Aboriginal Health Organization.

Contaminants Committee, Public Health Department, Cree Board of Health and Social Services of James Bay. 2006. The Issue of Mercury and Fish Consumption Advice to the James Bay Cree Population.

Dersch, A. (FMA Heritage Resources Consultants Inc.). 2009. Personal Communication, Response to Swan Hill Consumption Advisory of 1996.

Dietitians of Canada. 2007. Community Food Security – Position of Dieticians of Canada. Public Policy Statement.

Duhaime, G., Chabot, M., Frechette, P., Robichaud, V. and Solange, P. 2004. The Impact of Dietary Changes Among the Inuit of Nunavik (Canada): A Socioeconomic Assessment of Possible Public Health Recommendations Dealing with Food Contamination. Risk Analysis, Vol. 24, No. 4, 1007-1018.

Fall, J.A. and Field, L.J. 1996. Subsistence Uses of Fish and Wildlife before and after the Exxon Valdez Oil Spill, American Fisheries Society Symposium 18:819-836.

Fediuk, K. 2003. Contemporary & Desired Use of Traditional Resources in a Coast Salish Community: Implications for Food Security and Aboriginal Rights in British Columbia. 26th Annual Meeting of the Society for Ethnobiology, Seattle, WA.

Furgal, C.M., Powell, S. and Myers, H. 2005. Digesting the message about contaminants and country foods in the Canadian North: A review and recommendations for future research and action. Arctic 58(2):103-114.

Gliori, G., Imm, P., Anderson, H.A., and Knobeloch, L. 2006. Fish Consumption and Advisory Awareness among Expectant Women. Wisconsin Medical Journal. 105.2 41-44.

Imm, P., Knobeloch, L., Anderson, H.A. and the Great Lakes Sport Fish Consortium. 2005. Fish Consumption and Advisory Awareness in the Great Lakes Basin. Environmental Health Perspectives. 113.10 325-329.

Jakus, P., McGuinness, M., and Krupnick, A. 2002. The Benefits and Costs of Fish Consumption Advisories for Mercury. Resources for the Future.

Jardine, C. 2007. Factors Affecting the Communication and Understanding of Known and Potential/Theoretical Risks to Health in Northern Aboriginal Communities, Health Policy Research Program, Summary of Research Results.

Kuhnlein, H. V. and H. M. Chan, 2000. Environment and Contaminants in Traditional Food Systems of Northern Indigenous Peoples. Annual. Review . Nutrition. 20:595–626

Myers, H. and Furgal C. 2006, Long-Range Transport of Information: Are Arctic Residents Getting the Message about Contaminants? Arctic. Vol. 59, No 1 47–60.

Quigley, D. 2001. Ethical Considerations in Research Methodologies for Exposure Assessment of Toxic and Radioactive Contaminants in Native Communities, “Collaborative Initiative for Research Ethics in Environmental Health”.

IR# JRP.83

Sustainable Development – Ecosystem Integrity and Biodiversity

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Subject – Sustainable Development – Ecosystem Integrity and Biodiversity

References:

EIS Guidelines, Section 2.4 (Sustainable development), Section 4.5.1 (General)

EIS Guidelines, Section 3.1 (Study Strategy and Methodology)

EIS Volume IIB, Section 7.0 (Conclusions and Sustainability)

Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment (2006). Commission for Environmental Assessment. http://www.cbd.int/doc/decisions/cop-08-dec-28-en.pdf

Related Comments / Information Requests:

CEAR # 182 (M. Rudd and Dr. N. Raheem)
CEAR # 184 (Sierra Club Atlantic)
CEAR # 185 (S. Pottle – Memorial University of Newfoundland, Faculty Submission)

Rationale:

The EIS Guidelines require the Proponent to consider the objectives of sustainable development which include the preservation of ecosystem integrity, including the capability of natural systems to maintain their structures and functions and to support biological diversity. In Section 7.0 of the EIS the Proponent states that the Project will adhere to sustainable development ideals by meeting the sustainability management objectives which include consideration of the extent to which biological diversity is affected by the Project.

The Proponent acknowledges in the EIS that "[l]oss of habitat, fragmentation of the landscape, or a reduction in the number of species in a defined geographic region can affect biodiversity, ecological function and the sustainability of the ecosystem" (Vol. IIB, p.5-1).

The EIS states that the lower Churchill River valley will continue to extend several hundred kilometres inland, and provide elevational relief attractive for many biological species and that the area will continue to offer a regionally high biological diversity and similar species richness as currently exists (p.7-12) but does not provide any comprehensive ecosystem integrity or biodiversity analysis to support these statements.

The Panel wants to gain a better understanding of the impacts of the project on ecosystem integrity, including the capacity of the Lower Churchill valley natural systems to maintain their structures and functions and to support biological diversity.

The Panel recommends the Proponent refer to the "Voluntary Guidelines on Biodiversity- Inclusive Impact Assessment" (see complete reference above) and employ the precautionary principle particularly when assessing areas (such as riparian habitat) where the success of mitigation measures may impact on the potential loss of biodiversity.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Information Requested:

Using all currently available biodiversity information provided in the EIS and Component Studies, not only Key Indicators, the Proponent is requested to provide an analysis of:

a. **the ecosystem diversity indicating to which extent the project will lead (directly or indirectly) to serious loss or damage of an ecosystem(s), or land-use type(s) leading to a loss of ecosystem services of ecological or cultural value;**

In doing its analysis, the Proponent should reference, to the extent possible, the map(s) requested by the Panel in JRP.15 and JRP.16 (2009-04-28).

As a general comment in response to this IR, the baseline data that was used to prepare the maps for the response to IR# JRP.15 and IR# JRP.16 was also used for the analysis presented in Attachment A to this IR. IR# JRP.15 and IR# JRP.16 are not specifically referenced in this response because the analysis of biodiversity and fragmentation presented here used FRAGSTATS 3.3 software, rather than a visual approach.

Response:

Indirect effects to remaining ecosystems not directly affected by Project construction and operation are not expected to have long-term effects to their integrity or sustainability, although the wildlife populations that inhabit the affected areas will necessarily be displaced to comparable habitats elsewhere. Composition (i.e., species composition and condition, indicator and/or keystone species, and guilds), structure (i.e., class structure, snags, and coarse woody debris), function (plant growth and mortality rates) are expected to remain within their historic range of variability. Landscape-level effects will remain, with likely minor effects to flows between disturbed and undisturbed ecosystems. Therefore, it is predicted that within the Assessment Area there will not be a loss of ecosystem services of ecological or cultural value.

The spatial data mapped within the baseline component studies and EIS were analysed quantitatively. The effect of the proposed Project on ecosystem diversity is derived from Table 3 in Attachment A.

The ecotypes that will be most affected proportionally will be Gravel Bar (GB), Riparian Thicket (RT) and Marsh (MA). Appropriate mitigation measures to compensate for these losses are presented in the Fisheries Habitat Compensation Plan (IR# JRP.49, IR# JRP.107 and IR# JRP.49S), and include those proposed for Riparian Habitat (IR# JRP.101).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Information Requested:

Using all currently available biodiversity information provided in the EIS and Component Studies, not only Key Indicators, the Proponent is requested to provide an analysis of:

- **b. the species diversity indicating if the proposed project will lead to a direct or indirect loss of a population of species or alter the species-richness or species-composition of habitat in the study area;**

In doing its analysis, the Proponent should reference, to the extent possible, the map(s) requested by the Panel in JRP.15 and JRP.16 (2009-04-28).

Response:

The spatial data mapped within the baseline component studies and EIS were analysed quantitatively. Based on the spatial analyses, species-richness of Black Spruce/Feathermoss (BF) (SR=61), Fir-White Spruce Forest (FW) (SR=64), Gravel Bar (GB) (SR=15), Mixedwood Forest (MW) (SR=93), River (RI) (SR=36), and Riparian Thicket (RT) (SR=80) ecotypes will be most affected by the Project. Although some of these ecotypes have high species richness, there are patches in relatively close proximity elsewhere in the Assessment Area with similarly diverse populations. Nevertheless, there likely will be some effects to localized genetic diversity between remaining metapopulations although inbreeding depression and metapopulation contraction (size reduction) is not expected for the species within these remnant impacted ecosystems. As such, no loss of a population of species or alteration in the species-richness or species-composition of habitat in the study area is predicted.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Information Requested:

Using all currently available biodiversity information provided in the EIS and Component Studies, not only Key Indicators, the Proponent is requested to provide an analysis of:

c. **the genetic diversity and if the proposed project will lead to an extinction of a population of a localized endemic species of scientific, ecological, or cultural value and to what extent it will limit opportunities for populations to interact (i.e. habitat fragmentation);**

In doing its analysis, the Proponent should reference, to the extent possible, the map(s) requested by the Panel in JRP.15 and JRP.16 (2009-04-28).

Response:

The baseline component studies and EIS were reviewed in addition to published literature. Based on the review, it is concluded that the extinction of local populations of endemic species of scientific, ecological, or cultural value is not expected as the majority of the species present within the Project footprint do not have restricted or narrow ecological amplitudes. While the landscape analyses indicate that there will be habitat fragmentation, the magnitude of the effects and the distribution and/or isolation on the landscape is not expected to compromise population viability.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Information Requested:

Using all currently available biodiversity information provided in the EIS and Component Studies, not only Key Indicators, the Proponent is requested to provide an analysis of:

d. predicted habitat fragmentation with reference to specific phases of the project; and

In doing its analysis, the Proponent should reference, to the extent possible, the map(s) requested by the Panel in JRP.15 and JRP.16 (2009-04-28).

Response:

The baseline component studies and EIS were reviewed and quantitative analyses were conducted. Based on the quantitative analysis, the reservoir clearing, construction, and operation of the Project will result in the removal of riparian and wetland habitat over the long term. The mitigation measures planned for the Project include creation of riparian and wetland habitat. The KI wildlife species will not likely be affected adversely by habitat fragmentation or isolation. The ecotypes most affected by habitat fragmentation will be the Black Spruce/Feathermoss Forest (BF), Fir-White Spruce Forest (FW), Spruce Fir/Feathermoss Moss Forest (SF), and Riparian Thicket (RT). Habitat fragmentation is not expected to be high for the upland ecotypes but may be an issue for the Riparian (RT) type and the wildlife species that use this habitat to satisfy their life-requisites. Although these ecotypes make up a relatively small proportion of the landscape, riparian thickets as wildlife corridors contribute disproportionately to population dispersal and connectivity (Malanson 1993; Collinge and Forman 2009). Once in operation, the residual Project effects on biodiversity will likely remain in a relatively steady-state.

References:

Collinge, S.K. and R.T.T. Forman. (2009). Ecology of Fragmented Landscapes. Johns Hopkins University Press, Bethesda. 360 pp.

Malanson, G.P. (1993). Riparian Landscapes. Cambridge University Press, New York. 296 pp.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.83**

Information Requested:

Using all currently available biodiversity information provided in the EIS and Component Studies, not only Key Indicators, the Proponent is requested to provide an analysis of:

e. the biodiversity identifying all significant gaps in knowledge and explain their relevance to key conclusions with respect to the impacts of the project on ecosystem integrity.

In doing its analysis, the Proponent should reference, to the extent possible, the map(s) requested by the Panel in JRP.15 and JRP.16 (2009-04-28).

Response:

The baseline component studies and EIS were reviewed and further literature was consulted in preparation of the response.

Low species richness, the contrast among species traits, and the low redundancy within functional groups is a major characteristic of boreal ecosystems. Because of these attributes, removal of any single species from a boreal forest ecosystem may have an important effect on ecosystem functioning (UNEP 2004).

Knowledge of amphibian/habitat relationships and their distribution in Labrador is limited (Minaskuat 2008a and IR# JRP.10) as is the knowledge of the distribution of vascular and non-vascular plants (Minaskuat 2008b). The knowledge of the biology and ecology of the majority of the plants and animals is relatively comprehensive with the exception that information on the genetic diversity of boreal and taiga ecosystem species is limited. However, there were no major gaps in knowledge and the biodiversity is predicted to remain at current levels, with no likely impacts on ecosystem integrity.

References:

Minaskuat Inc. 2008a. Herpetile Surveys in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2008b. Rare Plant Survey in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project .

United Nations Environmental Program. UNEP. (2004). Convention on Biological Diversity. Scientific Assessment. UNEP/CBD/SBSTTA/10/7, United Nations, New York. 15 pp.

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

JOINT REVIEW PANEL

Attachment A
Sustainable Development – Ecosystem Integrity and Biodiversity Response

IR# JRP.83

October 5, 2009

ATTACHMENT A

LOWER CHURCHILL HYDROELECTRIC GENERATION PROJECT JOINT REVIEW PANEL

IR# JRP.83 – SUSTAINABLE DEVELOPMENT – ECOSYSTEM INTEGRITY AND BIODIVERSITY RESPONSE

Report Prepared for:

NALCOR Energy – Lower Churchill Project

Prepared by:

Matrix Solutions Incorporated

September 2009
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1.0 INTRODUCTION

Jacques Whitford Environment Limited and their sub-consultants (i.e., AMEC Earth and Environmental, Beak Consultants Limited, Harlequin Enterprises, Hunter and Associates, Conor Pacific Environmental Technologies Incorporated, LGL Limited, Minaskuat Incorporated, Northland Associates (1995) Limited, Sikumiut Environmental Management Limited, and Westworth Associates Environmental Limited) conducted several biophysical (terrestrial and aquatic) baseline and impact assessments on behalf of Newfoundland and Labrador Hydro. The studies undertaken by these consultants included (1) background literature reviews, (2) plot sampling for terrain, soils, vegetation, and rare plants, (3) ground- and aerial-based wildlife habitat use (population or presence/absence) surveys for selected terrestrial and aquatic vertebrates, (4) trapping for small mammals and bears, (5) point count surveys for forest song birds, (6) spring staging, breeding pair and brood surveys for waterfowl, (7) nest surveys for raptors, (8) ground-based transects for herpetiles, (9) gillnet, fyke net and angling sampling as well as habitat characterization for fish, (10) habitat modeling, and (11) cross-discipline incidental/anecdotal observations. The data collected, summarized and analyzed by these consultants was provided as terrain and ecological mapping at local and regional scales, home range and habitat use tables and/or maps, density/movement patterns tables and maps, population status and trends tables, species biology and ecology descriptions, and catch-based utilization indices and habitat validation for aquatic species.

Each of these studies represents a component of an overall baseline and post-development biodiversity and ecosystem integrity assessment for the proposed Lower Churchill Hydroelectric Generation project. When these studies were combined, biodiversity and ecosystem integrity was assessed qualitatively in the impact assessment.

Matrix Solutions Incorporated (Matrix) was contracted by NALCOR Energy Incorporated to prepare a response to the Joint Review Panel (IR # JRP.83) Sustainable Development – Ecosystem Integrity and Biodiversity information request. Matrix used the information described briefly above in the preparation of the responses to the Joint Review Panel information requests. The specific responses to the information requests are presented separately. The intent of this report (Appendix A) is to provide detailed supporting documentation (i.e., conceptual background, methodology, and background information) for the specific responses.

2.0 CONCEPTUAL BACKGROUND – BIODIVERSITY AND ECOSYSTEM INTEGRITY

2.1 Biodiversity

Maintenance of current biodiversity levels is considered an important component of ecosystem management (Bocking 2002, Millenium Ecosystem Assessment 2005, Canadian Hewritage 2008). Biodiversity is an important component in ecosystem functioning (Kimmins 1997, Naeem et al. 1999, Loreau et al. 2001, Symstad et al. 2003) and provides an important conceptual link in integrating ecological land classification (ELC), wildlife, and ecosystem health and sustainability (Caldwell 1998, Hak et al. 2007). Integration of biodiversity assessments at all relevant levels, i.e., species, populations, communities, habitats, ecosystem, landscape and bioregional, is now undertaken as part of the environmental impact assessment (EIA) process (Treweek 1999). As well, connections between levels of biodiversity are examined by looking at structural and functional relationships such as connectivity, fragmentation, and disturbance within the landscape (Fahrig 2003, Hongmei 2007).

Diversity is difficult to define but has been described as the relative degree of abundance of plant or animal species, communities, habitats, or habitat features per unit of area (Gaston and Spicer 1998). The convention on biological diversity recognized three levels: genetic, species and ecosystem (Usher 2005). The term genetic diversity refers to intraspecific genetic diversity which represents the range of heritable differences of a trait or set of traits among individuals within a species and includes diversity among individuals within populations as well as variation among different populations (Clarke and Young 2000). Genetic diversity is the fundamental organizational component of biodiversity since species diversity is built from genetic diversity, and ecosystem diversity derives from species diversity. Genetic diversity is shaped by past population processes and affects the sustainability of species and populations in the future (Millar 1999). Stressors that affect survival or selection would be expected to affect genetic diversity by increasing genetic differentiation. If population size within fragments is decreased, fragmentation should result in lower genetic diversity within populations.

Species diversity is often treated as being synonymous with ecological diversity but species diversity is not the only form of ecological diversity (Begon et al. 1995). Habitat diversity is an index that measures the structural complexity of the environment or the number of communities present, while functional diversity is based on ecosystem function or the role of a respective organism within an ecosystem (Kratochwil 1999, Hooper et al. 2002).

Several levels or scales of diversity have been distinguished but, for the purposes of this study, only three are described: (1) alpha diversity – homogeneous habitat or within-habitat diversity, (2) beta diversity – species turnover rates between adjacent habitats and (3) gamma diversity – the diversity of a larger unit such as an island or landscape (Magurran 2003).

2.2 Ecosystem Integrity and Habitat Fragmentation

Also related to biodiversity is ecosystem integrity. Integrity is defined as the quality of being unimpaired, sound, or complete. Ecological integrity measures the composition, structure, and function of an ecosystem, as compared with its historical range of variability (Tierney et al. 2009). To have integrity, an ecosystem should be relatively unimpaired across a range of characteristics and across spatial and temporal scales (De Leo and Levin 1997). Biological production and ecosystem stability sometimes occurs with higher species richness but this can be idiosyncratic. For example, dominant species, individual species traits and not just species richness (number of species) may be more important than the shape of the diversity-functioning relationship (Wall 2004).

An important determinant of ecosystem integrity is the degree of habitat fragmentation (Saunders et al. 1991). Ecosystem fragmentation causes large changes in the physical environment as well as biogeographic changes (Hunter 1999). Fragmentation generally results in a landscape that consists of remnant areas or patches of ecosystems altered or reduced from their historic distribution on the landscape. As a result, fluxes of radiation, momentum (i.e., wind), water, and nutrients across the landscape are altered. The impacts to abiotic factors in turn can have important influences on the biota within remnant areas. The degree of isolation of remnant areas also has important consequences for the biota. These consequences vary with the time elapsed since isolation, distance from other ecosystems, and degree of connectivity with other remnants. As well, the influences of physical and biogeographic changes are modified by the size, shape, and position in the landscape of individual remnants, with larger remnants being less adversely affected by the fragmentation process. The dynamics of remnant areas are driven primarily by factors within the surrounding landscape (Collinge and Forman 2009).

2.3 Boreal (Taiga) Ecozone Biodiversity

The northern boreal forest and subarctic is often characterized as a large, homogeneous expanse with relatively warm summers, cold winters and low species diversity (Johnson and Miyanishi 1999, Elliott-Fisk 2000). Boreal vegetation can be divided into latitudinal subzones and regions (Larson 1980, Meades 1990). As well, boreal forests have two contrasting spatial elements, they are relative homogeneous at the regional level and heterogeneous at the habitat level (Väisänen 1995). The implication of this dichotomy in scale to biodiversity is that taxa "perceive" forested landscape patterns differently. For example, a stand that is homogeneous for birds may be heterogeneous for beetles (Haila et al. 1994).

In general, species diversity decreases poleward due to the severity of the cold winters (Väisänen 1995). The adaptations of the species reflect the short growing season, cold winters and relatively low diversity of resources and adaptations (Oechel and Lawrence 1985). Typically, habitat generalists are more widespread than habitat specialists in the zone (Danks and Foottit 1989, Virkalla 1987). Low species richness, the contrast among species regarding their traits, and the low redundancy within each functional group is a major characteristic of boreal ecosystems. Boreal forests appear to be richer in species below the surface than they are above ground level, a distinctive that separates these ecosystems from those at lower latitudes (Väisänen 1995). In general, the results of the analyses are comparable to the published literature described above.

3.0 METHODOLOGY

The approach used to respond to the Joint Review Panel is provided below:

- Review Joint Review Panel Sustainable Development – Ecosystem Integrity and Biodiversity Information Request IR # JRP.83;
- Review relevant sections of the Component Studies and Environmental Impact Statement (EIS);
- Import and review spatial data and, where necessary, develop integrated and/or surrogate sustainable development, ecosystem integrity and biodiversity metrics;
- Conduct spatial analysis and database queries; and
- Prepare written responses.

Summarized data collected as part of the ELC and related terrestrial and aquatic programs were used as inputs for the assessment. The ELC units were used both to describe vegetation floristic and structural diversity and to act as surrogates for potential animal diversity in the baseline biodiversity assessment. The spatial attributes of the mapped ecosystems were used as the data for the landscape-level biodiversity assessment. Summaries of the life form and structural stage data were also generated from these data. Landscape level statistics such as patch number, patch density, and diversity were calculated to assess patterns and structure in the landscape (Turner et al. 2001, Botequilha Leitão et al. 2006). FRAGSTATS 3.3 software (McGarigal and Marks 1995) was used to calculate the landscape metrics.

4.0 RESULTS

The following section summarizes the analysed data used in support of the responses to the information request of the Joint Review Panel.

4.1 Surficial Geology/Soils

Surficial materials, i.e., their physical and chemical properties as well as their resultant landform geomorphic landforms, are ecosystem drivers along with climate and disturbance regimes (Tierney et al. 2009). Geomorphic surfaces are substrates for ecosystem development and function (Wall 2004); terrain features and soil abiotic and biotic properties are important to consider in biodiversity and ecosystem sustainability assessments (Usher 2005). Consequently, a comparison of surficial materials was undertaken (see Table 1).

The greatest change in the abiotic ecosystem components will be to the water body map unit. Terrestrial fluvial and colluvial parent materials as substrates for upland ecosystems will be lost as well. Smaller impacts were noted for morainal materials.

Approximately 66% of the regional study area is covered by glacial and alluvial tills (sand and gravel podzolic) soils (Ferro-Humic Podzols and Humo-Ferric Podzols) (Minaskuat Incorporated 2008g). Approximately 24% of the study area has Organic soils, with the remainder classified as rock and unconsolidated material. Dystric Brunisols occur on fine textured lower terraces (Roberts et al. 2006).

Table 1. Baseline / post-development surficial geology comparison.

Surficial Geology	Baseline		Post-development		Change
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	Proportion (%)
Anthropogenic	413.66	0.25	413.66	0.25	0.00
Bedrock	190.87	0.12	186.99	0.11	0.00
Colluvial	13,170.46	8.05	12,085.22	7.39	-0.66
Eolian	6,199.11	3.79	6,194.76	3.79	0.00
Fluvial	12,838.09	7.85	10,562.41	6.46	-1.39
Glaciofluvial	21,958.08	13.42	21,303.59	13.02	-0.40
Glaciomarine	1,723.31	1.05	1,567.17	0.96	-0.10
Organic	4,329.43	2.65	4,129.63	2.52	-0.12
Till	77,636.84	47.46	77,541.63	47.40	-0.06
Water Body	25,116.30	15.35	19,382.14	11.85	-3.51
Development	0.00	0.00	10,208.97	6.24	6.24

4.2 Plant Species Diversity

Alpha diversity (within habitat) diversity was not calculated nor was species richness for Anthropogenic/Disturbed (AN) and Unvegetated (UV) map units due to a lack of data. Beta (between habitat) diversity was highly variable within the study area (Table 2). Forested ecotypes such as the Hardwood Forest (HA), Mixedwood Forest (MW) and Spruce-Fir/Feathermoss (SF) had the highest species richness values, while the Wetland (WL) and Gravel Bar (GB) ecotypes had the lowest. The greatest contributors to species richness were forbs, followed by shrubs and graminoids. Bryophyte richness was greatest in the Hardwood Forest (HA) and Mixedwood Forest (MW), while the Black Spruce/Lichen Woodland (BL) contained the greatest number of lichen species.

Table 2. Species diversity.

Ecotypes/Map Units	Number of Samples	Trees	Shrubs	Forbs	Grasses, Sedges and Rushes	Mosses and Liverworts	Lichens	Species Richness
Anthropogenic/Disturbed (AN)	ND	–	–	–	–	–	–	–
Black Spruce/Feathermoss Forest (BF)	24	5	18	22	2	7	7	61
Black Spruce/Lichen Woodland (BL)	28	5	17	12	–	9	12	55
Black Spruce on Bedrock Outcropping (BO)	1	4	7	9	–	2	6	28
Black Spruce/Sphagnum Woodland (BS)	17	3	21	33	8	7	8	80
Fen (FE)	4	4	13	30	18	1	–	66
Fir-White Spruce Forest (FW)	9	7	12	30	5	8	2	64
Gravel Bar (GB)	4	–	3	8	3	–	1	15
Hardwood Forest (HA)	14	7	25	44	9	13	4	102
Low Shrub Bog (LB)	11	2	8	21	15	3	6	55
Marsh (MA)	4	–	6	10	20	–	–	36
Mixedwood Forest (MW)	22	8	17	44	5	11	8	93
Open Water (OW)	2	–	6	9	6	1	–	22
River (RI)	22	–	5	11	20	–	–	36
Riparian Meadow (RM)	4	-	6	14	6	-	-	26
Riparian Thicket (RT)	12	3	15	39	11	8	4	80
Spruce-Fir/Feathermoss Forest (SF)	37	5	22	37	3	12	8	87
Unvegetated (UV)	ND	–	–	–	–	–	–	–
Wetland (WL)	1	–	–	5	6	–	–	11

Sources: Minaskuat Incorporated (2008f, 2008i, 2008j), AMEC Earth and Environmental (2008)

4.3 Ecosystem Structural and Functional Diversity

Functional diversity was inferred from the ELC data by aggregating plant species by life form. The number of tree species is limited within the study area. Forested areas typically have only 3-4 tree species. Shrub species richness, cover and vertical structure, attributes important for small mammals and avifauna are greatest in the Riparian Thicket (RT) and Riparian Meadow (RM) ecotypes. Lichen cover, important as nitrogen fixers and potentially as forage for caribou, is greatest in stands of the Black Spruce/Lichen Woodland (BL) ecotype.

The structural stage descriptions were used to characterize structural diversity at the landscape level (Table 3). Mature open and closed canopy coniferous forests (MCF) are the dominant structural stage in both the baseline (n=3378, 72.65%) and post-development (n=4054, 71.43%) scenarios. Based on the Regional Study (Minaskuat Incorporated 2008g), 49% of the regional study area is classified as coniferous forest, of which, the majority is classified as open or sparse. This statistic is comparable to the Local Study Area, although lower.

Deciduous (MDF) or Mixedwood (MMF) forests comprise a smaller portion of both the baseline (n=467, 5.37%) and post-development (n=544, 4.80%) conditions. Deciduous shrublands and forests contain a greater number and diversity of fauna, particularly bird species, than the coniferous forests within the study area. The observed stature of the forests illustrates potentially the importance of fire in altering the landscape, ecosystems and wildlife habitat in the study area.

Aquatic-dominated structural stage vegetation covers 16.91% (n=914) and 13.42% (n=1795) of the baseline and post-development scenarios, respectively. In comparison, graminoid-dominated fens and marshes comprise only 2.17% (n=309) of the baseline scenario and only 1.64% (n=397) of the post-development scenario.

4.4 Landscape-level Diversity

The size of the study area is 163,576.15 ha and landscape-level calculations revealed that there are a total of 3504 patches within the study area currently. Of the nineteen ecological map units, patch number and abundance were greatest for three ecosystems: (1) Black Spruce/Feathermoss Forest (BF), (2) Black Spruce/Lichen Woodland (BL), and (3) River (RI) ecotypes (Table 4). In general, the proposed project will result in a decrease in mean patch size for each ecotype/map unit and an increase in the number of patches per ecotype (Table 5). The various metrics calculated revealed that patch richness is higher (by one) for the post-development in comparison to the baseline conditions but other metrics reveal that the mean patch size is smaller in the post-development scenario. Landscape structural connectivity, as interpreted by the area-weighted mean radius of gyration, is less in the post-development scenario in comparison to baseline conditions (Table 6).

Table 3. Structural stage diversity.

Structure	Ecotypes/Map Units	Baseline		Post-development		Change
		Number of Polygons	Area (ha)	Number of Polygons	Area (ha)	Area (ha)
aquatic – non-vegetated (AQ-SP)	Open Water (OW)	249	1,126.63	245	958.77	-167.86
aquatic – graminoid-dominated (AQ)	River (RI)	14	23,997.31	898	18,462.06	-5,535.25
aquatic vegetation (AQ)	Wetland (WL)	651	2,532.81	652	2,527.37	-5.44
bryoid-dominated (BR)	Low Shrub Bog (LB)	27	308.18	25	268.35	-39.83
forb-dominated [sparsely vegetated, low shrub] (SP, FO, LS)	Gravel Bar (GB)	201	2,569.45	311	1,876.9	-692.55
graminoid-dominated (GR)	Fen (FE)	77	793.42	69	736.81	-56.61
	Marsh (MA)	31	186.69	17	69.59	-117.10
mature coniferous forest (MCF)	Black Spruce/Feathermoss Forest (BF)	1,608	67,189.55	2017	66,309.27	-880.28
	Black Spruce/Lichen Woodland (BL)	1,285	35,522.49	1330	35,420.08	-102.41
	Spruce-Fir/Feathermoss Forest (SF)	139	8,771.25	272	8,593.13	-178.12
	Black Spruce/Sphagnum Woodland (BS)	131	1144.7	132	1,125.92	-18.78
	Fir-White Spruce Forest (FW)	215	6,216.38	303	5,400.51	-815.87
mature mixedwood forest (MMF)	Mixedwood Forest (MW)	301	6,066.67	357	5,361.51	-705.16
mature deciduous forest (MDF)	Hardwood Forest (HA)	166	2,719.41	187	2,486.99	-232.42
low shrub (LS)	Black Spruce on Bedrock Outcropping (BO)	82	1,078.44	91	1,078.44	0
shrub – graminoid-dominated (TS-GR)	Riparian Meadow (RM)	22	498.84	30	432.62	-66.22
low – tall deciduous shrub (LS-TS)	Riparian Thicket (RT)	188	1,864.07	277	1,272.28	-591.79
sparse – herb-dominated (SP-FO)	Anthropogenic/Disturbed (AN)	62	940.13	73	940.14	0.01
sparse – non-vegetated (SP)	Unvegetated (UV)	10	49.72	17	46.43	-3.29

Table 4. Comparison of baseline and post-development ecotype distribution (diversity).

Ecological Land Classification Unit (Ecotype)	Baseline			Post-development		
	Number of Polygons	Area (ha)	Mean Patch Size ± SD (ha)	Number of Polygons	Area (ha)	Mean Patch Size ± SD (ha)
Anthropogenic/Disturbed (AN)	62	940.13	15.16 ± 30.44	73	940.14	12.88 ± 28.55
Black Spruce/Feathermoss Forest (BF)	1,608	67,189.55	41.78 ± 77.76	2017	66,309.27	32.88 ± 71.10
Black Spruce/Lichen Woodland (BL)	1,285	35,522.49	27.64 ± 63.07	1330	35,420.08	26.63 ± 87.15
Black Spruce on Bedrock Outcropping (BO)	82	1,078.44	13.15 ± 17.44	91	1,078.44	11.85 ± 17.00
Black Spruce/Sphagnum Woodland (BS)	131	1,144.70	8.74 ± 18.33	132	1,125.92	8.53 ± 18.31
Fen (FE)	77	793.42	10.30 ± 12.32	69	736.81	10.68 ± 12.94
Fir-White Spruce Forest (FW)	215	6,216.38	28.91 ± 58.31	303	5,400.51	17.82 ± 49.32
Gravel Bar (GB)	201	2,569.45	12.78 ± 22.61	311	1,876.90	6.04 ± 14.00
Hardwood Forest (HA)	166	2,719.41	16.38 ± 26.39	187	2,486.99	13.30 ± 23.97
Low Shrub Bog (LB)	27	308.18	11.41 ± 11.88	25	268.35	10.73 ± 11.91
Marsh (MA)	31	186.69	6.01 ± 5.04	17	69.59	4.09 ± 4.31
Mixedwood Forest (MW)	301	6,066.67	20.16 ± 30.16	357	5,361.51	15.02 ± 22.17
Open Water (OW)	249	1,126.63	4.52 ± 9.95	245	958.77	3.91 ± 4.57
River (RI)	14	23,997.31	1714.09 ± 6369.38	898	18,462.06	20.56 ± 46.10
Riparian Meadow (RM)	22	498.84	22.67 ± 30.91	30	432.62	14.42 ± 27.56
Riparian Thicket (RT)	188	1,864.07	9.92 ± 16.36	277	1,272.28	4.57 ± 11.57
Spruce-Fir/Feathermoss Forest (SF)	139	8,771.25	63.10 ± 203.64	272	8,593.13	86.35 ± 772.92
Unvegetated (UV)	10	49.72	4.97 ± 3.58	17	46.43	2.73 ± 3.57
Wetland (WL)	651	2,532.81	3.89 ± 4.86	652	2,527.37	3.88 ± 4.86
Project-related Disturbances	–	–	–	148	10,208.97	68.98 ± 833.83

Table 5. Change in ecotype patch areas and proportions.

Ecological Land Classification Unit (Ecotype)	Baseline		Post-development		Change	
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
Anthropogenic/Disturbed (AN)	940.13	0.57	940.14	0.57	0.01	0.00
Black Spruce/Feathermoss Forest (BF)	67,189.55	41.08	66,309.27	40.54	-880.28	0.54
Black Spruce/Lichen Woodland (BL)	35,522.49	21.72	35,420.08	21.65	-102.41	-0.06
Black Spruce on Bedrock Outcropping (BO)	1,078.44	0.66	1,078.44	0.66	0.00	0.00
Black Spruce/Sphagnum Woodland (BS)	1,144.7	0.70	1,125.92	0.69	-18.78	-0.01
Fen (FE)	793.42	0.49	736.81	0.45	-56.61	-0.03
Fir-White Spruce Forest (FW)	6,216.38	3.80	5,400.51	3.30	-815.87	-0.50
Gravel Bar (GB)	2,569.45	1.57	1876.9	1.15	-692.55	-0.42
Hardwood Forest (HA)	2,719.41	1.66	2,486.99	1.52	-232.42	-0.14
Low Shrub Bog (LB)	308.18	0.19	268.35	0.16	-39.83	-0.02
Marsh (MA)	186.69	0.11	69.59	0.04	-117.10	-0.07
Mixedwood Forest (MW)	6,066.67	3.71	5,361.51	3.28	-705.16	-0.43
Open Water (OW)	1126.63	0.69	958.77	0.59	-167.86	-0.10
River (RI)	23,997.31	14.67	18,462.06	11.29	-5,535.25	-3.38
Riparian Meadow (RM)	498.84	0.30	432.62	0.26	-66.22	-0.04
Riparian Thicket (RT)	1,864.07	1.14	1272.28	0.78	-591.79	-0.36
Spruce-Fir/Feathermoss Forest (SF)	8,771.25	5.36	8,593.13	5.25	-178.12	-0.11
Unvegetated (UV)	49.72	0.03	46.43	0.03	-3.29	-0.00
Wetland (WL)	2,532.81	1.55	2,527.37	1.55	-5.44	-0.00
Project-related Disturbances	0.00	0.00	10,208.97	6.24	10,208.97	6.24

Table 6. Landscape-level statistics.

Metrics	Value	
	Baseline	Post-development
Total Area (TA)	163,576.15	163,576.15
Number of Patches (NP)	3,504	3,540
Patch Density (PD)	2.14	2.17
Patch Richness (PR)	19	20
Largest Patch Edge (LPI)	14.58	7.68
Total Edge (TE)	6,551,050	6,300,650
Edge Density (ED)	40.06	38.53
Landscape Shape Index (LSI)	45.97	44.41
Mean Patch Size (AREA_MN)	46.67	46.20
Area-weighted Mean Patch Size (AREA_AM)	5,092.05	3,363.93
Patch Size Coefficient of Variation (AREA_CV)_	1,039.73	847.45
Area-weighted Mean Radius of Gyration (GYRATE_AM)	13,311.09	6,698.31

4.5 Wildlife

Several surveys were undertaken to document the presence and distribution of vertebrates in the study area. The results of these surveys are summarized briefly for the purposes of providing a holistic interpretation of species diversity for the study area. The habitat types used in these reports correspond directly or indirectly with the ELC ecotypes described in the above text.

Woodland caribou use peatlands and mature black spruce forests (e.g., Black Spruce/Feathermoss Forest [BF] and Black Spruce/Lichen Woodland [BL]) (Minaskuat Incorporated 2009). Stuart-Smith et al. (1997) suggest that caribou use spruce forests because they provide refuge from predators while Dunford et al. (2006) suggest these habitats provide an abundance of lichens. In terms of foraging ecology, woodland caribou are lichen specialists that feed on *Cladonia*, *Cladina* and *Usnea* species.

Moose are generalists and adapt to relative abundance of habitat and forage (Conor Pacific Environmental Technologies Incorporated and Westworth Associates Environmental Limited 2000). Within the study area, moose were associated with Fir-White Spruce Forest (FW), Black Spruce/Feathermoss (BF) and other mixed coniferous forests in the fall and winter and wetlands in the spring and summer (Minaskuat Incorporated 2008a).

Bears were associated with black spruce dominated and mixed spruce forests in the spring and summer and habitats ranging from Black Spruce/Feathermoss (BF) to Hardwood (HA) forests in the spring and summer. Wolves were recorded in burned areas infrequently and in all other coniferous forest ecotypes except the Black Spruce / Lichen Woodland (BL). Sign of colored fox were typically documented in riparian, burned, and Mixedwood Forest (MW) stands (Minaskuat Incorporated 2008h). Marten were observed commonly in Black Spruce/Feathermoss Forest (BF) and Black Spruce/Lichen Woodland (BL) ecotypes (Sikumuit Environmental Management Limited 2007).

Porcupine frequent mature Fir-White Spruce stands although they inhabit a variety of mature structural stage forests. Snowshoe hares typically were associated with Mixed-Fir Mixed-Spruce and moist spruce forests (Minaskuat Incorporated 2008h).

Small mammal surveys revealed that red-backed voles were common in moist spruce forests, while meadow voles and woodland jumping mouse inhabit Mixedwood Forests (MW) typically. Red squirrels were observed in most coniferous forest stands (Minaskuat Incorporated 2008h).

Breeding waterfowl inhabit wetland habitat types (e.g., string bogs, fens, marshes, riparian meadows, and riparian thickets) in central Labrador (AGRA Earth and Environmental and Harlequin Enterprises 1999, LGL Limited Environmental Research Associates 2008). Other species that utilize riparian and wetlands in the Lower Churchill River watershed include river otter, beaver, and muskrat (Minaskuat Incorporated 2008b, 2008c). Mink were limited to Riparian Thickets (RT) consisting of willows and alder (Sikumuit Environmental Management Limited 2007a).

Bird richness and abundance were highest in Hardwood Forest (HA) and Mixedwood Forest (MW) forests, were intermediate in riparian areas, and were lowest in spruce-dominated forests. Hardwood Forests (HA), Fir-White Spruce Forest (FW) and Mixedwood Forest (MW) ecotypes provide greater structural diversity and have more diverse ground cover and larger diameter trees. Black Spruce/Feathermoss Forest (BF), Black Spruce/Lichen Woodland (BL), and Black Spruce/Sphagnum Woodland (BS) ecotypes had low breeding songbird richness and abundance and low structural diversity (Minaskuat Incorporated 2008d).

Wetland and white spruce-dominated habitats supported significantly more avifauna species and individuals at lower elevations. Osprey and Bald Eagle nests were located in tall white and black spruce adjacent to water bodies (Jacques Whitford Environment Limited 1999, Minaskuat Incorporated 2008e).

American toads, northern leopard frog, mink frog, and wood frog were reported in riparian (RT and RM) ecotypes. Two-lined salamander was recorded in a Mixedwood (MW) ecotype (Minaskuat Incorporated 2008c).

Fisheries surveys conducted by AMEC Earth and Environmental and Sikumiut Environmental Management Limited (2007) revealed 4 species within the Lake Melville area and 16 species within the Churchill River.

5.0 SUMMARY

Spatial biophysical data was acquired for the Lower Churchill Hydroelectric Generation Project and analysed for baseline and post-development. The data were analyzed for impacts on biodiversity, and ecosystem integrity and sustainability. The proposed project will have direct impacts to stands of several ecosystems (ecotypes). The ecotypes most affected will be the Black Spruce/Feathermoss (BF), Fir-White Spruce Forest (FW), Mixedwood Forest (MW), and Riparian Thicket (RT). Due to a smaller presence on the landscape, the Riparian Thicket ecotype will be proportionately more affected. As expected, the River (RI) map unit will be lost to inundation. Based on habitat quantification, there will be aquatic habitat alteration due to the physical presence of the reservoirs but an overall increase in productive fish habitat is anticipated.

6.0 REFERENCES

AGRA Earth and Environmental and Harlequin Enterprises. (1999). *Churchill River Power Project. LHP98-01 Waterfowl*. Prepared for Labrador Hydro Project by AGRA Earth and Environmental and Harlequin Enterprises, St. John's. 158 pp.

Abell, R., D. Olson, E. Dinerstein, P. Hurley, J. Diggs, W. Eichbaum, S. Walters, W. Wettengel, T. Allnutt, C. Loucks and P. Hedao. (1999). *Freshwater Ecoregions of North America, A Conservation Assessment*. Volume 2. World Wildlife Fund and Island Press, Washington DC. 368 pp.

AMEC Earth and Environmental. (2007). *Lower Churchill Hydroelectric Development Fish and Fish Habitat Baseline: Catch-based Utilization Index Validation and Additional Habitat Surveys*. Prepared for Newfoundland and Labrador Hydro by AMEC Earth and Environmental, A Division of AMEC Americas Limited, St. John's. 154 pp.

AMEC Earth and Environmental. (2008). *Lower Churchill Hydroelectric Generation Project Aquatic Vegetation Studies*. Prepared for Newfoundland and Labrador Hydro by AMEC Earth and Environmental, A Division of AMEC Americas Limited, St. John's. 54 pp.

AMEC Earth and Environmental and Sikumiut Environmental Management Limited. (2007). *Lower Churchill Hydroelectric Generation Project Habitat Quantification (TF6110443).* Prepared for Newfoundland and Labrador Hydro by AMEC Earth and Environmental, A Division of AMEC Americas Limited, St. John's. 268 pp.

Baird-Callicott, J. and K. Mumford. (1998). Chapter 3. Ecological sustainability as a conservation concept. *Ecological Sustainability and Integrity: Concepts and Approaches*. (J. Lemons, L. Westra and R. Goodland, Editors). Environmental Science and Technology Library, Kluwer Academic Publishers, New York. pp. 31-45.

Begon, M, J.L. Harper and C.R. Townsend. (1995). *Ecology: Individuals, Populations and Communities*. Third Edition. Blackwell Scientific Publications, Boston. 1000 pp.

Bocking, S. (2002). *Biodiversity in Canada. Ecology, Ideas and Action*. Broadview Press, Toronto. 400 pp.

Botequilha Leitão, A., J. Miller, J. Ahern and K. McGarigal. (2006). *Measuring Landscapes: A Planner's Handbook*. Island Press, Washington DC. 268 pp.

Caldwell, L.K. (1998). Chapter 1. The concept of sustainability: a critical approach. *Ecological Sustainability and Integrity: Concepts and Approaches*. (J. Lemons, L. Westra and R. Goodland, Editors). Environmental Science and Technology Library, Kluwer Academic Publishers, New York. pp. 1-15.

Clarke, G.M. and A.G. Young. (2000). Introduction: genetics, demography and the conservation of fragmented populations. *Genetics, Demography and Viability of Fragmented Populations*. Cambridge University Press, Cambridge. pp. 1-6.

Collinge, S.K. and R.T.T. Forman. (2009). *Ecology of Fragmented Landscapes*. Johns Hopkins University Press, Bethesda. 360 pp.

Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. (2000). *Moose and the Proposed Churchill River Power Project: A Literature Review. LHP 98-25. Labrador Hydro Project*. Prepared by Newfoundland and Labrador Hydro by Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Limited, St. John's and Edmonton. 185 pp.

Danks, H.V. and R.G. Foottit. (1989). Insects of the boreal zone of Canada. *Canadian Entomologist*, 121, 626-690.

De Leo, G.A. and S. Levin. (1997). The multifaceted aspects of ecosystem integrity. *Conservation Ecology*, 1, 3.

Dunford, J.S., P.D. McLoughlin, F. Dalerum and S. Boutin. (2006). Lichen abundance in the peatlands of northern Alberta: implications for boreal caribou. *Ecoscience*, 13, 4, 469-474.

Elliott-Fisk, D.L. (2000). The taiga and boreal forest. *North American Terrestrial Vegetation*. Second Edition. (M.G. Barbour and W.D. Billings, Editors). Cambridge University Press, Cambridge. pp. 41-74.

Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology and Systematics*, 34, 487-515.

Gaston, K.J. and J.I. Spicer. (1998). *Introduction to Biodiversity*. Blackwell Science Publishers, Malden. 128 pp.

Government of Canada. (1995). *Canadian Biodiversity Strategy: Canada's Response to the Convention Biological Diversity*. Environment Canada, Ottawa. 84 pp.

Haila, Y., I.K. Hanski, J. Niemelä, P. Puntilla, S. Raivio and H. Tukia. (1994). Forestry and the boreal fauna: matching management with the natural forest dynamics. *Annales Zoologici Fennici*, 31, 187-202.

Hak, T., B. Moldan and A.L. Dahl. (2007). *Sustainability Indicators: A Scientific Assessment*. Island Press, Washington DC. 413 pp.

Hongmei, W., Q. Jinping, Z. Xiulan and H. Xiubin. (2007). Biodiversity sustainability assessment of principal ecosystems in Hebei, China. *Wuhan University Journal of Natural Sciences*, 12, 4, 749-754.

Hooper, D.U., M. Solan, A. Symstad, S. Diaz, M.O. Gessner, N. Buchmann, V. Degrange, P. Grime, F. Hulot, F. Mermillod-Blondin, J. Roy, E. Spehn and L. van Peer. (2002). Chapter 17. Species diversity, functional diversity and ecosystem functioning. *Biodiversity and Ecosystem Functioning – Synthesis and Perspectives*. (Loreau, M., S. Naeem and P. Inchausti, Editors). Oxford University Press, Oxford. pp. 195-208.

Hunter, M., Jr. (1999). Biological diversity. Part I. Introduction. *Maintaining Biodiversity in Forest Ecosystems*. (M.L. Hunter Jr., Editor). Cambridge University Press, Cambridge. pp. 3-21.

International Association for Impact Assessment. (2005). *Biodiversity in Impact Assessment*. International Association for Impact Assessment, Fargo. 4 pp.

Jacques Whitford Environment Ltd. (1999). *Churchill River Power Project 1998 Environmental Studies. Osprey and Bald Eagle Study LHP 98-11.* Prepared for Newfoundland and Labrador Hydro by Jacques Whiford Environment Limited, Goose Bay. 54 pp.

Johnson, E.A. and Miyanishi. (1999). Subarctic lichen woodlands. *Savannas, Barrens and Rock Outcrop Plant Communities of North America*. (R.C. Anderson, J.S. Fralish and J. M. Baskin, Editors). Cambridge University Press, Cambridge. pp. 421-436.

Kimmins, J.P. (1997). Biodiversity and its relationship to ecosystem health and integrity. *The Forestry Chronicle*, 73, 2, 229-232.

Kratochwil, A. (1999). Biodiversity in ecosystems: some principles. *Biodiversity in Ecosystems: Principles and Case Studies of Different Complexity Levels*. Tasks for Vegetation Science 34. (A. Kratochwil, Editor). Kluwer Academic Publishers, Dordrecht. pp. 5-38.

Larson, J.A. (1980). *The Boreal Ecosystem*. Academic Press, New York. 500 pp.

LGL Limited Environmental Research Associates. (2008). *Waterfowl in the Lower Churchill River Area Environmewntal Baseline Report LCP 08-06-06(A), LCP 12-06-06 (B) and LCP 28-04-07 (C).* Final Report. July 2008. Prepared for Minaskuat Limited Partnership by LGL Limited Environmental Research Associates, Sidney. 162 pp.

Lindenmayer, D. and J. Fischer. (2006). *Habitat Fragmentation and Landscape Change: An Ecological and Conservation Synthesis*. Island Press, Covello. 344 pp.

Loreau, M., S. Naeem, P. Inchausti, J. Bengtsson, J.P. Grime, A. Hector, D.U. Hooper, M.A.Huston, D. Raffaelli, B. Schmid, D. Tilman and D.A. Wardle. (2001). Biodiversity and ecosystem functioning: current knowledge and future challenges. *Science*, 294, 804-808.

Magurran, A.E. (2003). *Measuring Biological Diversity*. Blackwell Science Publishers, Malden. 260 pp.

McGarigal, K. and B.J. Marks. (1995). *FRAGSTATS: Spatial Pattern Analysis Program for Quantifying Landscape Structure*. General Technical Report PNW-GTR-351. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland. 122 pp.

Meades, S.J. (1990). *Natural Regions of Newfoundland and Labrador*. Protected Areas Association, St. John's. 374 pp.

Millar, C. (1999). Genetic diversity. Part III. The Micro Approach, Managing Forested Stands. *Maintaining Biodiversity in Forest Ecosystems*. (M.L. Hunter Jr., Editor). Cambridge University Press, Cambridge. pp. 460-497.

Millenium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being: Biodiversity Synthesis*. Water Resources Institute, Washington DC. 96 pp.

Minaskuat Inc. (2008a). *The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Moose (Alces alces) LCP535746.* Interim Report. January 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 82 pp.

Minaskuat Inc. (2008b). *Inventory of Beaver Colonies in the Lower Churchill River Valley Environmental Baseline Report LCP 535743.* Final Report. June 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 56 pp.

Minaskuat Inc. (2008c). *Herpetile Surveys in the Lower Churchill River Valley Environmental Baseline Report LCP 535746.* Final Report. June 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 42 pp.

Minaskuat Inc. (2008d). *Forest Songbird Surveys Environmental Baseline Report LCP 535750.* Final Report. June 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 101 pp.

Minaskuat Inc. (2008e). *Inventory of Osprey, Bald Eagle and Golden Eagle Nest Sites in the Lower Churchill River Valley and Area Environmental Baseline Report. LCP535747.* Final Report. June 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 40 pp.

Minaskuat Inc. (2008f). *Rare Plant Survey in the Lower Churchill River Valley.* Final Report. June 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 108 pp.

Minaskuat Inc. (2008g). *Regional Ecological Land Classification Environmental Baseline Report LCP 535722*. Final Report. July 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 44 pp.

Minaskuat Inc. (2008h). *Wildlife Habitat Associations in the Lower Churchill Valley Environmental Baseline Report LCP 535740*. Draft Report. August 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 74 pp.

Minaskuat Inc. (2008i). *Lower Churchill Hydroelectric Generation Project. Environmental Baseline Report Wetland Assessment and Evaluation LCP 535750*. Final Report. September 2008. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 64 pp.

Minaskuat Inc. (2008j). *Project Area Ecological Land Classification Environmental Baseline Report LCP 535722. Final Report*. Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 206 pp.

Minaskuat Inc. (2009). *Project Area Ecological Land Classification Environmental Baseline Report: Caribou (Rangifer tarandus caribou). LCP 588577. Final Report.* Prepared for Newfoundland and Labrador Hydro by Minaskuat Limited Partnership, Happy Valley-Goose Bay. 84 pp.

Naeem, S., F.S. Chapin III, R. Costanza, P.R. Ehrlich, F. B. Golley, D.U. Hooper, J.H. Lawton. R.V. O'Neill, H.A. Mooney, O.E. Sala, A.J. Symstad and D. Tilman. (1999). Biodiversity and ecosystem functioning: maintaining natural life support processes. *Issues in Ecology*, 4, 2-12.

Oechel, W.C. and W.T. Lawrence. (1985). Taiga. *Physiological Ecology of North American Plant Communities*. (B.F. Chabot and H.A. Mooney, Editors). Chapman and Hall Publishers, New York. pp. 66-94.

Protected Areas Association of Newfoundland and Labrador. (1993). *Towards Sustainable Development. A Protected Natural Areas Strategy for Newfoundland and Labrador. Part 1 Terrestrial Component*. Prepared by the Protected Areas Association with the Environmental Partners Fund, Parks Division of the Department of Tourism and Culture and the World Wildlife Fund, St. Johns. 56 pp.

Ricketts, T., E. Dinerstein, D. Olson, C. Loucks, W. Eichbaum, D. DellaSalla, K. Kavanagh, P. Hedao, P. Hurley, K. Carney, R. Abell and S. Walters. (1999). *Terrestrial Ecoregions of North America, A Conservation Assessment*. Volume 2. World Wildlife Fund and Island Press, Washington DC. 508 pp.

Roberts, B.A., N.P.P. Simon and K.W. Deering. (2006). The forests and woodlands of Labrador, Canada: ecology, distribution and future management. *Ecological Research*, 21, 868-880.

Saunders, D.A., R.J. Hobbs and C.R. Margules. (1991). Biological consequences of ecosystem fragmentation: a review. *Conservation Biology*, 5, 18-32.

Sikumiut Environmental Management Ltd. (2007a). *Lower Churchill Hydroelectric Generation Project Environmental Baseline Report Furbearer Winter Habitat Use*. Prepared for Labrador Hydro Project by Sikumiut Environmental Management Limited, St. John's. 81 pp.

Sikumiut Environmental Management Ltd. (2007b). *Lower Churchill Hydroelectric Generation Project Environmental Baseline Report Seal Abundance and Distribution.* Prepared for Labrador Hydro Project, Newfoundland and Labrador Hydro by Sikumiut Environmental Management Limited, St. John's. 30 pp.

Stuart-Smith, A.K., C.J. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. (1997). Woodland caribou relative to landscape patterns in northeastern Alberta. *Journal of Wildlife Management*, 61, 622-633.

Symstad, A.J., F.S. Chapin III, D.H. Wall, K.L. Gross, L.F. Huenneke, G.G. Mittelbach, D.P.C. Peters and D. Tilman. (2003). Long-term and large-scale perspectives on the relationship between biodiversity and ecosystem functioning. *Bioscience*, 53, 1, 89-98.

Tierney, G.L., D. Faber-Langendoen, B.R. Mitchell, W.G. Shriver and J.P. Gibbs. (2009). Monitoring and evaluating the ecological integrity of forest ecosystems. *Frontiers in Ecology and the Environment*, 6, 7, 308-316.

The Precautionary Principle Project. (2003). *Guidelines for Applying the Precautionary Principle to Biodiversity Conservation and Natural Resource Management*. IUCN and Fauna and Flora International, Cambridge. 12 pp.

Canadian Heritage. (2008). *The Canadian Biodiversity Web Site*. The RedPath Museum, McGill University, Montreal. http://canadianbiodiversity.mcgill.ca/ accessed August 24th, 2009

Treweek, J. (1999). *Ecological Impact Assessment*. Blackwell Science Publishers, Malden. 364 pp.

Turner, M.G., R.H. Gardner and R.V. O'Neill. (2001). *Landscape Ecology in Theory and Practice: Pattern and Process*. Springer-Verlag Publishers, New York. 352 pp.

United Nations Environmental Program (UNEP). (2004). *Convention on Biological Diversity*. Scientific Assessment. UNEP/CBD/SBSTTA/10/7, United Nations, New York. 15 pp.

Usher, M.B. (2005). Soil biodiversity, nature conservation and sustainability. *Biological Diversity and Function in Soils*. (R.D. Bardgett, M.B. Usher and D.W. Hopkins, Editors). Cambridge University Press, Cambridge. pp. 363-380.

Väisänen, R. (1995). Boreal forest ecosystems. *Caring for the Forest: Research in a Changing World*. IUFRO XX World Congress, 6-12, 1995, Tampere, Finland. International Union of Forest Research Organizations Secretariat, Vienna. 12 pp.

Virkkala, R. (1993). Ranges of northern forest passerines: a fractal analysis. *Oikos*, 67, 218-226.

Wall, D. (2004). *Sustaining Biodiversity and Ecosystem Services in Soils and Sediments*. Island Press, Washington DC. 275 pp.

IR# JRP.84

Water Management and Operating Regime

Requesting Organization – Joint Review Panel **Information Request No.: JRP.84**

Subject – Water Management and Operating Regime

References:

EIS, Volume IIA, Appendix IIA-A (Biophysical Environmental Assessment Summary Tables)

EIS, Volume IIB, Section 5.11.2 (Change in Habitat during Operation and Maintenance) & Appendix IIB-A (Biophysical Environmental Assessment Summary Tables)

Related Comments / Information Requests:

IR#JRP.32

Rationale:

The EIS states that "The Gull Island Reservoir will operate as close to FSL (125 m) as possible, with minimum fluctuations in water level. Daily fluctuations will be a few centimetres, whereas weekly fluctuations could range up to 1 m. There may be periods when the reservoir level will change rapidly. For example, in preparation for the substantial inflows that result from melting snow in spring, **the reservoir could be drawn down to LSL at 122 m and could rise to FSL at 125 m**, upon the arrival of the water. The Gull Island Reservoir will have a maximum flood elevation of 127 m" (Volume IIB, p. 5-61) (emphasis added).

From this, the Panel understands that the possible range of fluctuation, which would be maximized in preparation for substantial inflows in the springtime, would be **3 m** (from 122 to 125 m).

However, the EIS also mentions that "the existing range of fluctuation is approximately **2.2 m**" (Volume IIB, p. 5-61) (emphasis added) and that "Consequently, the future operating regime (...) **will have less water level fluctuation than is currently the case** and will be less than occurs in a natural (unregulated) watershed." (Volume IIB, p. 5-61) (emphasis added).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.84**

Information Requested:

The Proponent is asked to clarify:

a. **the predicted range of fluctuations for the Gull Island Reservoir given the statement in the EIS that there will be "less water level fluctuation than is currently the case";**

Response:

The statement on page 5-61 of Volume IIB noted above takes into account two aspects of water level fluctuation with respect to the proposed reservoirs: the frequency of water level change and potential range of water level change. The overall potential range would be marginally greater but fluctuation frequency would be reduced.

A full drawdown in the Gull Island Reservoir from full supply to low supply level would result in slightly greater overall water level change during the drawdown and re-filling associated with capture of the spring freshet than is observed during current conditions within the Churchill River (Figures 1 and 2). However, the full drawdown and refilling cycle would last little more than approximately one month, with less time at the lower water levels, whereas during the remainder of the year, water levels would be maintained at full supply level (see Figure 1).

Both reservoirs of the Lower Churchill development will be operated as close as possible to full supply level (125 masl for Gull Island and 39 masl for Muskrat Falls). However, managing the reservoir in preparation for the spring freshet may require drawdowns of up to 3 m in the Gull Island Reservoir. Drawdown within the Gull Island Reservoir to a minimum elevation of 122 masl would occur during April in anticipation of the spring freshet (Figure 1). The reservoir would then be refilled to the full supply level once the spring freshet commences with the reservoir reaching full supply by early June (Figure 1). Throughout the rest of the year, Gull Island Reservoir will be maintained as near as possible to full supply level with minimal fluctuation.

Since drawing down the reservoir reduces the efficiency of the Gull Island plant, any decision to draw down the reservoir will be based on estimates of anticipated runoff based on snow pack estimates and precipitation forecasts. The actual drawdown level may be less than 3 m if strong runoff during the spring freshet is not anticipated.

Currently, the lower Churchill River experiences variation in river water levels, the degree dependent on the location along the river. Although water levels in some locations might vary by up to 2.2 m (Figure 2) water level fluctuations in most of the river will range between 0.5 to 1.6 m (Figure 2). Peaks typically will occur in May, with lows in September. The power production from the Churchill Falls Development also produces short-term fluctuations in water levels on a daily and weekly basis (see Figure 3). With the creation of the Gull Island and Muskrat Falls reservoirs, there will be little variability in reservoir water level throughout most of the year, except for the late winter/early spring drawdown (Figure 1).

It should be noted that the fish habitat compensation planning process has also recognized that fluctuations in water level, particularly during spring, can have implications for the survival of eggs spawned in these areas. This has been considered in ongoing compensatory habitat design.

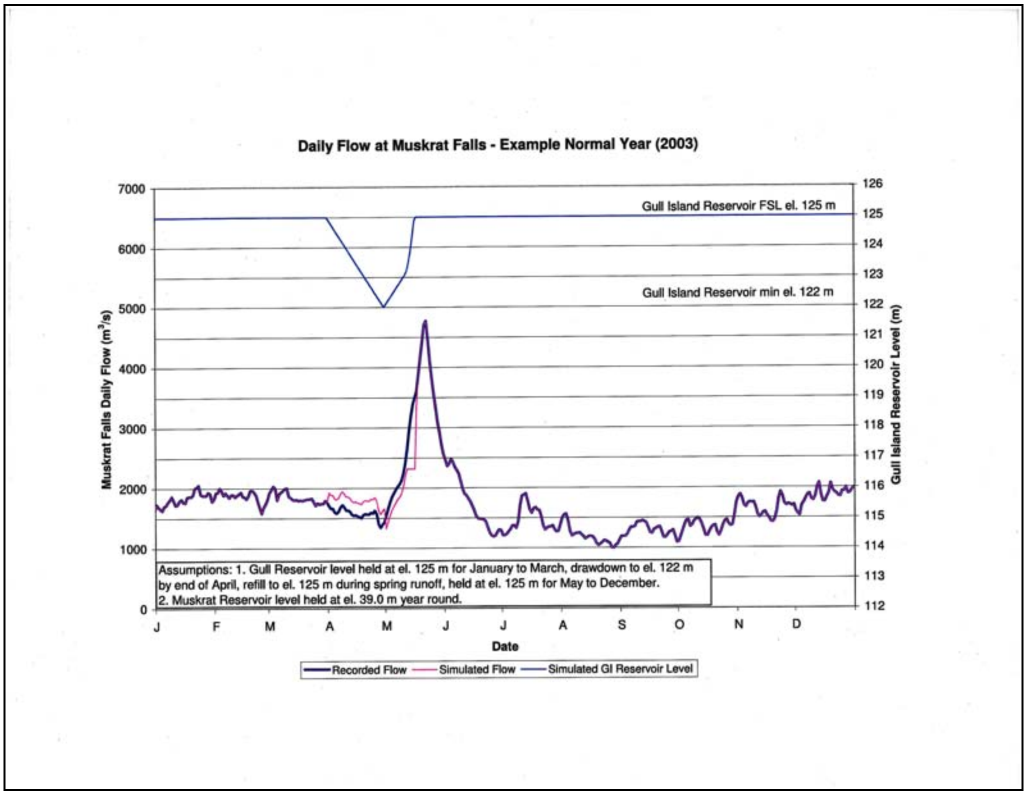


Figure 1 **Gull Island Reservoir Water Level and Daily Muskrat Falls Pre-Impoundment and Simulated Post Impoundment Discharge**

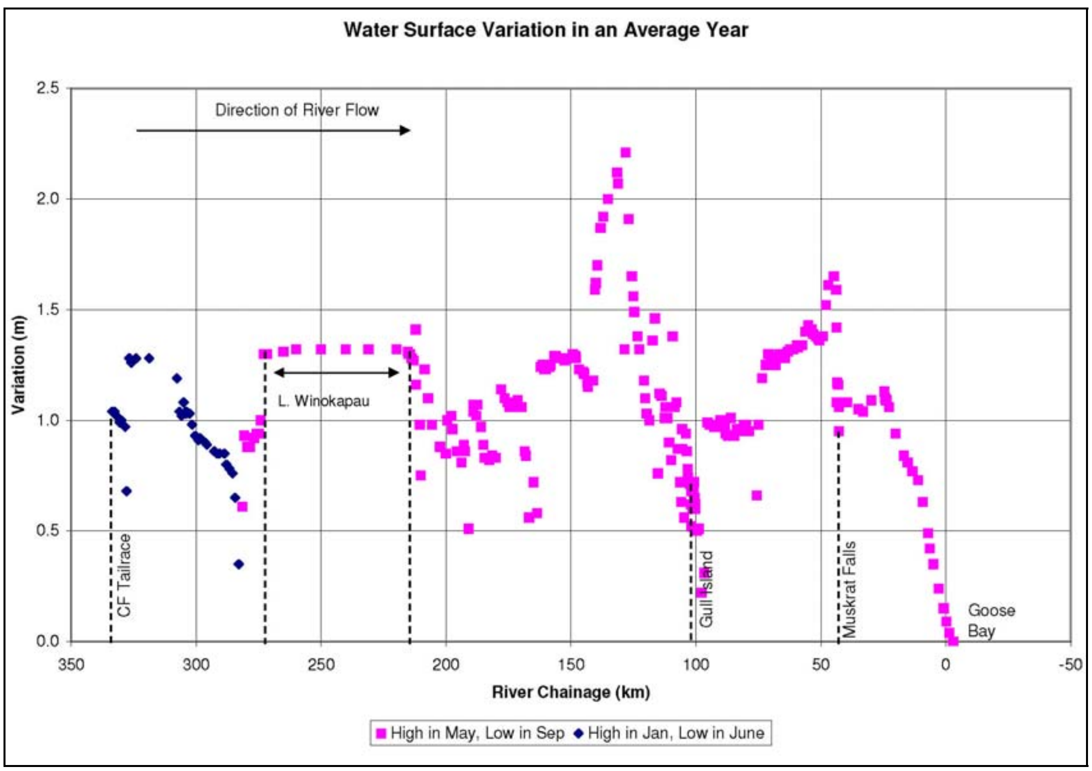


Figure 2 **Water Surface Variation of the Lower Churchill River throughout a Typical Year**

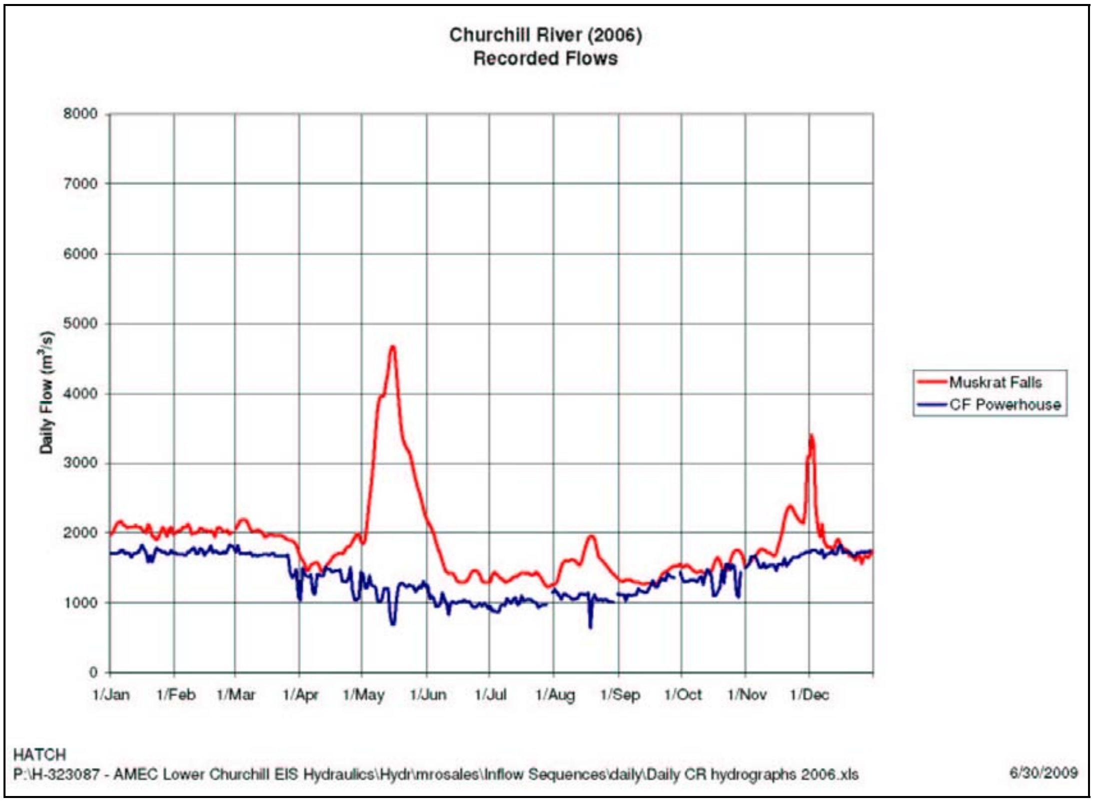


Figure 3 **Flows within the Lower Churchill River through the Churchill Falls Hydroelectric Development and at Muskrat Falls**

Requesting Organization – Joint Review Panel **Information Request No.: JRP.84**

Information Requested:

The Proponent is asked to clarify:

b. whether this apparent discrepancy (3 m versus 2.2 m) may influence the assessment of the Project's predicted environmental effects on the following environment components for which the various tables in Appendices IIA-A and IIB-A state that "fluctuations will be similar or less than existing conditions":

- **Fish and fish habitat (Table IIA-A-3);**
- **George River caribou herd (Table IIB-A-1);**
- **Moose (Table IIB-A-5);**
- **Black Bear (IIB-A-7);**
- **Beaver (IIB-A-9);**
- **Marten (IIB-A-11);**
- **Porcupine (II-A-13);**
- **Canada Goose (IIB-A-15);**
- **Surf Scoter (IIB-A-l7);**
- **Ruffed Grouse (IIB-A-19);**
- **Osprey (IIB-A-21);**
- **Wetlands sparrows (IIB-A-23);**
- **Harlequin duck (IIB-A-25); and**
- **Other species of concern (IIB-A-27).**

Response:

As explained in part (a), the statement on page 5-61 of Volume IIB of the EIS takes into account two aspects of water level fluctuation with respect to the proposed reservoirs: the frequency of water level change and potential range of water level change. While the fluctuation level may be slightly greater, the post-development fluctuation frequency is less than prior to the development. In this respect, there is no discrepancy between the identified water levels. The above information was incorporated into all assessments. Therefore, the predicted environmental effects on the above listed components remain valid.

IR# JRP.85

Project GHG Emissions

Requesting Organization – Joint Review Panel **Information Request No.: JRP.85**

Subject – Project GHG Emissions

References:

EIS Guidelines, Section 4.5.1 (Environmental Effects)

EIS Volume IIA, Section 2.2.3 (Greenhouse Gas Emissions)

Related Comments / Information Requests:
CEAR # 184 (Sierra Club Atlantic)
CEAR # 194 (Mouvement au Courant)
CEAR # 200 (Grand Riverkeeper Labrador Inc.)
CEAR # 203 (Hydro-Québec)

IRs # JRP.7, 27, 46, 88, 99, 100

Rationale:

The EIS Guidelines require that "the Proponent shall describe and analyze GHG emissions from the Project (including methane). This shall include provision of a GHG budget for emissions from all phases of the Project" (p. 33).

There is no reference to NOx as a contributor of GHGs and how it would contribute to the GHGs produced by the Project in the EIS.

In Section 2.2.3 of Volume IIA, the Proponent cites the results of a component study on greenhouse gas fluxes in the Smallwood Reservoir and future reservoir areas. The results presented are based on measurements made in 2006.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.85**

Information Requested:

The Proponent is asked to provide:

a. **any additional new data on GHGs that are available for the Smallwood Reservoir;**

Response:

Aside from information presented in the component study "Green House Gas Fluxes" (Environnement Illimité, 2007) which formed part of the original EIS submission, no additional data are available on GHGs for the Smallwood Reservoir.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.85**

Information Requested:

The Proponent is asked to provide:

b. **a comprehensive GHG budget for emissions from all Project sources from all phases, including Project emissions of NOx. Phases include construction, operation, and decommissioning, Project sources should be inclusive of both physical components and activities associated with the Project (i.e. timber harvesting, worker transportation, reservoir clearing, transport of timber, etc.);**

Response:

A comprehensive GHG emissions inventory has been developed for the Project for construction and operation and this has been presented in the EIS (Volume IIA, Chapter 3, Section 3.9.1.1 and 3.9.2). The GHG emissions for the decommissioning phase have not been considered by Nalcor Energy (Nalcor). This estimate would be prepared in the event that the plant is decommissioned (refer to response IR# JRP.40). For construction, the estimate was made on the basis of best estimates of heavy equipment and vehicle activity during construction and a best estimate of the anticipated fuel consumption throughout the construction period at each proposed site, including temporal overlap. This estimate includes the fuel used for worker transportation, reservoir clearing and timber harvesting. The assessment of GHG emissions during operation was made on the basis of the carbon stocks and carbon fluxes that are anticipated to occur during operation. The carbon modeling accounts for the change in forest cover, size of the reservoirs, zero, partial and full reservoir clearing, and organic material decomposition, among many other processes. This information has been provided in detail in the EIS (Volume IIA – Chapter 3 and in Lower Churchill Hydroelectric Generation Project GHG Emissions Study (Minaskuat 2008).

The compounds considered by Environment Canada in its *Notice with Respect to Reporting of Greenhouse Gases (GHGs) for 2009* do not list NOx as a greenhouse gas subject to mandatory reporting. Nitrous oxide or N_2O is subject to mandatory reporting, and it has been considered in the EIS. Since N_2O emissions from boreal reservoirs are typically very low, relative to CO_2 and CH_4 (United Nations Educational Scientific and Cultural Organization (UNESCO) 2006; International Panel on Climate Change (IPCC) 2006), it has been suggested that "N_2O emissions need not be included in future reservoir induced GHG research" (UNESCO 2006). As a result N_2O was not considered a GHG of substantive importance and therefore not considered further in the Lower Churchill Hydroelectric Generation Project GHG Emissions Study (Minaskuat 2008) or the EIS.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.85**

Information Requested

The Proponent is asked to provide:

c. **a discussion of how reservoir clearing and the loss of carbon sinks has been factored into the GHG budget, including how the Proponent will account for this loss over the long term; and**

Response:

The assessment of GHG emissions included, as part of the assessment, the reservoir clearing activities.

This assessment was made on the basis of the carbon stocks and carbon fluxes that are anticipated to occur during operation, when the reservoir areas are flooded. An inventory was done for the existing or baseline condition (pre-flooding) and a carbon model was set up and used to account for the changes to the carbon stocks as a result of the flooding over the reservoir area. The carbon modeling accounts for the change in forest cover, size of the reservoirs, zero, partial and full reservoir clearing, the organic material present initially, influxes from the watershed, organic material decomposition, and many other processes. The GHG emissions during operation have been predicted with the carbon model for three different clearing scenarios: no clearing, partial clearing and full clearing. The result is a range of estimated emissions as shown in Table 1 below.

This information has been provided in detail in the EIS (Volume IIA, Chapter 3 and in Lower Churchill Hydroelectric Generation Project GHG Emissions Study (Minaskuat 2008).

Table 1 GHG Emission Estimates for Lower Churchill Hydroelectric Generation Project – Effect of Reservoir Clearing

	Total Emissions – Gull Island and Muskrat Falls (tonnes CO_2 eq/yr)		
	No Clearing	**Partial Clearing**	**Full Clearing**
Year 2	1,160,176	1,090,831	938,625
Year 20	124,997	123,624	120,611
50-year average	280,275	218,706	143,313
100-year average	202,636	196,165	181,962

Notes:
Values based on information in Table 3-12 of the EIS Volume IIA, p. 3-18

Requesting Organization – Joint Review Panel **Information Request No.: JRP.85**

Information Requested:

The Proponent is asked to provide:

d. **a discussion of how this Project will affect short, medium and long term provincial, national and international emission reduction objectives, commitments, and requirements, including any plans to offset emissions.**

Response:

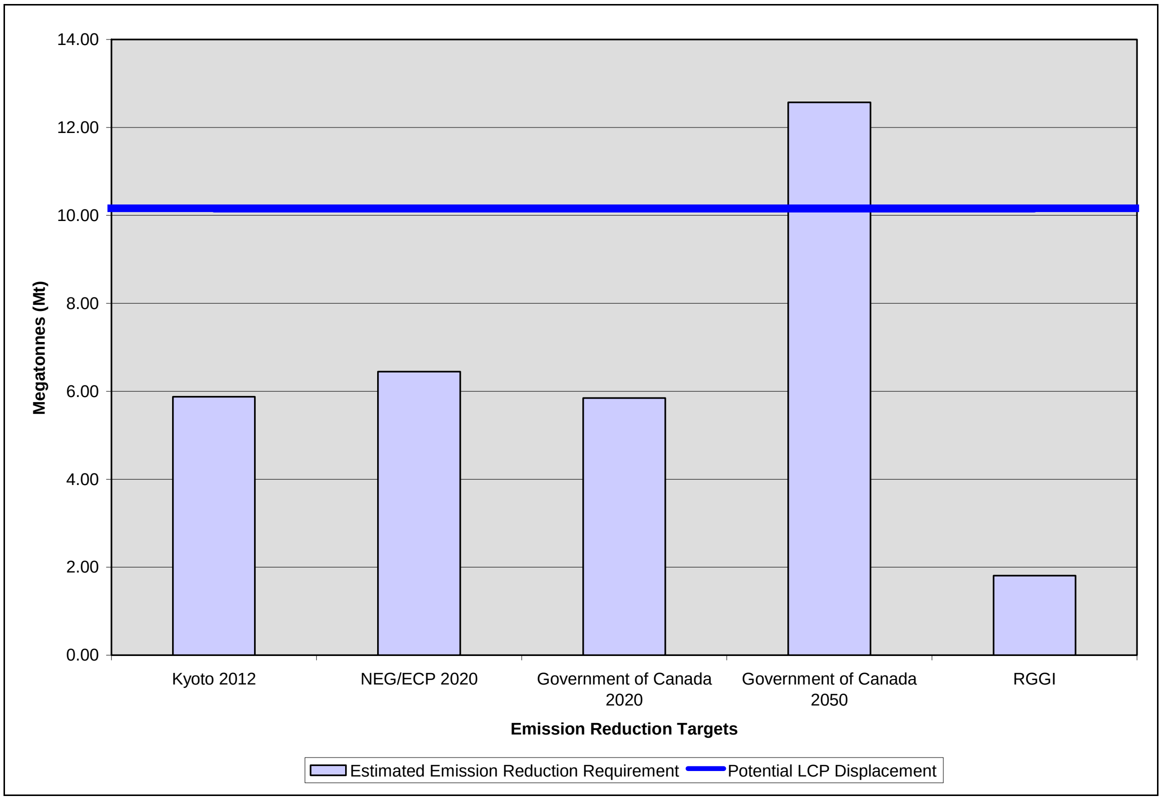
In the absence of emission forecasts, published 2004-2006 annual average emissions were used as a proxy for future emissions to estimate required reductions throughout this response. In addition, the potential greenhouse gas displacement values were calculated utilizing Nalcor's internal assumptions on the types of generation that would be displaced by power generation from the Project. As such, the reduction requirements identified in this response are general estimates only and should be treated as such by the Review Panel.

The response to IR# JRP.7 identified the potential displacement of up to 10.1 Mt of greenhouse gas emissions per year in Atlantic Canada based on different market sales scenarios.

Figure 1 highlights the emission reductions that are required in the electricity sector in Atlantic Canada to meet various GHG emission reduction targets. Estimates indicate that the potential displacement of fossil-fuel generation in the region by power generation from the Project could result in reductions that are sufficient to meet the most of the medium-term targets. In addition, the potential displacement of 10.1 Mt of emissions by the Project in the region accounts for approximately 14 percent of the reductions that would be required by the Atlantic Canadian electricity sector under the Government of Canada's long term GHG reduction target of 60-70 percent below 2006 emission levels.

The Project will also be a substantive contributor to GHG emission reduction targets at the national level. Figure 2 illustrates the potential reductions that would be required by the electricity sector across the country to meet the stated targets of the Government of Canada and the Kyoto Protocol. The total potential displacement of up to 11.5 Mt of GHG emissions from the Project (10.1 Mt in Atlantic Canada plus potential displacement from other sales) would account for 42 percent of the reductions required under Canada's medium-term target (20 percent below 2006 levels for the electricity sector) and 36 per cent of the Kyoto target (10 percent below 1990 levels). In addition, potential displacement resulting from the Project would be equal to almost 16 percent of the reductions that will be required in the national electricity sector under Canada's long-term target (60-70 percent below 2006 levels).

Figure 1 Greenhouse Gas Reduction Targets for the Electricity Sector - Atlantic Canada



Notes:

(1) Required reductions are calculated by applying the various GHG emission reduction targets to the 2004-2006 annual average emissions for the electricity sector in Atlantic Canada.

(2) The targets are:

- Kyoto 2012 – Kyoto Protocol target of 6% below 1990 levels by 2012[1]
- NEG/ECP 2020 - New England Governors/ Eastern Canadian Premiers target of 10% below 1990 levels by 2020[2]
- Government of Canada 2020 – Federal government target of 20% below 2006 levels by 2020[3]
- Government of Canada 2050 – Minimum of Federal government target of 60-70% below 2006 levels by 2050[4]
- RGGI – Regional Greenhouse Gas Initiative target of 10% below current levels.[5]

[1] Kyoto Protocol, United Nations Framework Convention on Climate Change, http://unfccc.int/resource/docs/convkp/kpeng.html

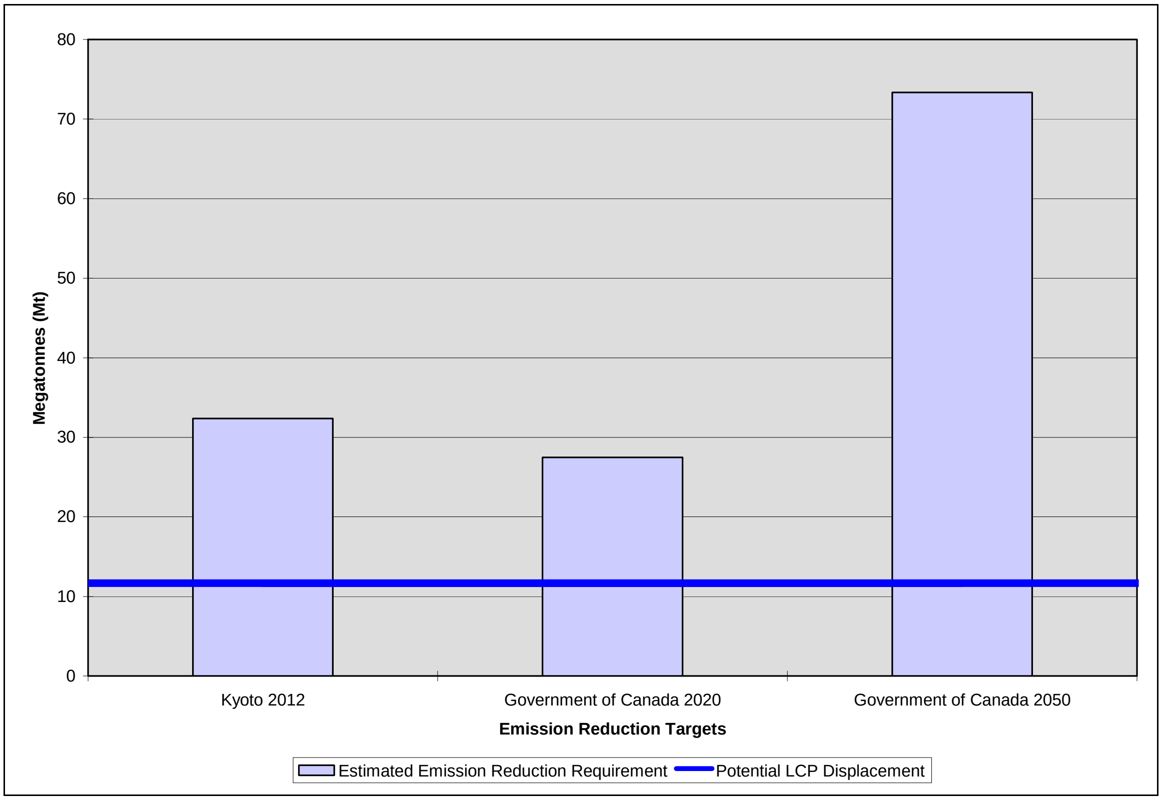
[2] Resolution 31-1, Resolution Concerning Energy and the Environment, 2007, New England Governors, Eastern Canadian Premiers, http://www.negc.org/documents/NEG-ECP_31-1.pdf

[3] Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions, 2008, Government of Canada, http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf

[4] Canada's Action Plan, Government of Canada, http://www.ec.gc.ca/cc/default.asp?lang=En&n=D80B0B3A-1

[5] Regional Greenhouse Gas Initiative, http://www.rggi.org/home

Figure 2 Greenhouse Gas Reduction Targets for the Electricity Sector - Canada



Notes:

(1) Required reductions are calculated by applying the various GHG emission reduction targets to the 2004-2006 annual average emissions for the electricity sector in Canada.

(2) The targets are:

- Kyoto 2012 – Kyoto Protocol target of 6% below 1990 levels by 2012[6]
- Government of Canada 2020 – Federal government target of 20% below 2006 levels by 2020[7]
- Government of Canada 2050 – Minimum of Federal government target of 60-70% below 2006 levels by 2050[8]

The supply of clean, renewable power from the Project could assist the Atlantic Provinces and the Federal Government meet not only the GHG reduction targets identified above but could also provide a means to partially address other environmental goals and objectives that have been established by the individual jurisdictions. Table 1 highlights the assistance the Project could provide to the federal and provincial governments in achieving their respective goals and objectives under the possible market sales scenarios outlined in the response to IR# JRP.7.

As the Project itself will reduce GHG emissions in the electricity sector, Nalcor has no specific plans to offset GHG emissions from this Project.

[6] Kyoto Protocol, United Nations Framework Convention on Climate Change, http://unfccc.int/resource/docs/convkp/kpeng.html

[7] Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions, 2008, Government of Canada, http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf

[8] Canada's Action Plan, Government of Canada, http://www.ec.gc.ca/cc/default.asp?lang=En&n=D80B0B3A-1

Table 1 Potential Impact of Lower Churchill Development on GHG Objectives, Commitments and Requirements

Jurisdiction	Policy Directive/ Target	Potential Impact of Project
Newfoundland and Labrador	Reduce reliance on the Holyrood Generating Station[1]	Will displace the existing generation at Holyrood
Nova Scotia	Reduce Nova Scotia's annual GHG emissions by 5 Mt by 2020[2]	Will displace up to 8.4 Mt in annual GHG emissions in the Maritimes
	Reduce Nova Scotia's annual GHG emissions by up to 80 percent by 2020[3]	Will displace up to 8.4 Mt in annual GHG emissions in the Maritimes (80 percent of 2007 emissions were 16.5 Mt)
	Ensure that at least 25 per cent of our electricity is generated from renewable energy sources by 2020[4]	Will result in up to 9.7 TWh of new, renewable energy in the Maritime markets
New Brunswick	10 percent of electricity sales must come from new renewable sources by 2016[5]	Will result in up to 9.7 TWh of new, renewable energy in the Maritime markets
Canada	90 percent of electricity needs to be provided by non-emitting sources[6]	Will result in 16.9 TWh of new non-emitting electricity production annually
	Clean Energy Task Force – 25 Mt reduction in annual GHG emissions from the electricity sector[7]	Will displace up to 11.5 Mt in annual GHG emissions (46 percent of targeted reduction)

Note: The impacts of the project are based on the possible market sales scenarios outlined in the response to IR# JRP.7.

Sources:

1. Focusing Our Energy, 2007, Government of Newfoundland and Labrador, http://www.nr.gov.nl.ca/energyplan/EnergyReport.pdf
2. Toward a Greener Future: Nova Scotia's Climate Change Action Plan, 2009, Government of Nova Scotia, http://www.gov.ns.ca/energy/resources/spps/energy-strategy/Climate-Change-Action-Plan-2009.pdf.
3. ibid.
4. ibid.
5. Climate Change Action: 2007-2012, 2007, Government of New Brunswick, http://www.gnb.ca/0009/0369/0015/0001-e.pdf
6. Canada's Action Plan, Government of Canada, http://www.ec.gc.ca/cc/default.asp?lang=En&n=D80B0B3A-1
7. Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions, 2008, Government of Canada, http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf

References:

Canada's Action Plan, Government of Canada http://www.ec.gc.ca/cc/default.asp?lang=En&n=D80B0B3A-1.

Canadian Premiers, http://www.negc.org/documents/NEG-ECP_31-1.pdf.

Cap & Trade Program Design, Western Climate Change Initiative http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program.

Climate Change Action: 2007-2012, 2007, Government of New Brunswick http://www.gnb.ca/0009/0369/0015/0001-e.pdf.

Environment Canada. 2009. Notice with respect to reporting of greenhouse gases (GHGs) for 2009. http://www.gazette.gc.ca/rp-pr/p1/2009/2009-07-11/html/notice-avis-eng.html#d101

Environnement Illimite Inc. and Environnement d'Hydro-Quebec. 2007. Green House Gas Fluxes.

Focusing Our Energy. 2007. Government of Newfoundland and Labrador http://www.nr.gov.nl.ca/energyplan/EnergyReport.pdf.

Kyoto Protocol, United Nations Framework Convention on Climate Change http://unfccc.int/resource/docs/convkp/kpeng.html.

Minaskuat Inc. 2008. Lower Churchill River Greenhouse Gas Emissions Study, Lower Churchill Hydroelectric Generation Project. Prepared for the Lower Churchill Hydroelectric Generation Project.

National Inventory Report, 1990-2005: Greenhouse Gas Sources and Sinks in Canada, 2007, Government of Canada http://www.ec.gc.ca/pdb/ghg/inventory_report/2005_report/ta9_1_eng.cfm.

Online Industrial GHG Search Tool, Environment Canada http://www.ec.gc.ca/pdb/ghg/onlineData/dataSearch_e.cfm.

Regional Greenhouse Gas Initiative http://www.rggi.org/home.

Resolution 31-1, Resolution Concerning Energy and the Environment, 2007, New England Governors, Eastern Canadian Premiers http://www.negc.org/documents/NEG-ECP_31-1.pdf.

Toward a Greener Future: Nova Scotia's Climate Change Action Plan, 2009, Government of Nova Scotia http://www.gov.ns.ca/energy/resources/spps/energy-strategy/Climate-Change-Action-Plan-2009.pdf.

Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions, 2008, Government of Canada http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf.

IR# JRP.86

Noise and Aboriginal Health

Requesting Organization – Joint Review Panel **Information Request No.: JRP.86**

Subject – Noise and Aboriginal Health

References:

EIS Guidelines, Section 2.2 (Aboriginal and Public Consultation), Section 4.4.4 (Description of existing environment), Section 4.8 (Consultation with Aboriginal Groups and Communities)

Volume IIB: Biophysical Assessment, Section 5.11.1.2 (Noise Zone of Influence)

Related Comments / Information Requests:

CEAR # 171 (Health Canada)

IR # JRP. 87

Rationale:

The EIS Guidelines require the Proponent to describe use of land and resources (including aquatic resources) by Aboriginal persons for traditional purposes, including location of camps, to inform and consult with the affected Aboriginal and local communities, and to demonstrate the Proponent's understanding of the concerns of Aboriginal groups with respect to the Project.

The EIS does not state whether noise concerns were raised during Aboriginal consultation, and does not contain specific statements about potential health effects of noise, or lack thereof, on Aboriginals at sites (camp locations) where harvesting occurs or where socially significant cultural or religious ceremonies occur.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.86**

Information Requested:

The Proponent is asked to:

a. **discuss whether noise was identified as a potential issue during Aboriginal consultation; and**

Response:

Noise was specifically identified as a potential issue by the Innu Nation in correspondence from the Newfoundland and Labrador Hydro – Innu Nation Task Force dated June 23, 2008:

> *14. Section 3.3 – The report suggest that "rather than investing in alternative routes, consideration should first be given to improving Hamilton River Road as the benefits to be gained would be long term to the town". The Reviewer questions to merits of this suggestion. While the traffic due to the Project may be limited to 16 vehicles per day, it is quite likely that other future projects will require access around Goose Bay. These other projects could be located on the Labrador coast (requiring transport from the TLH through to Northwest River and beyond) or on the TLH (requiring transport from the port to the TLH). Also, by improving the quality of the Hamilton River Road, it is possible that current traffic patterns to and from existing locations in Goose Bay could be altered. The net result could be an increase of large trucks on the Hamilton River Road that is far in excess in of 16 trucks. The Reviewer recommends that NLH conduct a noise assessment for the Hamilton River Road based on three different scenarios: 16 trucks reflecting the project alone; 50 trucks reflecting the likely future use of an improved road if a bypass is not constructed; and 100 trucks reflecting the extreme use of an improved Road if a bypass is not constructed. In summary, the Reviewer questions whether an improved Hamilton River Road without a bypass is actually beneficially for Goose in the long-term. As development increases in Labrador, a bypass around Goose Bay may be preferable.*

Noise was also mentioned on several occasions in the report of Innu environmental knowledge of the Mishta-shipu (Churchill River) area of Labrador collected by the Innu Traditional Knowledge Committee (Innu Nation 2007). These references were in association with other projects and human activity such as military aircraft training and vehicle movements along the Trans-Labrador Highway.

Reference

Innu Nation. 2007. Innu Kaishitshissenitak Mishta-shipu (Innu Environmental Knowledge of the Mishta-shipu (Churchill River) Area of Labrador in Relation to the Proposed Lower Churchill Project). Report of the work of the Innu Traditional knowledge Committee prepared by Wolverine & Associates, Inc. for Innu Nation.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.86**

Information Requested:

The Proponent is asked to:

b. **discuss whether noise may have an impact on Aboriginals at any location of relevance, including camps, harvesting locations and/or cultural/ceremonial sites;**

Response:

Project noise will be perceptible near the Gull Island and Muskrat Falls construction sites during the construction phase of the Project. The locations of aboriginal importance and approximate areas where Project noise would be perceptible, are presented in Figures 1 and 2 of IR# JRP.87 and include the following:

- harvesting areas;
- Aboriginal camps;
- hunting, trapping and fishing areas;
- cabins; and
- cultural/ceremonial sites.

Most harvesting, trapping, hunting and fishing locations would be several kilometers distant and unaffected by the Project. The cabin locations are sufficiently distant from the construction sites, such that little to no interaction with perceptible noise emissions is anticipated. The exception to this would be Manitu-utshu which is on the north side of, and adjacent to, the Muskrat Falls construction site. Project-related sound levels (including construction traffic) will be perceptible at this location where there would be a level of about 47 dBA at Manitu-utshu (refer to IR# JRP.87 response for more detail).

Nalcor consulted with the Innu Nation during Project planning regarding Manitu-utshu. To address noise and other concerns at Manitu-utshu, most construction activity associated with the Muskrat Falls component will be designed to occur on the south side of the river, substantially reducing the potential construction disturbance at Manitu-utshu. As a result, the predicted noise levels at this cultural location would be similar to normal conversation. Persons using the Maniu-utshu site will be able to hear construction noise occurring within approximately 500 m of the center of the construction activities. Elsewhere, the temporary noise associated with reservoir preparation could overlap with aboriginal land-use activity.

The sound levels from the operating hydroelectric facilities will be dramatically lower than those associated with construction. The anticipated transformer sound has been modeled (refer to IR# JRP.87, Figures 5 and 8). At Manitu-utshu, for example, the sounds of the transformers is predicted at about 13 dBA. As the assumed background level would be 35 dBA, transformer noise would not be perceptible. However, there will be incidental sounds related to the operation of service and employee vehicles, for example, that could be audible from Manitu-utshu. Dams have some sounds associated with the spillway discharge area that may be greater than the river noise prior to development, but these sounds are also similar to the natural environment. It is concluded that the transformer and other normal operational sound will not have a measurable effect on the known Aboriginal sites of importance.

IR# JRP.87

Noise and Human Receptors

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Subject - Noise and Human Receptors

References:

EIS Guidelines, Section 2.5 (Precautionary Principle), Section 4.2.4 (Relationship to Legislation, Permitting, Regulatory Agencies and Policies), Section 4.3.2.2 (Alternative Means of Carrying Out the Project), Section 4.5.3 Cumulative Effects) Section 4.4.4 (Description of existing environment), Section 4.5.1 (Environmental Effects – General)

Volume IIB: Biophysical Assessment, Section 5.11.1.2 (Noise Zone of Influence)

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec

Available at: http://www.ceaa-acee.gc.ca/Content/D/A/C/DACB19EE-468E-422F-8EF629A6D84695FC/%20Cumulative-effects_e.pdf

World Health Organization. 1999. Guidelines for Community Noise. WHO, Geneva. Available at: http://www.who.int/docstore/peh/noise/Comnoise-1.pdf

Related Comments / Information Requests:

CEAR # 171 (Health Canada)

IR# JRP.38, 39, 86

Rationale:

The EIS Guidelines require the Proponent to:

a. describe the existing ambient noise level;
b. consider predicted environmental effects (positive and negative, direct and indirect, short and long-term) quantitative and qualitatively for each project alternative and for each valued environmental component (VEC);
c. consider cumulative effects (using the Canadian Environmental Assessment Agency's Cumulative Effects Assessment Practitioners Guide (Hegmann et. al., 1999) as a reference);
d. demonstrate the proposed Project is assessed in a careful and precautionary manner; and
e. Identify the human environments likely to be affected by the Project.

Further, the EIS Guidelines 4.3.2.2 state that the Proponent is to consider economic, social and worker conditions (including health and hygiene) as well as any other relevant community, including Aboriginal community, considerations and environmental factors.

There are no specific statements about noise in worker camps and sleeping quarters in the EIS. The only mention of human exposure to noise in the EIS is in Volume IIB: Biophysical Assessment, Section 5.11.1.2, 2nd paragraph, which states "There are no communities or seasonal residences near the Project area, and the major concern about noise is the interaction with wildlife." Health Canada suggests consideration of potential sleep disturbances experienced by workers who reside on or near the Project site, addressing the World Health Organization Guidelines on Community Noise (1999).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

a. **identify and describe all existing and reasonably foreseeable human receptor locations in the area that may be influenced by Project-related noise as per Hegmann et. al. (1999). These include seasonal residences including camps, workers' living quarters, harvesting camps, and sites within the study area where socially significant First Nations cultural or religious ceremonies occur;**

Response:

All existing and reasonably foreseeable human receptor locations and other locations of interest in the areas that may be influenced by Project-related noise as well as the distances from each receptor to the proposed dam for both Project locations, Gull Island and Muskrat Falls are presented in Table 1, meeting all guidance provided by Hegmann et al. (1999). These locations, along with hunting and harvesting areas, have also been displayed in Figures 1 and 2, Gull Island Site and Muskrat Falls Site, attached.

Table 1 Receptor Distances from Gull Island and Muskrat Falls

Human Receptor Locations and other Areas of Interest	UTM Coordinates		Distance from the Dam (km)
	Easting	Northing	
Gull Island Site			
Abandoned Cabin	602576	5870478	2.4
Worker Accommodations	610124	5872072	5.5
Muskrat Falls Site			
Spiritually Important (Manitu-utshu)	648603	5902428	0.5
Visually Important (Lower Brook)	643155	5900391	6
Worker Accommodations	650924	590064	2.5
Cabin 1	642136	5901436	6.6
Cabin 2	643336	5903974	5.9
Cabin 3	643442	5904008	5.8
Cabin 4	643741	5904151	5.6
Cabin 5	644286	5904511	5.2
Cabin 6	644492	5904623	5.0
Cabin 7	644555	5904629	5.0
Cabin 8	646221	5905920	4.7
Cabin 9	646234	5906013	4.8
Cabin 10	646673	5905924	4.5
Cabin 11	646712	5905891	4.5
Cabin 12	651887	5903535	3.2
Cabin 13	652926	5903444	3.3

At the Gull Island Site, the closest potential human receptor location would be the abandoned trapper's cabin (tilt), approximately 2.4 km from the centre of the dam. It is assumed that this might be used occasionally by hunters. No other residences, permanent or seasonal, nor spiritually significant locations have been identified within 5 km. No permanent residences or other structures are found within 15 km.

At the Muskrat Falls Site, a number of cabins are located within 10 km of the Project site. One spiritual site, Manitu-utshu (Muskrat Hill), is located about 0.5 km north of the dam. The Project has taken care to minimize disturbance to this site, and most of the construction related activity and facilities are located on the south side of the river. The sound pressure levels at this site have been estimated, for the highest level of construction, at 47 dBA, during day time maximum activity. Further discussion on Manitu-utshu is provided in IR# JRP.86.

Reference:

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

b. **discuss the existing ambient noise level and undertake a noise and human health effects assessment, if there are existing and reasonably foreseeable human receptors that may be impacted by Project-related noise;**

Response:

No Project-related ambient noise level survey was conducted, as current noise emissions in the Project area from human sources are infrequent and the proposed Project sites are considered to be consistent with wilderness areas. The existing natural noise environment is characterized by wind in the trees, flowing water sounds (e.g., Muskrat Falls), and the sounds of wildlife. Background sound levels measured in association with other investigations (Minaskuat 2007) are in the range of 35 dBA during the night and 45 dBA during the day in remote areas, for example, and perhaps higher immediately adjacent to areas of rapids or turbulence in the river. To provide a more detailed characterization of the noise levels due to the Project, a series of predictions were made for the Project phases. The predictions address the worst case activities associated such as dam and transmission line construction, and the noise generated by the power transformers during operation of the Project.

The Province of Newfoundland and Labrador does not have noise specific guidelines for projects such as that proposed on the lower Churchill River. The construction activities at the dam sites will last 3 to 5 years for the various components, and there will be a normal sequence of equipment and activities at the sites, typical of large civil works. To provide an estimate of the sound emissions during the highest activity level, an equipment list was compiled and presented in the EIS (Volume IA, Chapter 4). This list of equipment for both dam construction sites is provided in Tables 2 and 3. The equipment associated with concrete production for the powerhouse and spillway was not incorporated into this study as it was assumed these activities would not occur concurrently with (and would be quieter than) other construction activities (i.e. diversion tunnels and five penstocks, spillway excavation and dam rock shell, dam, filters and transitions, and common excavation).

Table 2 Equipment List for the Construction of the Dam and Associated Facilities - Gull Island Site

Equipment	Diversion tunnels and five Penstocks	Spillway Ecavation and Daw Rock Shell	Dam, Filters and Transitions	Common Excavation
Point Sources				
3-Boom Jumbo	3			
Cat 988 Loader	2			
Cat 773 Trucks	5	15		10
Cat 14 or 16 Graders	1	1	1	1
Cat D8 Trackers	2	3	6	3
Dump Truck			30	
Crawler Drillers	6	6		
High Lift Platforms	3	3		
O&K RH120E Face Shovels		2		
Cat 385 and 345 Backhoes		2	3	3
Cat CS-533E Vibratory Compactors			5	
50 t Towed Compactors			2	
Cat CS-573 E Vibratory Roller		5		

Table 3 Equipment List for the Construction of the Dam and Associated Facilities - Muskrat Falls Site

Equipment	Spillway Excavation	Dam	Common Excavation
Point Sources			
Cat 773 Trucks	7		5
Cat 14 or 16 Graders	1	1	1
Cat D8 Trackers	2	4	2
Dump Truck		15	
Crawler Drillers	3		
High Lift Platforms	2		
O&K RH120E Face Shovels	1		
Cat 385 and 345 Backhoes	2	2	3
Cat CS-533E Vibratory Compactors		2	
50 t Towed Compactors		1	
Cat CS-573 E Vibratory Roller	2	5	

The predicted sound pressure levels at each of the human receptor locations and other locations of interest are presented in Table 4 below and in Figures 3 and 6 attached. The predicted sound pressure level results are approximately 60 dBA at 1.0 km from the centre of the proposed Gull Island dam site and approximately 47 dBA at 500 m from the Muskrat Falls dam site, at Manitu-utshu. The sound pressure levels predicted at the Muskrat Falls dam site at 500 m south, east and west of the site however are greater than 50 dBA, due to the topography of the land and the location of the associated facilities and equipment. The relocation of construction activates south was designed in part to mitigate the potential effects at the Manitu-utshu (refer to IR# JRP.86). The results predicted for the remainder of the human receptor locations are similar to background levels and will be temporary.

Table 4 Predicted Construction (Dam and Associated Facilities) Noise - Gull Island and Muskrat Falls

Discrete Receptor Site	UTM Coordinates		Predicted Sound Pressure Level (dBA)
	Easting	Northing	
Gull Island Site			
Abandoned Cabin	602576	5870478	46
Muskrat Falls Site			
Spiritually Important: Manitu-utshu	648603	5902428	47
Visually Important: Lower Brook	643155	5900391	30
Cabin 1	642136	5901436	27
Cabin 2	643336	5903974	30
Cabin 3	643442	5904008	30
Cabin 4	643741	5904151	31
Cabin 5	644286	5904511	32
Cabin 6	644492	5904623	33
Cabin 7	644555	5904629	33
Cabin 8	646221	5905920	33
Cabin 9	646234	5906013	33
Cabin 10	646673	5905924	34
Cabin 11	646712	5905891	34
Cabin 12	651887	5903535	45
Cabin 13	652926	5903444	45

For the transmission line construction component, sound pressure levels were modeled for a representative section, using a comprehensive list of equipment (Tables 5 and 6) along a section of corridor that is assumed to be similar to what the "footprint" of this activity might be at a given time. The schedule may have inactive periods between clearing, foundation preparation, and erection, and it is likely that the aggregate period in one location would be less than a month. The sound sources are distributed along and to the side of the centreline of the actual route.

Table 5 Equipment List for the Construction of the Transmission Line - Gull Island Site

Equipment	Equipment (Number)
Cat 14 or 16 Graders	1
Dump Truck	4
Rotec Creter Crane	1
4x4 Pick Up Truck	30
Bull Dozer	2
Boom Truck	10
Muskeg	20
Crawler Crane (150 T)	1
Quad	10
Excavator	15
Nodwell	5
Float	4

Table 6 Equipment List for the Construction of the Transmission Line - Muskrat Falls Site

Equipment	Equipment (Number)
Cat 14 or 16 Graders	1
Dump Truck	3
Rotec Creter Crane	1
4x4 Pick Up Truck	20
Bull Dozer	2
Boom Truck	7
Muskeg	17
Crawler Crane (150 T)	1
Quad	8
Excavator	10
Nodwell	3
Float	3

The predicted sound pressure levels at each of the human receptor locations and other locations of interest are presented in Table 7 below and in Figures 4 and 7 attached. Assuming all equipment is in operation at the same time, sound levels will exceed 55 dBA within about 1 km of the corridor and 60 dBA within about 500 m of the centreline for the transmission line. None of these sites will experience levels of 70 dBA or greater.

Table 7 Predicted Construction (Transmission Line) Noise - Gull Island and Muskrat Falls

Discrete Receptor Site	UTM Coordinates		Predicted Sound Pressure Level (dBA)
	Easting	Northing	
Gull Island Site			
Abandoned Cabin	602576	5870478	26
Muskrat Falls Site			
Spiritually Important: Manitu-utshu	648603	5902428	45
Visually Important: Lower Brook	643155	5900391	37
Cabin 1	642136	5901436	36
Cabin 2	643336	5903974	49
Cabin 3	643442	5904008	49
Cabin 4	643741	5904151	49
Cabin 5	644286	5904511	52
Cabin 6	644492	5904623	52
Cabin 7	644555	5904629	53
Cabin 8	646221	5905920	44
Cabin 9	646234	5906013	42
Cabin 10	646673	5905924	42
Cabin 11	646712	5905891	42
Cabin 12	651887	5903535	<20
Cabin 13	652926	5903444	<20

The sound levels from the operating hydroelectric dams will be dramatically lower than emissions during construction. The transformer sound has been modeled and the predicted sound pressure levels at each of the human receptor locations and other locations of interested are presented in Table 8 and on Figures 5 and 8. At the site known as Manitu-utshu, for example, the sounds of the transformers are predicted to be virtually negligible, at about 13 dBA, whereas the assumed background would be of the order of 35 dBA at night, perhaps up to 45 dBA during the day. The transformer sounds should not affect the site at all, but there will be minor incidental sounds – service and employee vehicles – that may be audible at the site. Dams have some sounds from the spillway discharge area that may be greater than the river noise prior to development, but these sounds are also similar to the natural environment, therefore not considered to be a negative effect. It is concluded that the transformer and other normal operational sound will meet a sound level criterion of 40 dBA at night. This level is used by the Alberta Utilities Commission (2009) for energy facilities in rural areas, and is adopted here in the absence of limits of the Government of Newfoundland and Labrador.

Table 8 Predicted Operational Noise - Gull Island and Muskrat Falls

Discrete Receptor Site	UTM Coordinates		Predicted Sound Pressure Level (dBA)
	Easting	Northing	
Gull Island Site			
Abandoned Cabin	602576	5870478	14
Muskrat Falls Site			
Spiritually Important: Manitu-utshu	648603	5902428	13
Visually Important: Lower Brook	643155	5900391	<10
Cabin 1	642136	5901436	<10
Cabin 2	643336	5903974	<10
Cabin 3	643442	5904008	<10
Cabin 4	643741	5904151	<10
Cabin 5	644286	5904511	<10
Cabin 6	644492	5904623	<10
Cabin 7	644555	5904629	<10
Cabin 8	646221	5905920	<10
Cabin 9	646234	5906013	<10
Cabin 10	646673	5905924	2
Cabin 11	646712	5905891	2
Cabin 12	651887	5903535	14
Cabin 13	652926	5903444	14

Reference:

Minaskuat Limited Partnership. 2007. Field Testing of Nest Monitors Canada Goose (*Branta canadesis*) Component. Prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL. Project MIN0429.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

c. **provide an analysis of the cumulative effects from current and future noise-related activities (e.g. military flights) in combination with Project-related noise;**

Response:

With respect to military activity, the scale of activity in the low level military flight program has decreased by over two orders of magnitude since it was reviewed in the environmental assessment by DND (1994). The total number of annual military training sorties from 5 Wing Goose Bay is presently less than 100. Therefore the contribution of these flights to the sound environment (including the lower Churchill River watershed) is well below the assessed and approved levels proposed by DND (1994) and is transitory in nature, meaning there is no permanent continuous source of sound.

Individual military flights often have a rapid onset of elevated sound (particularly at lower elevations), but the incremental effect of noise from the Project is minimal in comparison to the noise from an overhead aircraft. If, for example, the sound pressure level from the Project is 70 dBA at a particular location close to the Project, and the sound pressure level from an overhead aircraft was 100 dBA (Barron Kennedy Lyzon 1994, Trimper et al. 1998, Pigeon 2001), the cumulative sound pressure level would be 100.3 dBA.

During construction, any military training activity in the vicinity of the Project will need to be coordinated.

References:

Barron Kennedy Lyzun & Associates Ltd., 1994: EIS: Military Flight Training, Technical Report 1C, Prepared for National Defence Canada, Ottawa, ON.

DND (Department of National Defence). 1994. An Environmental Impact Statement on Military Flying Activities in Labrador and Quebec. Ottawa, ON.

Pigeon, M. 2001. Managing low-level jet aircraft noise. Special Topics – Effects of Noise on Wildlife Conference. Terra Borealis No. 2, Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL.

Trimper, P.G., N.M. Standen, L.M. Lye, D. Lemon, T.E. Chubbs and G.W. Humphries. 1998. Effects of low-level jet aircraft noise on the behavior of nesting osprey. Journal of Applied Ecology 35: 122-130.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

d. **provide a justification as to why any receptors that may be influenced by the Project noise that were excluded from this study have not been assessed;**

Response:

The list of receptors provided in these responses represents known and reasonably expected receptors. It is based upon a thorough review by the study team of published and in-house maps, and consultation with Aboriginal representatives.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

e. **indicate whether communities were consulted about noise, what concerns were identified and proposed mitigation methods including communications strategies; and**

Response:

Nalcor has searched its files regarding public consultation in Newfoundland and Labrador communities and has found no reference to noise being discussed as an issue with this forum. The nearest communities, Happy Valley-Goose Bay and Mud Lake, are approximately 30 and 40 km away from the Muskrat Falls site. The community of Churchill Falls is 2 km away from the termination of the transmission line between the Churchill Falls switchyard and the Gull Island plant.

Given the distances of the communities from Project activities, there is no reason to believe that noise would be an issue for concern for the associated residents.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.87**

Information Requested:

The Proponent is asked to:

f. **provide a discussion for the potential of the Project to cause workers residing on or near the Project site to experience sleep disturbances.**

Response:

The World Health Organization Guideline (1999) recommends that sleeping quarters (i.e., the indoor sleeping environment), maintain sound pressure levels of 30 dBA, or less, to avoid undue sleep disturbances. Workers housed in the accommodation quarters for this Project will be separated from the main construction sites by 1.5 and 5 km at Muskrat Falls and Gull Island, respectively (refer to Figures 1 and 2). Construction camps of this type are often of high quality, as contractors recognize the value of healthy, contented workers on remote projects. The buildings are well insulated to withstand the sub-Arctic climate, and as a consequence the exterior walls would typically provide a sound attenuation of about 20 to 30 dBA or more. The ambient sound levels associated with the locations of the accommodations, are expected to be about 46 dBA for Muskrat Falls and about 40 dBA for Gull Island, respectively, for daytime, maximum construction case conditions. This assumes that indoor sound sources will also be managed to reduce noise emissions. A common strategy employed is to locate day-shift and night-shift workers in separate building areas.

Reference:

World Health Organization. 1999. Guidelines for Community Noise.

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

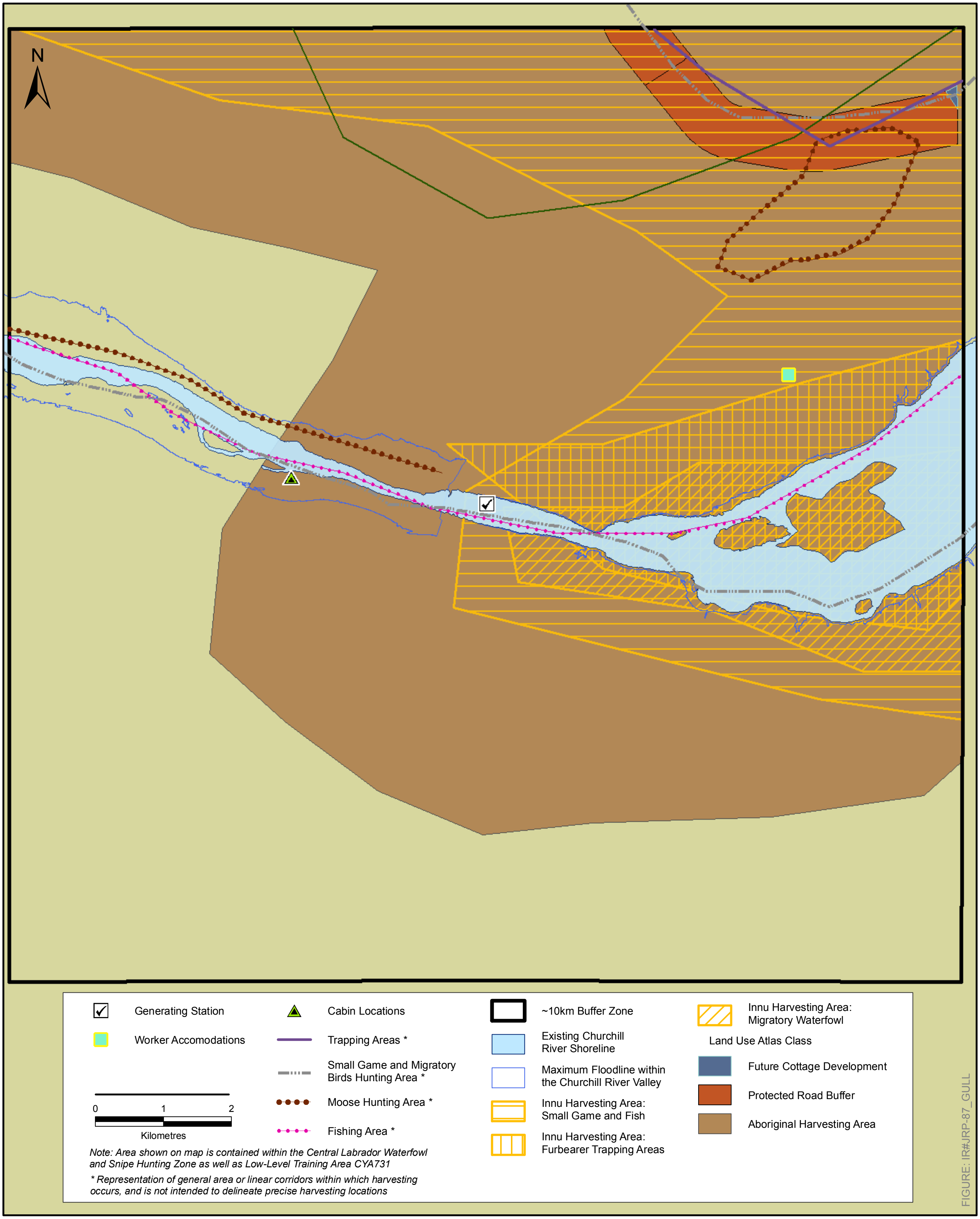
JOINT REVIEW PANEL

Attachment A

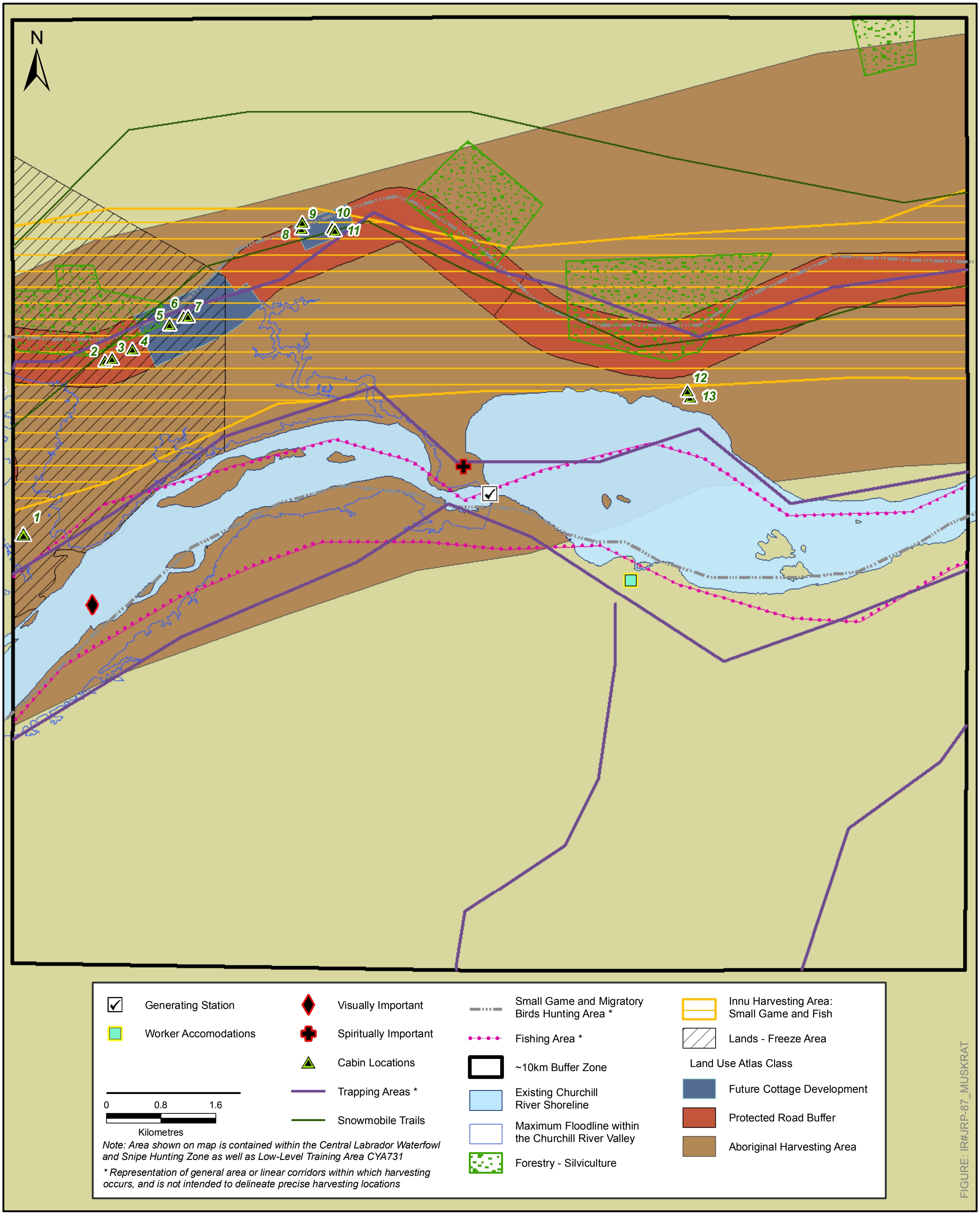
Figures

IR# JRP.87

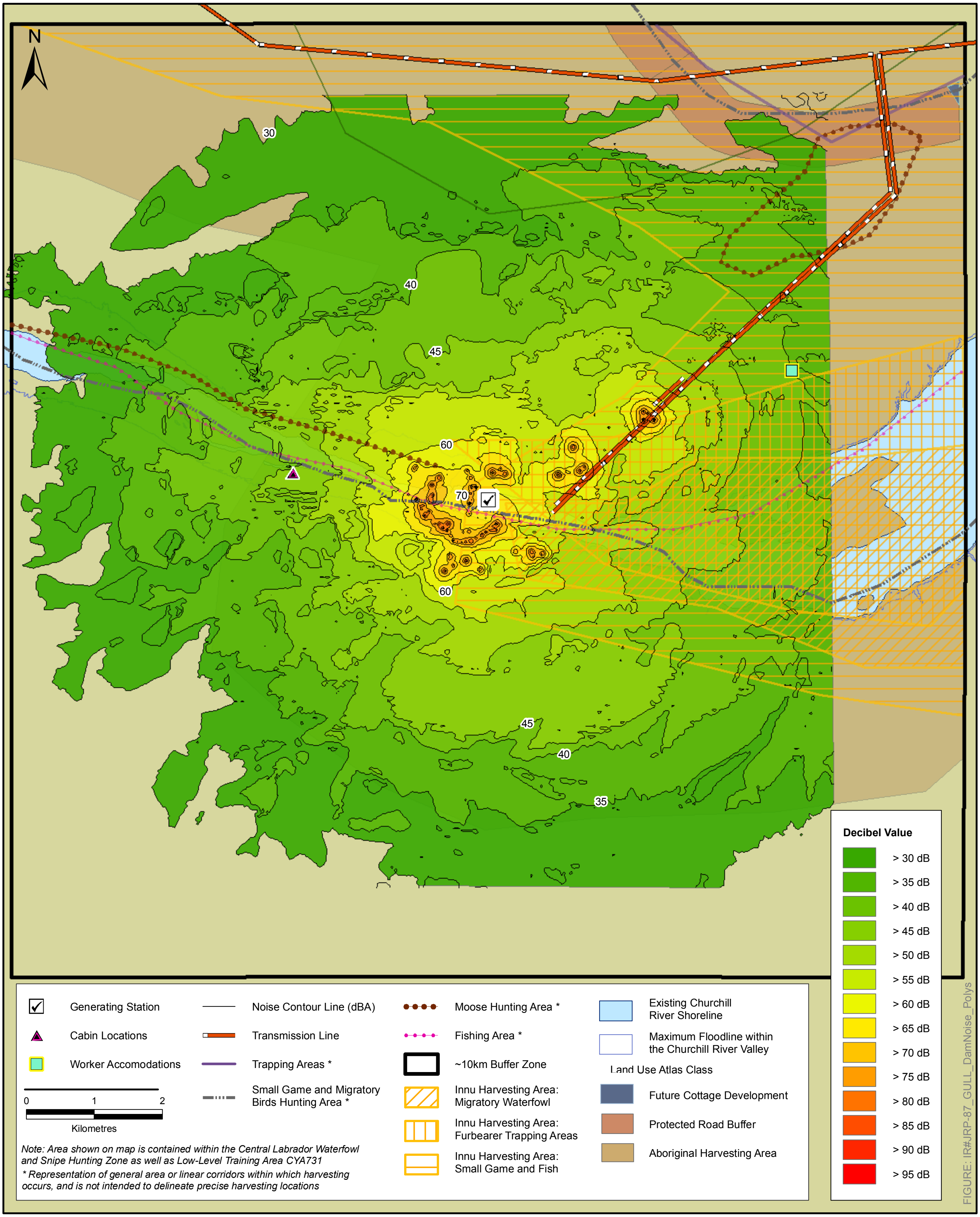
October 5, 2009



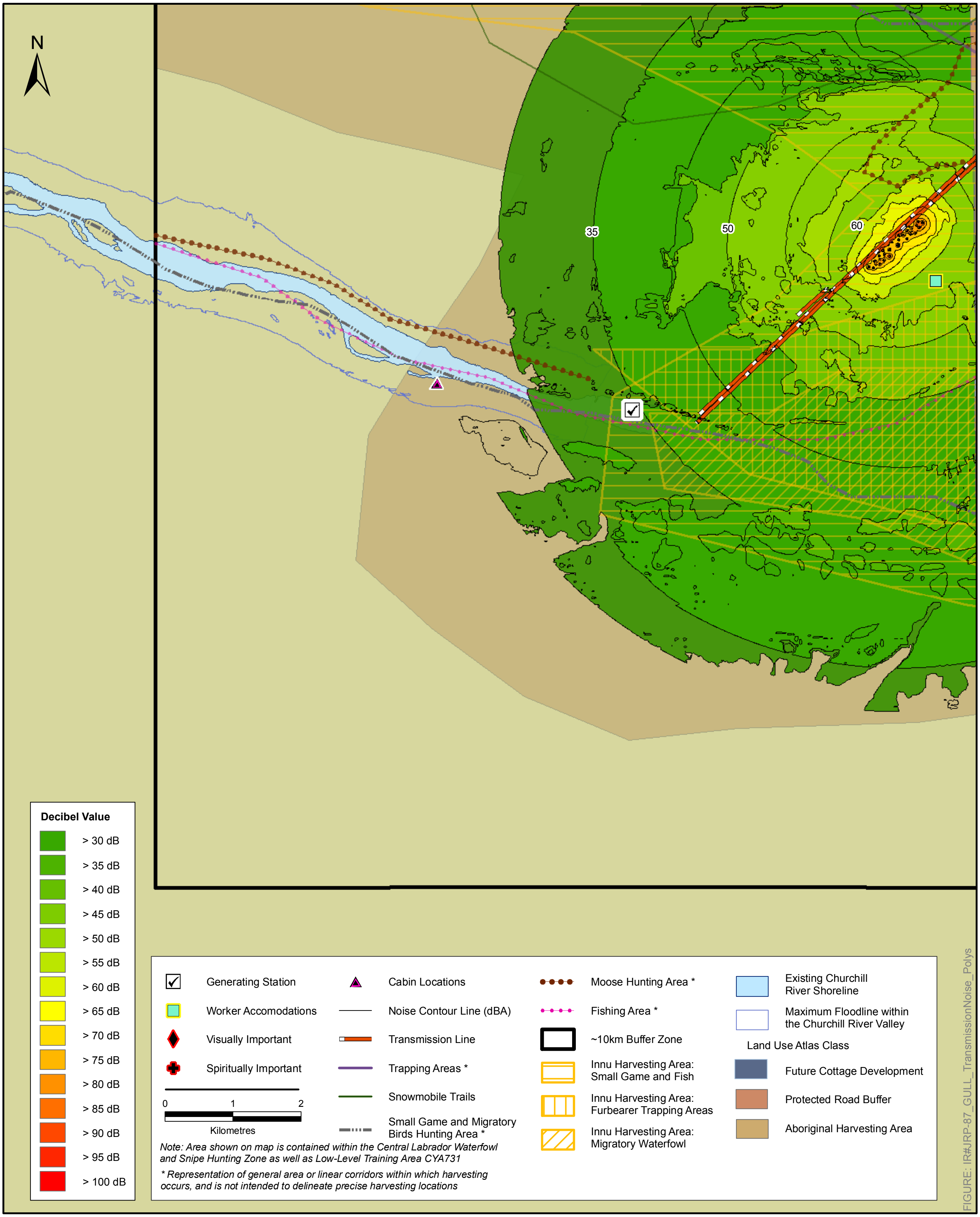
IR#JRP.87	Figure 1: Human Receptor Locations and Other Areas of Interest - Gull Island Site	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



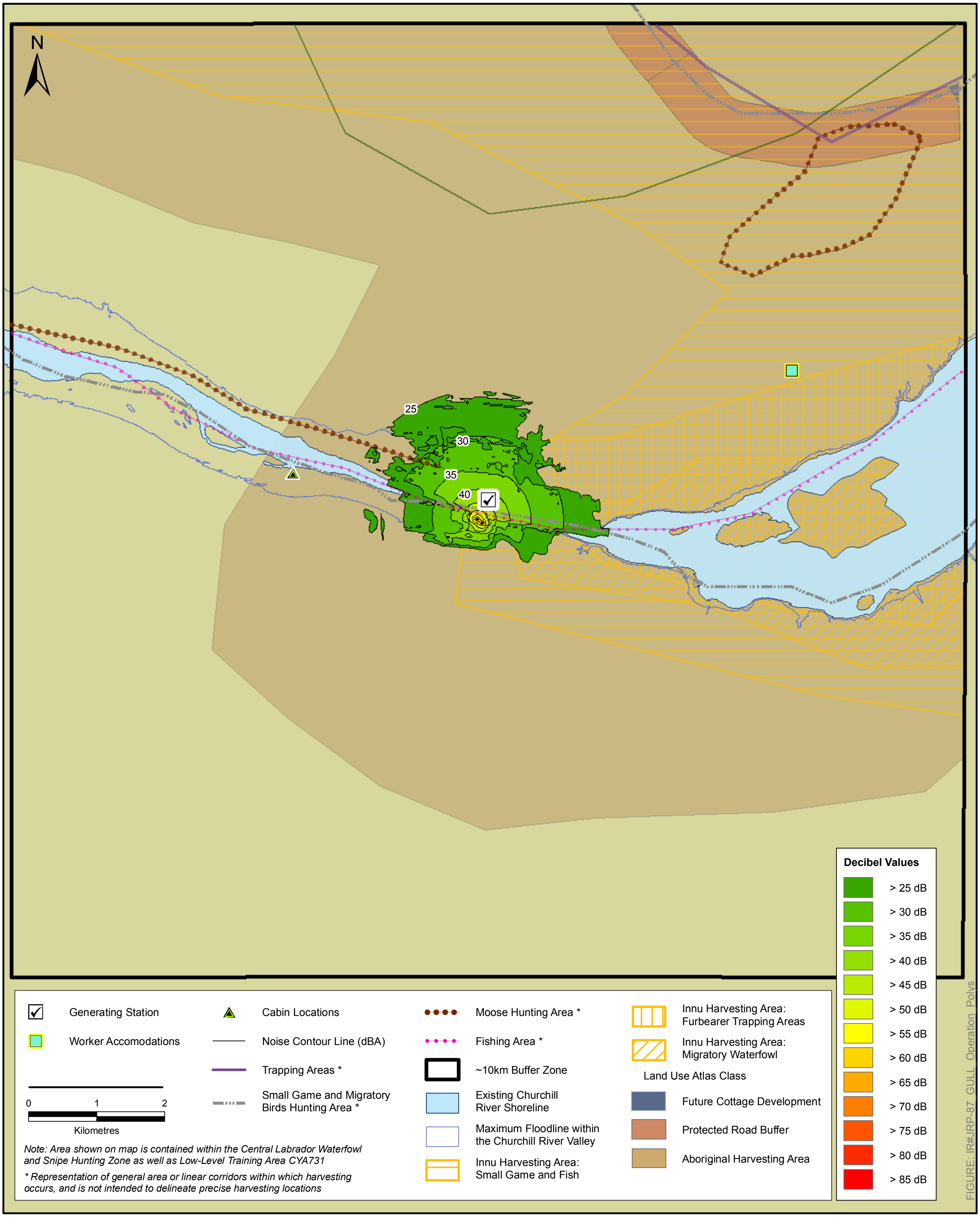
IR#JRP.87	**Figure 2: Human Receptor Locations and Other Areas of Interest - Muskrat Falls Site**	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



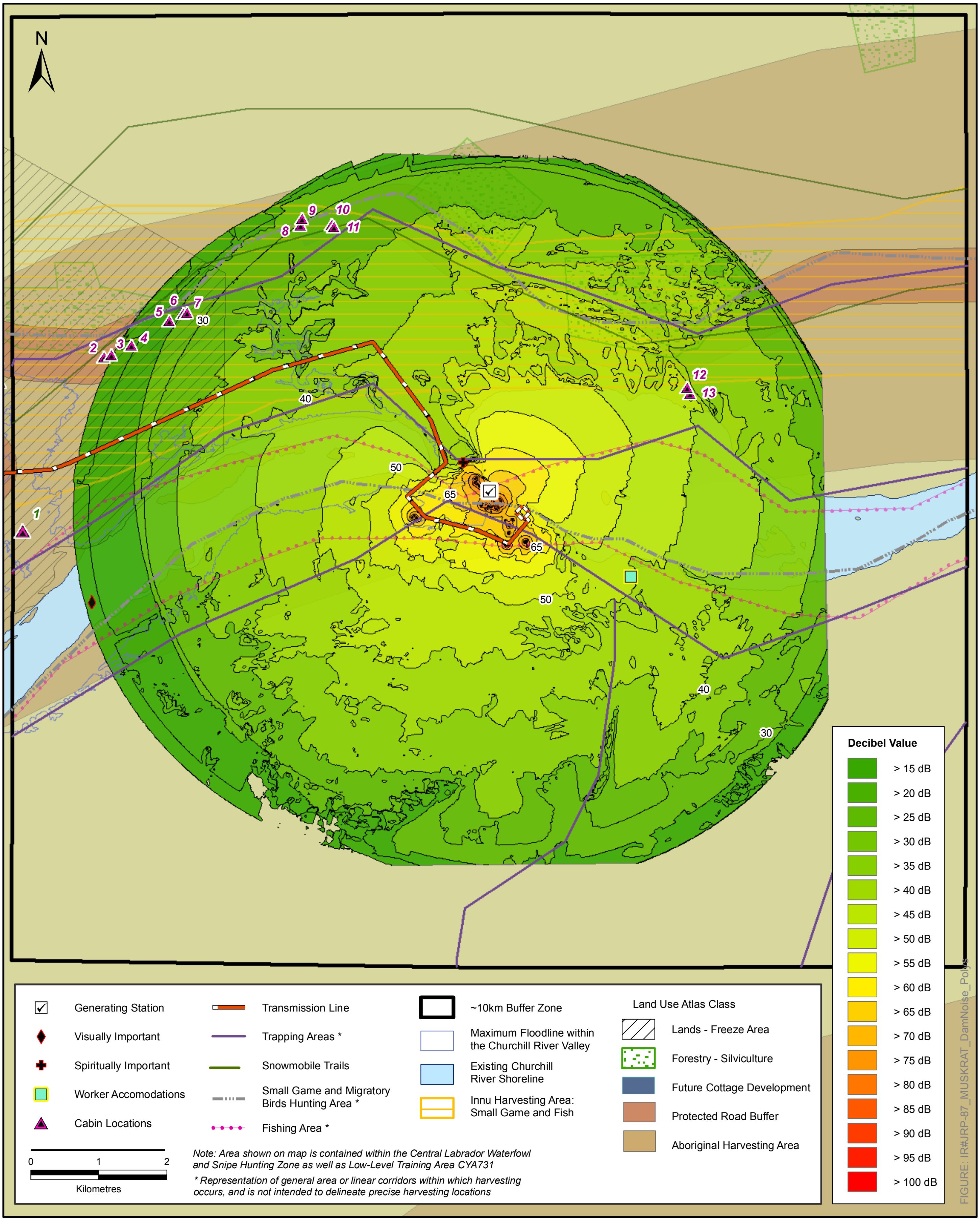
IR#JRP.87	Figure 3: Predicted Worst Case Construction (Dam & Associated Facilities) Noise (1-Hr L_{eq} dBA) - Gull Island Site	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



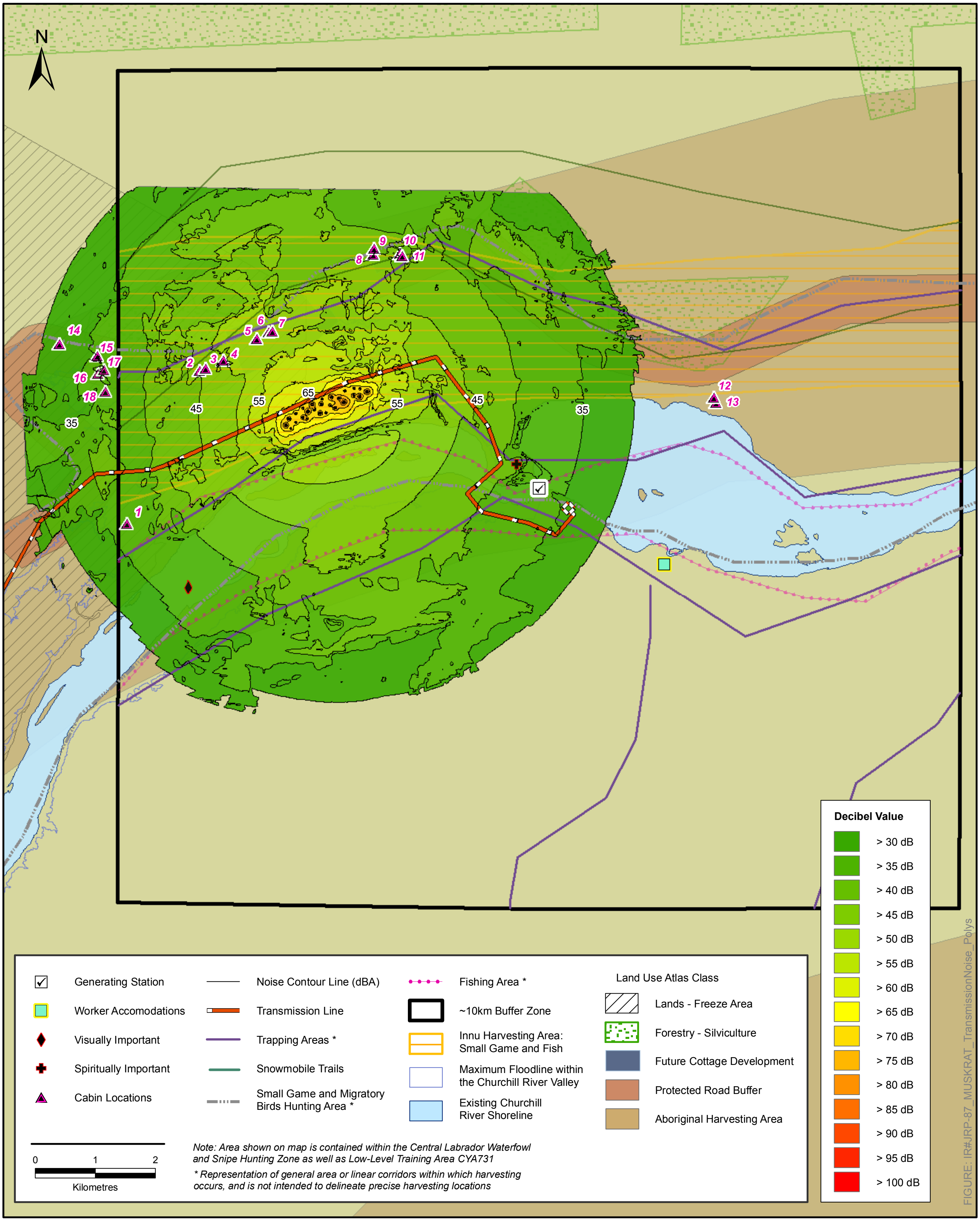
IR#JRP.87	Figure 4: Predicted Worst Case Construction (Transmission Line) Noise (1-Hr L_{eq}, dBA) - Gull Island Site	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



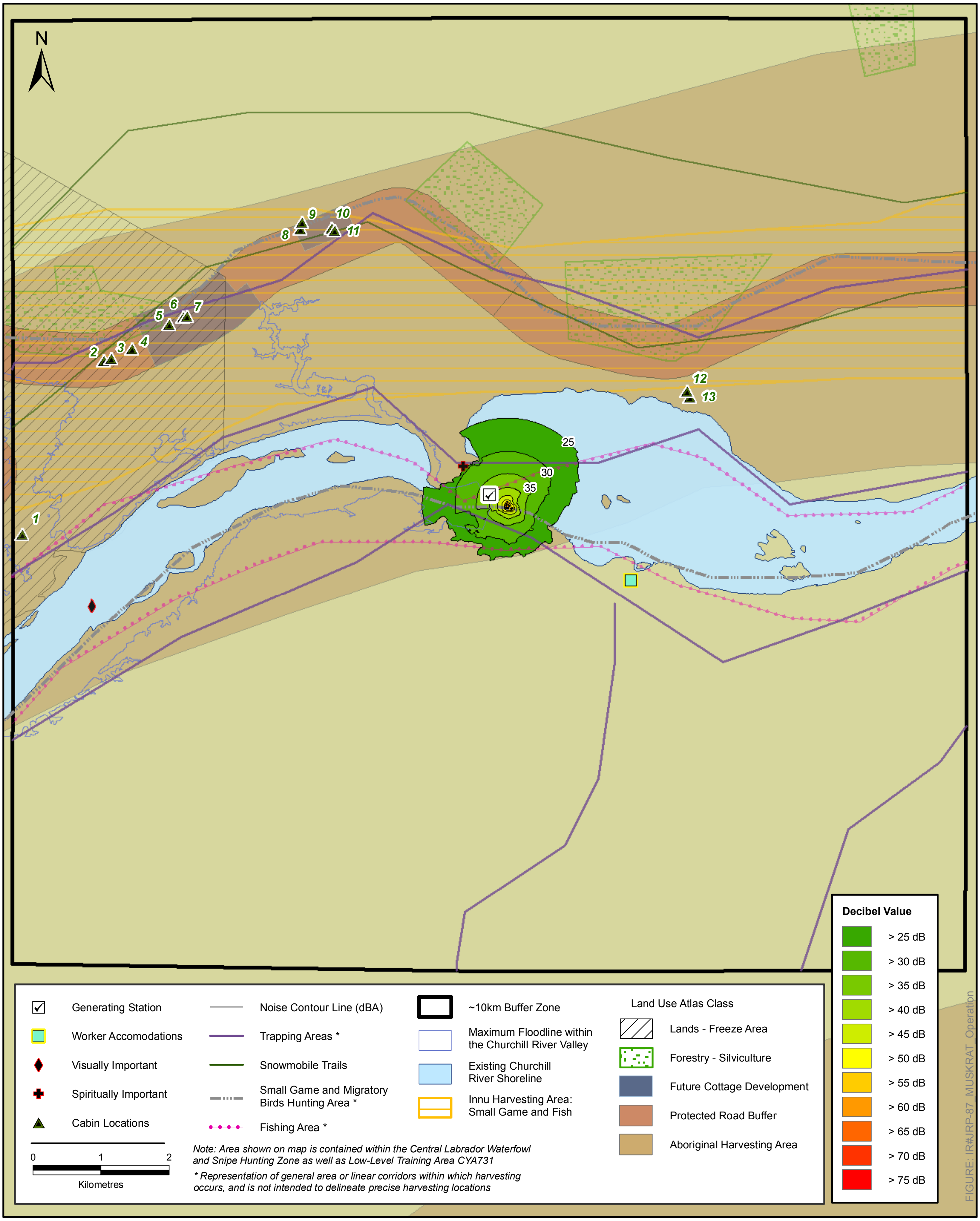
IR#JRP.87	**Figure 5: Predicted Worst Case Operation (Transformer) Noise (1-Hr L_{eq}, dBA) - Gull Island Site**	DRAFT DATE: 6/8/2009 REVISION DATE: 13/07/2009



IR#JRP.87	Figure 6: Predicted Worst Case Construction (Dam & Associated Facilities) Noise (1-Hr L_{eq},dBA) - Muskrat Falls Site	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



IR#JRP.87	Figure 7: Predicted Worst Case Construction (Transmission Line) Noise (1-Hr L_{eq}, dBA) - Muskrat Falls Site	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009



IR#JRP.87	**Figure 8: Predicted Worst Case Operation (Transformer) Noise (1-Hr L_{eq}, dBA) - Muskrat Falls Site**	DRAFT DATE: 8/6/2009 REVISION DATE: 13/07/2009

IR# JRP.88

Air Quality – Health Impacts

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Subject - Air Quality – Health Impacts

References:

EIS, Volume IIA, Section 3.7.2 (Air Quality – Existing Knowledge), p. 3-10 & Tables 3.9, 3.10, pp.3 – 14, 3.15

Related Comments / Information Requests

CEAR # 171 (Health Canada)

IRs # JRP.7, 27, 46, 85, 99

Rationale:

The Proponent has presented the air quality impacts as tonnes per year emissions of contaminants of potential concern (COPC) (e.g. sulphur dioxide, nitrogen oxides, volatile organic compounds, particulate matter (PM) during the construction phase of the project and placed these emissions in the context of total transportation-related emissions for the province in 2005. The Proponent has not undertaken a specific air quality effects assessment for this Project (including construction, operation and decommissioning). In addition, polycyclic aromatic hydrocarbons (PAHs) and PM2.5 were not included in the list of COPCs and these substances are expected to be emitted during the construction phase.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

a. **inventory of COPC associated with all aspects of the proposed Project (including PAHs and PM2.5);**

Response:

A detailed emissions inventory based on the best available design information for the facilities and Project was prepared in parallel to a review of available information on the existing conditions with respect to air quality (existing emissions sources and ambient concentrations of air contaminants). From the types and quantities of air contaminants listed in the inventory and the current state of air quality in the area, a decision was then made on whether a qualitative assessment or a detailed quantitative assessment should be undertaken. The decision to follow a combined approach was based on available data, experience with similar projects, and professional expertise and judgment.

The environmental effects assessment for the Lower Churchill Hydroelectric Generation Project consisted of both quantitative and qualitative analyses of baseline air quality in the determination of potential environmental effects on air quality from Project activities. An inventory of Chemicals of Potential Concern (COPC) was prepared for this assessment (Volume IIA, Chapter 3, Table 3.10, page 3-15) based on the estimated type and number of heavy equipment required (including trucking) for the Project. The construction inventory is reproduced below from the EIS and has been revised to include emissions of particulate matter less than 2.5 microns ($PM_{2.5}$) and polycyclic aromatic hydrocarbons (PAH) as requested.

Table 3.10 from the EIS (Volume IIA, Chapter 3, Table 3.10, page 3-15) with $PM_{2.5}$ and PAH added to the inventory is presented below.

Table 3.10 Reproduced from the EIS, Volume IIA (amended): Emissions of Air Contaminants from Off-Road Construction Equipment

Contaminant	Emissions of Air Contaminants (tonnes/yr)										
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
Gull Island											
PM	48	203	156	196	183	10	-	-	-	-	796
$PM_{2.5}$	41	172	132	166	156	9	-	-	-	-	676
SO_2	45	190	146	183	171	10	-	-	-	-	744
NO_X	684	2,883	2,215	2,785	2,606	147	-	-	-	-	11,321
CO	147	621	477	600	561	32	-	-	-	-	2,439
VOC	56	235	181	227	213	12	-	-	-	-	924
Total PAH	0.026	0.109	0.084	0.106	0.099	0.006	-	-	-	-	0.430
Muskrat Falls											
PM	-	-	-	21	104	80	100	94	6	-	404
$PM_{2.5}$	-	-	-	17	88	68	85	80	5	-	343
SO_2	-	-	-	19	97	75	93	88	5	-	378
NO_X	-	-	-	293	1,482	1,140	1,417	1,336	81	-	5,750
CO	-	-	-	63	319	246	305	288	18	-	1,239
VOC	-	-	-	24	121	93	116	109	7	-	469
Total PAH	-	-	-	0.011	0.056	0.043	0.054	0.051	0.003	-	0.218
Transmission Lines and Associated Equipment											
PM	3	15	41	53	23	13	17	19	6	1	191
$PM_{2.5}$	3	13	35	45	19	11	15	17	5	1	162
SO_2	3	14	39	49	21	12	16	18	5	1	179
NO_X	49	212	586	749	326	179	244	277	81	16	2,720
CO	11	46	126	161	70	39	53	60	18	4	586
VOC	4	17	48	61	27	15	20	23	7	1	222
Total PAH	0.002	0.008	0.022	0.028	0.012	0.007	0.009	0.011	0.003	0.001	0.103

Emission factors from US EPA AP-42 for total PAH, naphthalene and benzo(a)pyrene emissions from heavy duty commercial vehicles were also used to estimate emissions of these PAH compounds from construction activities. The annual estimated benzo(a)pyrene emissions for Newfoundland for 2007 were 735 kg with the majority of emissions originating from residential wood combustion (NPRI 2007 data). Total benzo(a)pyrene emissions from project construction are estimated at less than 1 kg. Nalcor Energy (Nalcor) is unaware of construction projects that have been found to contribute substantively to PAH concentrations, and the construction of this Project in particular will not have any features that would lead to PAH emissions in excess of those emitted from other diesel vehicles. As the Project construction will be temporary and emission sources are mobile, it is unlikely that emissions of PAHs from construction will noticeably influence ambient levels of PAHs in the area.

Construction emissions of $PM_{2.5}$ from heavy duty commercial vehicles were estimated based on the estimated emissions of total particulate matter and the fraction of total particulate matter that is $PM_{2.5}$ for diesel fuelled heavy construction vehicles (calculated using Transport Canada emission factors). In any given construction year, the maximum estimated emissions of $PM_{2.5}$ is 172 tonnes. To place these emissions into perspective, the total estimated emissions from mobile sources in Newfoundland for 2007 was 2,305 tonnes. Therefore, during the peak year construction of the Project could contribute approximately 7 percent to the $PM_{2.5}$ emissions from mobile sources. As these sources will be transient, over a large area of the project construction, $PM_{2.5}$ emissions from the Project should not influence ambient concentrations any more substantively than emissions from traffic on a highway. This statement is based on the total number of heavy equipment planned for the Project in comparison to the typical daily traffic on various Atlantic highways. For example, based on data compiled by Transport Canada, traffic in Newfoundland in 1996 was an average of 3,800 vehicles per day whereas the Project has less than 200 pieces of equipment planned at any given site and time (Transport Canada 2000).

The total $PM_{2.5}$ emissions from existing sources in Newfoundland were estimated at 19,565 tonnes therefore the Project emissions (at 172 tonnes) will not contribute substantively to this total (NPRI 2007 data).

Fugitive particulate matter mitigation will be used throughout construction and well maintained, newer model construction vehicles will be used to minimize emissions of all air contaminants from fuel combustion.

As stated in the EIS, (Section 3.9.1.2, Volume IIA) the total air pollutant emissions from construction of the Project are expected to be low relative to emissions from existing sources in the region or province, and are not expected to noticeably change ambient air quality in the Assessment Area. The environmental effects of the Project on Air Quality are therefore predicted to likely be not significant.

References:

NPRI. 2007. Data available at: http://www.ec.gc.ca/pdb/websol/emissions/ap/ap_result_e.cfm?year=2007&substance=pm25&location=NL&submit=Search

Transport Canada.2000. Transportation in Canada, http://www.tc.gc.ca/pol/EN/Report/anre2000/tc0010ce.htm

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

b. justification for elimination of COPC from further assessment;

Response:

During construction of a hydroelectric facility such as with this Project, emissions to the atmosphere consist primarily of combustion gases from heavy equipment activities and particulate matter from equipment exhaust and in the form of airborne dust from fugitive sources (e.g., truck tires when transporting excavated materials or from aggregate storage piles). No COPCs were eliminated from the COPC list, rather contaminants were selected to be on the COPC list based on analyses from other construction projects. As shown in the response to part (a), the COPC list is PM, $PM_{2.5}$, SO_2, NO_x, CO, VOC, and PAH.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

c. **characterization of baseline levels of COPC undergoing further assessment;**

Response:

The COPC are generally monitored for ambient concentrations in areas with moderate to heavy industrial presence, or where long range transport of air pollutants from other regions may substantively affect air quality. Since this is not the case for this particular air shed, there is no ambient monitoring data available for the Assessment Area. As discussed in Volume IIA, Section 2.2.5 of the EIS, there are no major industrial emissions sources in the area; therefore, no ambient air quality monitoring program exists in the area of the Project. While the lack of ambient air quality information specifically in the area of the Project is a technical boundary of the EIS, it is overcome by the absence of large industrial sources in the area and relatively non-substantive and temporary emissions from the Project itself. As the Project will result in minimal, temporary air contaminant emissions, dispersion modelling or supplementary monitoring to further establish the baseline conditions is deemed to be not necessary. Quantitative baseline values for ambient concentrations of air contaminants are not known; however, ambient air quality in the lower Churchill River watershed is considered representative of a pristine environment as there are no substantive emissions sources near the area of the Project.

As baseline ambient air quality data are not available, the assessment of environmental effects is mainly based on the following aspects: i) the evaluation of the total estimated emissions from construction of the Project, ii) the implementation of mitigation measures to minimize the environmental effects, and iii) most likely air contaminants of concern for this type of project (particulate matter/dust). Refer to part (e) of this IR for examples of relevant projects.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

d. modelling predictions for airborne levels of COPC as a result of Project-related activities using appropriately validated software;

Response:

Please refer to parts (b) and (c) above. Modelling of this aspect was deemed to be unnecessary in this environmental assessment. This is a reasonable conclusion on the basis of the expected activities and associated emissions for these types of activities.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

e. comparison of predicted COPC levels to baseline levels and applicable air quality standards, as appropriate;

Response:

With the implementation of mitigation, the potential environmental effects will likely be not significant. Regarding this Project, it was concluded, based on various types and scopes of construction projects (Jacques Whitford 2008; Jacques Whitford 2006a,b; Jacques Whitford 2005; Jacques Whitford 2004a; Jacques Whitford 2004b, 2004c; Jacques Whitford 2003; Jacques Whitford 2000), that with mitigation (equipment maintenance and dust suppression), the potential environmental effects are expected to be not significant.

References:

Jacques Whitford. 2008. Environmental Impact Assessment – Route 8 Bypass, Marysville to South Portage. February 2008.

Jacques Whitford. 2006a. Brunswick Pipeline Project Environmental & Socio-Economic Assessment, Volume 1. May 2006.

Jacques Whitford. 2006b. Brunswick Pipeline Project Environmental & Socio-Economic Assessment, Volume 2. May 2006.

Jacques Whitford. 2005. Screening Report: Route 95 Highway Twinning Project, Woodstock, New Brunswick. May 11, 2005.

Jacques Whitford. 2004a. Final Screening Report: New Route 2 Trans-Canada Highway Project, Grand Falls to Aroostook, New Brunswick. August 3, 2004.

Jacques Whitford. 2004b. Final Comprehensive Study Report – New Route 2 Trans-Canada Highway Project, Perth-Andover to Woodstock. Prepared by Jacques Whitford Environment Limited, Fredericton, NB.

Jacques Whitford. 2004c. Final Comprehensive Study Report – New Route 2 Trans-Canada Highway Project, Grand Falls to Aroostook. Prepared by Jacques Whitford Environment Limited, Fredericton, NB.

Jacques Whitford. 2003. Environmental Screening Report – Route 2 Bypass, Pokiok/Nackwick Area to Longs Creek. Final Report to NBDOT – Planning and Land Management. Prepared by Jacques Whitford Environment Limited, Fredericton, NB.

Jacques Whitford. 2000. Environmental Background Studies for the Letang Impoundment, Pocologan River, and New River, Upgrading of Route 1 Letang to Lepreau, New Brunswick. NBF10236.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

f. assessment of COPC exposure of applicable human receptor groups (e.g. hunters, workers living in camps); and

Response:

Overall, based on the air quality effects assessment summarized above, it is unlikely that human receptor groups (hunters, workers living in camps) will experience health issues in relation to air contaminant emissions from the construction and/or operation of the Project. Worker health and safety will be further managed by Nalcor's Occupational Health and Safety Policy (Volume IA, Chapter 3). Risk to health associated with air contaminants on any specific work task would be identified and mitigated through the use of personal protective equipment if needed. In this context, air quality dispersion modelling and the preparation of a Human Health and Ecological Risk Assessment for air quality were deemed to be not necessary.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.88**

Information Requested:

The Proponent is asked to provide an air quality effects assessment including, but not necessarily limited to, the following steps for Construction, Operation and Decommissioning, with particular emphasis on the Construction phase which is expected to generate the highest emissions of COPCs:

g. description of any follow-up and/or mitigation efforts (as necessary).

Response:

As presented in Volume IIA, Chapter 3 of the EIS, feasible mitigation measures typically used during construction are proposed, including application of dust suppressants as required, following equipment maintenance schedules (to optimize efficient operation), preservation of natural vegetation where possible to minimize dust. An anti-idling policy for vehicles will be implemented. As presented in Volume IIB, Section 7.3 of the EIS, should complaints of excessive airborne dust be received during construction or operation, the root causes of these complaints will be determined by Nalcor, and corrective action will be taken if warranted. Ambient monitoring of dust may be conducted if required to identify the source or extent.

These programs would be designed and implemented as outlined in IR# JRP.112 and would be developed in consultation with the regulators.

IR# JRP.89

Fish and Fish Habitat – Inadequacies in Modelling

Requesting Organization – Joint Review Panel **Information Request No.: JRP.89**

Subject - Fish and Fish Habitat — Inadequacies in Modelling

References:

EIS Guidelines Section 2.5 (Precautionary Principle) & Section 4.5 (Environmental Effects)

EIS Volume IA, Section 9.12 (Precautionary Approach)

EIS Volume IIA, Section 4.1—4.14 (Environmental Effects Assessment)

EIS Volume IIB, Section 7.4 (Precautionary Approach)

Hatch Ltd. 2008. *Salt Water Intrusion 3D Model Study*. Prepared for Newfoundland and Labrador Hydro, St. John's, NL

Hatch Ltd. 2008. *Hydraulic Modeling of River*. Prepared for Newfoundland and Labrador Hydro, St. John's, NL

Minaskuat Inc. 2008. *Water and Sediment Quality Modelling in the Lower Churchill River*. Prepared for the Lower Churchill Hydroelectric Generation Project

Related Comments / Information Requests:

CEAR# 164 (Unidentified)
CEAR # 170 (Fisheries and Oceans Canada)
CEAR # 184 (Sierra Club Atlantic)
CEAR # 203 (Hydro-Québec)

Rationale:

Section 2.5 of the EIS Guidelines specifies that the Project is to be considered in a careful and precautionary manner to ensure that it does not cause significant adverse environmental effects. Section 4.5 of the EIS Guidelines requires the Proponent to conduct a comprehensive analysis of any environmental predictions.

DFO has indicated that the EIS falls to conduct adequate modelling to predict the effects of certain components of the Project. In particular:

- there is uncertainty as to whether the salinity values used in the salt water intrusion modelling are representative of actual values in the Lower Churchill River;
- the data used in the erosion potential calculations in the sediment transport modelling were taken from other river systems and may not be applicable to the Lower Churchill;
- there is insufficient modelling of the hydrological regime of future reservoirs in order to properly assess predictions about their productivity and bioaccumulation of mercury, and
- there is no modelling of the recovery of aquatic vegetation, which is important for certain life stages of some fish species.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.89**

Information Requested:

The Proponent is asked to provide:

a. validate the salinity values used in the salt water intrusion model;

Response:

The salinity values used in the salt water intrusion modeling are field measurements of actual salinity in the Lower Churchill River, as noted by Hatch (2008a: Hydrology Component Study Report 2 of 8, 2008b: Hydrology Component Study Report 8 of 8). As noted in those reports, the salinity data were obtained during the 1998-1999 field program conducted by AMEC/BAE-NewPlan (AMEC et al. 2001: Hydrology Component Study Report 6 of 8).

According to hydraulic theory (Keulegan 1966), the length of an arrested saline wedge is a function of the difference in density at the boundary between the two masses of water, and a function of river depth and velocity. In the case of the field measurements, there was a measured salinity of river water of 2 PSU in late April and 0 PSU in late September. As illustrated in the salinity contour mapping (Hatch 2008a, 2008b), the model analysis defines the leading edge of the wedge as the location where the salinity increases by 2 units relative to that of the receiving mass of river water (to either 4 or 2 PSU, for spring and fall scenarios, respectively). The simulated hydraulic conditions of depth and velocity are similar. Thus the defined extent of the intrusion (2 or more units above baseline condition) is seen to be similar, whether the simulated river salinity is 0 or 2 PSU.

References

AMEC Earth & Environmental Limited and BAE-NewPlan Group Limited. 2001. Aquatic Environment in the Goose Bay Estuary. Prepared for Labrador Hydro Project, St. John's, NL, May 2001.

Hatch. 2008a. Salt Water Intrusion 3D Model Study. Prepared for Newfoundland and Labrador Hydro, October 2008.

Hatch. 2008b. EIS0016 – Salt Water Intrusion 3D Model Study Addendum No. 1. Prepared for Newfoundland and Labrador Hydro, December 2008.

Keulegan, G.H. 1966. The mechanism of an arrested saline wedge. Estuary and Coastline Hydrodynamics, McGraw-Hill Book Co., 546-574.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.89**

Information Requested:

The Proponent is asked to provide:

b. **determine values used in deriving erosion potential in the sediment model specifically for the Churchill River;**

Response:

Shoreline erosion will be a parameter included in the post-project monitoring program associated with the Fish Habitat Compensation Plan (see response to IR# JRP.107). This information will improve the ability to predict post-project shoreline and fish habitat substrate compositions. Discussions with DFO and within the Compensation Workshops (see response to IR# JRP.107), have identified that site-specific shoreline information would greatly assist bank stability estimations. It is anticipated that a field program will be completed to address this.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.89**

Information Requested:

The Proponent is asked to provide:

c. **model the hydrological regime of the future reservoirs in greater detail; and**

Response:

The modeling of the future reservoirs has been completed using HEC-RAS modeling of over 265 established transects throughout the lower Churchill River. The details of the transect locations as well as existing and future channel velocity (m/s), maximum channel water depth (m) and water surface elevation (m) is provided in Appendix D of the Habitat Quantification report appended to the EIS (AMEC and Sikumiut 2007: Fish and Fish Habitat Component Study Report 3 of 11). This data was used to map the fish habitat for future conditions in the same report (see pages 80-88 and 98-108 in AMEC-Sikumiut 2007) as well as in the EIS (see pages 4-29 to 4-38 in Volume IIA), based primarily on the mean water velocity habitat classification ranges of each habitat type.

Reference:

AMEC Earth & Environmental Ltd. – Sikumiut Environmental Management Ltd. 2007. Lower Churchill Hydroelectric Generation Project Habitat Quantification. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.89**

Information Requested:

The Proponent is asked to provide:

d. model or assess in greater detail the recovery time of aquatic vegetation impacted by new water levels and flow regimes using suitable hydrological data sources.

Response:

The majority of aquatic vegetation recorded by AMEC (2008a: Fish and Fish Habitat Component Study Report 1 of 11) was at the mouths of tributary streams and it is anticipated that this will be the pattern first observed when the new reservoirs are created. The primary initial seed sources for the re-establishment of aquatic vegetation within reservoirs will likely be the numerous tributaries and upstream of Winokapau Lake on the main stem of the lower Churchill River. In addition, depending on the timing of inundation, seeds and propagules of the plants within the inundation zone may also be available for initial re-colonization. Habitat instability at the mouths of tributaries and along the shorelines, in both reservoirs, will continue until they have stabilized (anticipated to occur within 20 years) resulting generally in lower biomass and cover compared to a final stable shoreline. To ensure vegetation establishment within the reservoir Nalcor Energy (Nalcor) will implement programs to hasten aquatic vegetation establishment (see the EIS, Volume IIA, Section 4.10.2). As part of reservoir preparation work and Fish Habitat Compensation planning, Nalcor has committed to the enhancement of delta habitat at strategic locations within the reservoirs. In addition, sections of the reservoir shoreline where fine sediments are present are also predicted to provide suitable habitat. Given tributary delta enhancements and an immediate seed source from upriver locations, establishment is predicted to be within one or two growing seasons. It should be noted that the Fish Habitat Compensation Plan will include appropriate monitoring of habitat stability and utilization and therefore aquatic vegetation growth in areas of created or enhanced habitat is being considered for inclusion.

Factors such as propagule sources and availability of suitable habitat are considered below in further assessing the recovery time of aquatic vegetation.

Aquatic Vegetation Propagules

Aquatic vegetation commonly uses water as the medium for the dispersal of propagules (Merritt and Wohl 2002; Gurnell et al. 2007; Goodson et al. 2003 and Cellott et al. 1998). Therefore the waters of the Gull Island and Muskrat reservoirs and tributary streams/rivers will play a role in the establishment and distribution of aquatic vegetation within the newly formed reservoirs.

The existing aquatic communities within the main stem of the Churchill River as well as its many tributaries will act as seed stock for the newly created reservoirs. In particular, the upper reaches of the Churchill River, including the Unknown and Valley Rivers, near the tailrace of the Upper Churchill Hydroelectric Development will experience little change in water level due to the creation of the Gull Island Reservoir. During the 2006 aquatic plant surveys, the majority of the aquatic vegetation along the lower Churchill River was located at the mouth of tributary streams (AMEC 2008a), therefore it is anticipated that these streams will also serve as viable sources of seed for aquatic vegetation regeneration via downstream transport from populations and communities above the area of inundation.

The quantity of seed will depend on several factors such as impoundment timing and the proximity of seed sources along the shoreline and within the riparian zone. For example, the current timing of inundation is planned for August to October (see the EIS, Volume IIA, Section 4.10.1 and 4.11.1.3). Inundation in the early fall would be conducive to greater seed availability and hence dispersal and re-colonization.

Availability of Suitable Habitat

In order for any seed to successfully germinate, it needs the appropriate range of environmental conditions. These conditions include suitable water velocity, water depth and substrate.

<u>Water Velocity</u>

As a result of reservoir creation, mean water velocities will be reduced in many reservoir habitats compared to existing fast velocity habitat types. As with existing nearshore, shallow and/or backwater areas, new nearshore areas will also have water velocities suitable for the establishment of aquatic vegetation. Slower velocities and back water areas have greater deposition potential of nutrients and organic debris.

<u>Water Depth and Water Level Fluctuation</u>

During the Aquatic Vegetation study, aquatic vegetation was typically found in sheltered back water locations where water velocities were low with a sand/silt substrate and shallow water (0 to 0.5 m), (AMEC 2008a). Some species (*Sparganium sp.*) were also recorded in deeper areas with depths up to 2 m. These conditions will be available within the reservoirs, both naturally and at areas being designed for fish habitat.

Potential large and frequent water level fluctuations, e.g. due to reservoir management, are known to have had a negative effect on the establishment of riparian as well as aquatic vegetation (Bouchard et al. 2001; Bunn and Arthington 2002; Turner et al. 2005). Typically drawdown can result in loss of macrophyte species richness, cover and biomass (Tarver 1980; Roslett 1989, Roslett and Johansen 1996, in: Turner et al. 2005). Aquatic habitat is also generally less complex along newly formed littoral zones (Bunn and Arthington 2002). Drawdown often also results in a change in species composition, which may occur after a single drawdown event (Roslett 1989 in: Turner et al. 2005). For example, frequency and cover of aquatic vegetation in La Grande Rivière has been reduced, likely in relation to daily water level fluctuations (Bouchard et al. 2001) which have been attributed to desiccation in summer and freezing in winter (Hellsten et al. 1996, in: Turner et al. 2005). The effects of drawdowns, however, can be reversed in one or two growing seasons (Paller 1997 in Turner et al. 2005). Roslett (1989 in Turner et al. 2005) also noted that subsequent drawdowns may have less dramatic effects, since drawdown-resistant species will replace drawdown-sensitive ones.

Due to the level and the pattern of existing water level fluctuations (up to 2.2 m) in the lower Churchill River, it is expected that the aquatic vegetation currently present is adapted to existing water level fluctuations. The species composition is likely influenced by existing water level fluctuations, and at least some of the plants found during the aquatic vegetation study are "drawdown-resistant". Most of the aquatic vegetation found during the aquatic vegetation surveys was also located near/within tributaries, where the effects of lower water levels would be mitigated by water flow from the tributary itself.

Information on preferred water depth, reproduction and known drought resistance for several vascular plant species found during the lower Churchill River Aquatic Vegetation Surveys is provided in Table 1.

Table 1 Information on Aquatic Plant Habitat Conditions (Lahring 2003 and Burland 1989)

Species	Habitat	Water Depth	Regeneration Rate	Reproduction	Drought Resistance
Submergents					
Potamogeton gramineus	Shallow lakes, slow moving water	>2 m	Next growing season	Seeds and rhizomes	Low
Ranunculus flammula	Shallow lakes, slow moving water	>2 m	Next growing season	Seeds	Low
Sparganium sp.	Shallow lakes, slow moving water	1 to 2 m	Next growing season	Seeds and rhizomes	Low
Emergents					
Eleocharis acicularis	Shallow lakes, slow moving water	<1 m	Next growing season	Rhizomes	Moderate
Glyceria borealis	Shallow lakes, slow moving water	<1 m	Next growing season	Seeds and rhizomes	Moderate
Scirpus atrocinctus	Shallow lakes, slow moving water	<1 m	Next growing season	Seeds and rhizomes	Moderate

Both reservoirs of the Lower Churchill development will be operated as close as possible to full supply level (125 m for Gull Island and 39 m for Muskrat Falls above sea level [asl]). However, due to operational demands reservoir drawdown may be required (up to 3 m in Gull Island Reservoir and 0.5 m in Muskrat Reservoir). Drawdown within the Gull Island Reservoir to a minimum elevation of 122 m asl would occur during April in anticipation of the spring freshet (Figure 1). The reservoir would then be refilled to the full supply level once the spring freshet commences with the reservoir reaching full supply by early June (Figure 1). Throughout the rest of the year, Gull Island Reservoir will be maintained as near as possible to full supply level with minimal fluctuation.

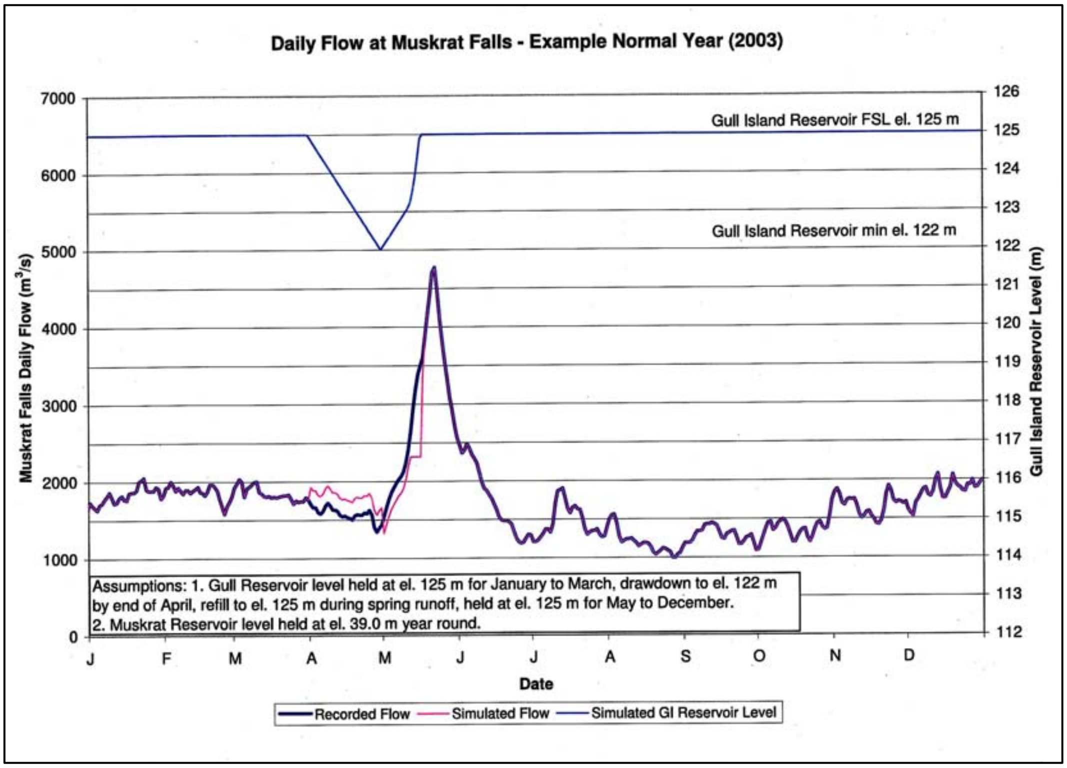


Figure 1 **Gull Island Reservoir Water Level and Daily Muskrat Falls Pre-Impoundment and Simulated Post Impoundment Discharge**

The Muskrat Falls Reservoir would show less variability than current conditions, as current annual variation in water levels ranges from 0.25 m to 1.5 m within the stretch of river the reservoir would occupy. Drawdown in the Muskrat Falls Reservoir is forecast to be 0.5 m or less during operation. As a result of the minimal drawdown, water level fluctuations in the Muskrat Falls Reservoir will be conducive to aquatic vegetation establishment.

The resulting flow regime is therefore similar to the flow pattern that is currently experienced in the Lower Churchill River, which is dependent on the operational requirements of the Upper Churchill Hydroelectric Development. Hence the proposed fluctuations are not considered limiting to aquatic vegetation establishment.

Substrate

From the results of the substrate analysis conducted as part of the Aquatic Plant Survey conducted by AMEC (2008a) it is evident that aquatic vegetation was found in substrates comprised of fine sand and silt or areas of cobble and pebble with interspersed finer substrate. It is expected that for aquatic plants to become established within the newly formed reservoirs, similar substrates must be available. As was found during the aquatic vegetation field survey, it is expected that near the mouths of tributary rivers and areas of reduced velocity will contain the most suitable locations for aquatic vegetation to become established.

Bank stability and the associated rate of shoreline erosion will play an important role in the establishment of aquatic vegetation within the reservoirs. AMEC (2008b: Hydrology Component Study Report 1 of 8) has conducted a study of the bank stability and erosion potential of the proposed reservoir shorelines. The findings of this study indicate that reservoir shoreline stability and erosion potential are different between the two reservoirs. Within the Gull Island reservoir, shorelines are predicted to be stable with low erosion potential and low wave energy (AMEC 2008b). Conversely the Muskrat Falls reservoir has a terrain stability rating and soil erosion potential of high to very high, indicating that the overall erosion potential is higher, especially along the southern shore (AMEC 2008b). As part of reservoir preparation work and Fish Habitat Compensation planning, Nalcor has committed to the enhancement of delta habitat at strategic locations within the reservoirs. In addition, sections of the reservoir shoreline where fine sediments are present are also predicted to provide suitable habitat. Given tributary delta enhancements and an immediate seed source from upriver locations, establishment is predicted to be within one or two growing seasons. It should be noted that the Fish Habitat Compensation Plan will include appropriate monitoring of habitat stability and utilization and therefore aquatic vegetation growth in areas of created or enhanced habitat is being considered for inclusion.

References:

AMEC. 2008a. Lower Churchill Hydroelectric Generation Project Aquatic Vegetation Studies. Prepared for Newfoundland and Labrador Hydro.

AMEC. 2008b. Lower Churchill Hydroelectric Generation Project Bank Stability Study. Prepared for Newfoundland and Labrador Hydro.

Bouchard, D., J. Ouzilleau, R. Denis et S. Besner. 2001. Complexe La Grande. Suivi environnemental de la végétation riveraine et aquatique. Rapport synthèse pour la période 1979-1999. Rapport pour l'unité Hydraulique et Environnement, Hydro-Québec Production. FORAMEC inc., Québec. 133 p. English language summary available at: http://www.hydroquebec.com/sustainable_development/ documentation/complexe_lagrande.html

Burland, R. 1989. An Identification Guide to Alberta Aquatic Plants. Alberta Environment, Pesticide Management Branch, Edmonton, Alberta.

Bunn, S.E., and A. H. Arthington. 2002. Basic Principles and Ecological consequences of Altered Flow Regimes for Aquatic Biodiversity. Environmental Management 30(4): 492- 507.

Cellot, B., Mouillot, F. and Henry, C.P. 1998. Flood Drift and Propagule bank of Aquatic Macrophytes in a Riverine Wetland. Journal of Vegetation science 9**:** 631-640.

Goodson, J.M., Gurnell, A.M., Angold, P.G. and Morrissey, L.P. 2003. Evidence for Hydrochory and the Deposition of Viable Seeds within Flow-Deposited Sediments: The River Dove, Derbyshire, UK. River Research and Applications 19: 317-334.

Gurnell, A., Goodson, J., Thompson, K., Clifford, N., Armitage, P. 2007. The river-bed: a dynamic store for plant propagules? Earth Surface Processes and Landforms 32**:** 1257-1272.

Keulegan, G.H. 1966. The mechanism of an arrested saline wedge. Estuary and Coastline Hydrodynamics, McGraw-Hill Book Co., 546-574.

Lahring, H. 2003. Water and wetland plants of the prairie provinces. Canadian Plains Research Centre. U of R.

Merritt, D.M. and Wohl, E.E. 2002. Processes Governing Hydrochory Along Rivers: Hydraulics, Hydrology, and Dispersal Phenology. Ecological Applications 12: 1071-1087.

Turner, M.A., Huebert, D.B. Findlay, D.L., Hendzell, L.L., Jansen, W.A., Bodaly, R.A., Armstrong, L.M. and Kasian, S.E.M. 2005. Divergent impacts of experimental lake-level drawdown on planktonic and benthic plant communities in a boreal forest lake. Canadian Journal of Fisheries and Aquatic Sciences 62: 991-1003.

IR# JRP.90

Fluvial Geomorphology - Change in Habitat during Operation and Maintenance - Downriver from Muskrat Falls

Requesting Organization – Joint Review Panel **Information Request No.: JRP.90**

Subject - Fluvial Geomorphology - Change in Habitat during Operation and Maintenance - Downriver from Muskrat Falls

References:

Volume IIA, Section 4.12 (Environmental Effects Assessment — Change in Habitat Quality), Change in Habitat during Operation and Maintenance (p. 4-39 to 4-44), Downriver from Muskrat Falls (p. 4-45 to 4-46)

Northwest Hydraulic Consultants. 2008. Lower Churchill Hydroelectric Generation Project Sedimentation and Morphodynamics Study. Prepared for Newfoundland and Labrador Hydro, St. John's, NL

Related Comments / Information Requests:

CEAR # 183 (Central Labrador Environmental Action Network)
CEAR # 198 (G. Davis)
CEAR # 202 (Natural Resources Canada)
CEAR # 203 (Hydro-Quebec)

IR# JRP.23, 43, 49, 50, 51, 52, 53, 54, 55, 56

Rationale:

Section 4.12.2 of the EIS, "Downstream of Muskrat Falls", is based on Northwest Hydraulic Consultants (2008), which analyzes the effect of the Muskrat Falls dam on the sediment supply to the lowest reach of the Churchill River (i.e., decrease in sediment transport, possible channel degradation, and possible channel pattern response). However, the meaning of the last sentence of the following quoted paragraph is not clear and is not derived from this component study.

From the EIS p. 4-46 (last paragraph of section Downriver from Muskrat Falls (p. 4-45 to 4-46))

> *"The sediment transported downstream from Muskrat Falls will be much reduced. This will lead to a new equilibrium of erosion and deposition being established within the river below Muskrat Falls. This will alter the current dynamic nature of fish habitat in this region due to the decline in available sediments from upstream, and it will also lower the suspended sediment load. Both of these changes may lead to improvements in the habitat quality downstream because increases in bed scour (i.e., water depths) are predicted with negligible change in aerial extent."*

Requesting Organization – Joint Review Panel **Information Request No.: JRP.90**

Information Requested:

The Proponent is asked to:

a. **explain how a predicted increase in bed scour would lead to increased water depth if the aerial extent of the channel remains unchanged; and**

Response:

The predicted increase in bed scour, and hence increased water depth, and the aerial extent of the channel are not mutually inclusive processes. The reduction in the upstream sediment load is expected to induce bed degradation (i.e., scour) starting below Muskrat Falls Dam and progressing downstream. The degradation of the riverbed will eventually reduce channel slope such that river energy, and hence sediment transport potential, is reduced. This process will allow the river to reach a new equilibrium with respect to sediment supply and river flow energy. This degradation is predicted to occur nearer Muskrat Falls and to be negligible in the lower reaches of the river. Figure 4.4 (see below) of Northwest Hydraulic Consultants (NHC 2008) demonstrates the relative predicted change in thalweg (deepest part of the channel) and water depth along the lower Churchill River as the river adjusts to reduced sediment supply. As the overall slope of the river bed degrades (i.e., reduces slope/grade) over the modeled 100 years in response to reduced sediment load, the predicted water level profile remains relatively unchanged. It should be noted that the figure does show a slight reduction in water elevation near Muskrat Falls but this translates to negligible changes in aerial habitat extent due to the river cross section (see Figure 4.5 below from NHC).

The aerial extent of the channel is dictated by water surface elevation. Without a major alteration to water flow (see response to IR# JRP.43a), water surface elevation would be controlled by a downstream constriction or impediment to flow (i.e., hydraulic control). As demonstrated in the Sedimentation and Morphodynamics Study (NHC 2008 – appended to the EIS), the sedimentation processes at the mouth of the river are expected to remain similar to existing conditions and hence changes in the hydraulic control of the river are expected to remain. Therefore bed scour upstream of the hydraulic control can lead to increased water depth without changing the aerial extent of the channel.

Figure 4.4 Relative Predicted Change in Thalweg and Water Depth along the Lower Churchill River (NHC 2008)

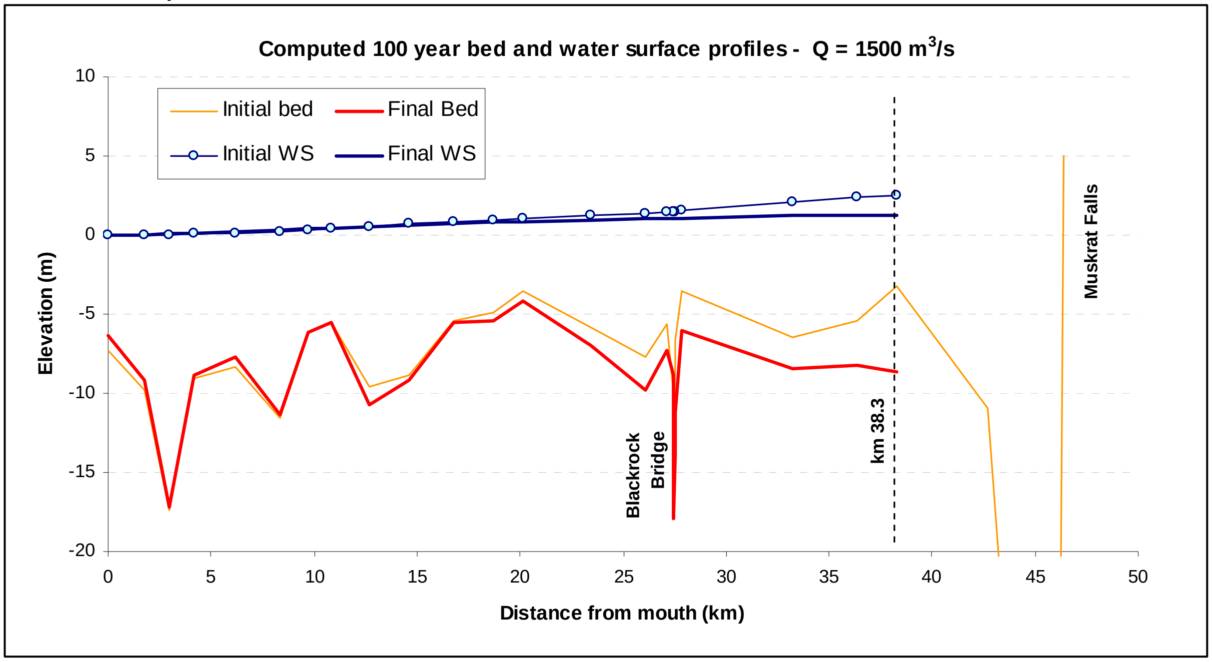
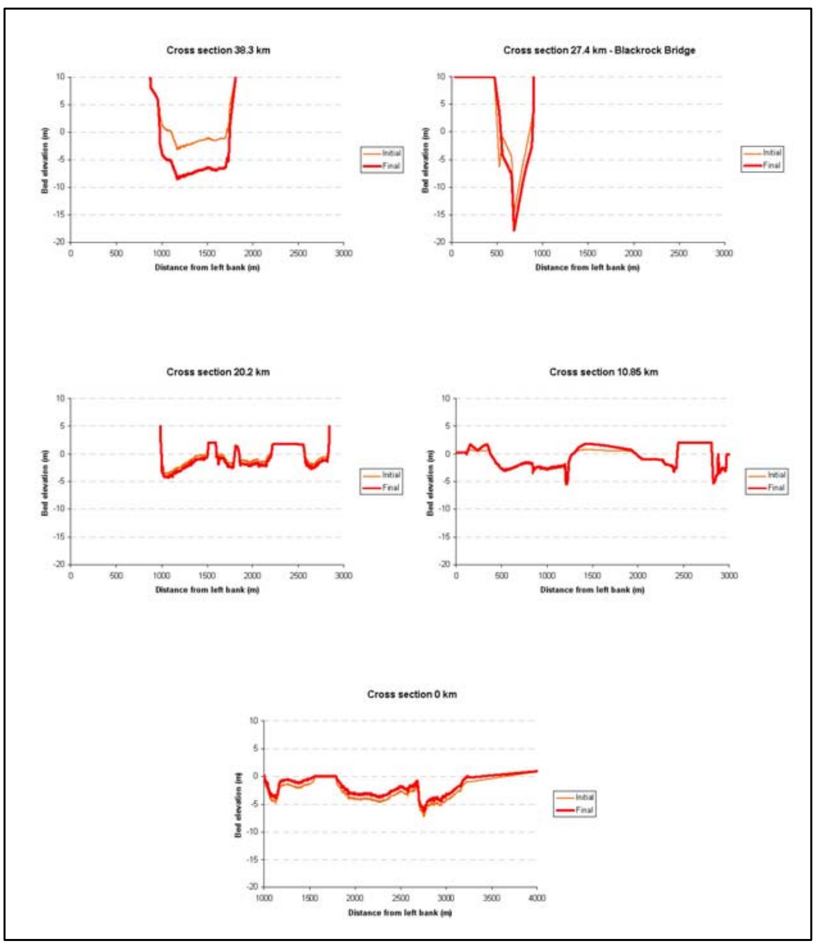


Figure 4.5 Examples of Computer Bed Changes at Five Cross Sections (NHC 2008)



Reference:

NHC (Northwest Hydraulic Consultants). 2008. Lower Churchill Hydroelectric Generation Project, Sedimentation and Morphodynamics Study, 2008.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.90**

Information Requested:

The Proponent is asked to:

b. **provide details of how this will lead to improvements in habitat quality downstream.**

Response:

The predicted changes to sediment transport conditions may lead to fish habitat improvements. While river flow and habitat type classification are not predicted to change (see response to IR# JRP.43b), there is predicted to be a defined thalweg with increased depth (see Figure 4.5 above and response to IR# JRP.43b). This may offer improvements in habitat quality for certain species, or life stages, by increasing protection from predation and as a potential thermal refuge.

IR# JRP.91

Use of Herbicides along the Transmission Corridor

Requesting Organization – Joint Review Panel **Information Request No.: JRP.91**

Subject - Use of Herbicides along the Transmission Corridor

References:

EIS Guidelines, Section 4.3.5 (b) (Operation and Maintenance – Access Roads and Transmission Facilities), Section 4.5 (Environmental Effects)

EIS Volume IIB, Section 5.11.2.3 (Other Operation and Maintenance Activities), Section 5.14.4.2 (Residual Environmental Effect – Black Bear: Operation and Maintenance), Section 5.14.8.2 (Residual Environmental Effect – Canada Goose: Operation and Maintenance)

EIS Volume IIB, Appendix Table IIB-A-7 and elsewhere (Transmission Line – Use of Herbicides)

Related Comments / Information Requests:

CEAR #181 (Protected Areas Association of Newfoundland and Labrador)
CEAR #195 (R. Goodfellow-Baikie)

IR# JRP.30, 70, 74, 99

Rationale:

EIS Guidelines (Section 4.3.5 (b)) require that the Proponent describe all aspects of the operation and maintenance of the undertaking including vegetation management along the transmission corridor.

In volume IIB, Section 5.11.2.3, the EIS mentions that "Vegetation management of the transmission line right-of-way will begin three to four years after construction is completed. Crews will use approved herbicides mixed with a surfactant, which will be sprayed using a tracked vehicle with a 1,500 or 2,000 L tank. (…) The vehicle will apply the herbicide directly, so that only target areas are treated. Cut and stump applications may also be used and use of this method will be limited."

However, in Volume IIB, Appendix Table IIB-A-7 and elsewhere in the table, it is indicated that "If used, herbicides will be applied from the ground by hand". The EIS does not discuss the effect of the use of herbicides on the aquatic environment, terrestrial environment, specifically Black Bear, Canada Goose, and other wildlife using the transmission corridor, or on potential human health effects from food harvested along the corridor.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.91**

Information Requested:

The Proponent is asked to provide:

a. **clarification of herbicide application along the transmission corridor and the methods of application;**

Response:

Industrial herbicide application is a provincially regulated activity, requiring operator and applicator licenses, and the requirement of weekly reporting to the provincial government regarding where treatment is applied, how much and what type of chemical was used.

Currently there are two chemical application techniques used on transmission lines by Newfoundland and Labrador Hydro, a subsidiary of Nalcor Energy (Nalcor) and an approved operator for the application of herbicides by the Department of Environment and Conservation. The first and most common technique is a directed foliar application. This technique consists of a sprayer system mounted on a tracked machine such as a muskeg (each application vehicle is licensed under the *Environmental Protection Act,* SNL2002-E-14.2 and Pesticide Control Regulations, 2003). The sprayer system is a single nozzle at the end of a long wand controlled with a trigger by the applicator on the back of the machine. As the name suggests the operator directs the chemical mix to the target vegetation (e.g., spruce, fir, birch, poplar, alder, and maple) as the machine moves along the line. Each operator is also licensed and trained to apply herbicide. Treatment of compatible species also found on the right-of-way is avoided or minimized. Compatible species are low growing and do not grow to a sufficient height to reach energized lines or cause significant impediment or safety concerns to maintenance crews traveling in the right-of-way. Compatible species include berries, Labrador Tea, Kalmia species, Trailing Juniper, Dwarf Birch, and grass. This selective application of herbicide maintains the compatible species within the right-of-way giving them increased growing space with the removal of the target species. Once compatible species have established it makes it more difficult for the target species to re-establish and the length of time between treatments is increased.

The second application technique is a cut and stump treatment. This treatment consists of cutting the target species and applying herbicide to the stump using a back pack sprayer or a sprayer mounted on the brushsaw. This kills the root system and prevents re-sprouting. This system is very expensive and labor intensive. It is typically used in sensitive areas.

Buffer zones are applied to all water bodies, private land, wells, and human habitation (temporary or permanent). Buffers on water bodies for foliar treatments are 30 m to 50 m depending on the slope (slopes over 20° get the 50 m buffer). It is possible to cut and stump treat up to 2 m from the water body using glyphosate based products but it is not typically done on a transmission line. Buffer zones for wells, private land, and human habitation are 50 m.

The use of herbicides along the proposed transmission line corridor for the Project will be in accordance with the procedures described above and will be applied as appropriate along the transmission line right of way. Approval and appropriate licensing will be obtained from the Department of Environment and Conservation.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.91**

Information Requested:

The Proponent is asked to provide:

b. an assessment of the potential environmental effects of herbicide application along the corridor on the aquatic environment;

Response:

All herbicide products used are registered by the Federal Department of Health for their intended purpose. This registration process involves in-depth science to determine risks to flora, fauna and humans associated with the storage, application, transport and handling of these products and the potential risks posed to the natural environment. The Provincial Department of Environment and Conservation is responsible for regulating the use of these federally registered products in Newfoundland and Labrador (NL) (*Environmental Protection Act*, SNL2002-E-14.2 and Pesticide Control Regulations, 2003). The Province is responsible for the requirements associated with the application, storage and handling of these products within NL. The Province establishes buffer zones for the application of herbicides in NL. These buffer zones are based on the fate and persistence parameters of the herbicides applied and are intended to prevent the movement of herbicides and/or their residues into waterbodies adjacent to application sites and, in general, to protect the natural environment where these products are used.

Herbicide application by Nalcor will meet or exceed these regulations. In addition, Nalcor employs knowledgeable and experienced inspectors to oversee all operations involving the application of herbicides in the field. These inspectors are responsible to see that all requirements associated with compliance during mixing, loading and application operations are strictly adhered to and prepare Daily Application Reports to support their observations.

Through adherence to the above regulations, there are no predicted environmental effects on the aquatic environment from herbicide application along the corridor.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.91**

Information Requested:

The Proponent is asked to provide:

c. **an assessment of the potential health effects of the use of herbicides on wildlife, such as bears, using the corridor for foraging, and potential health risks to humans using the corridor to gather country food; and**

Response:

As outlined in part (b) of this IR, the application of herbicide products is a highly regulated activity. Nalcor will meet or exceed the requirements of the application regulations. As such, the potential effects of herbicide application along the corridor on wildlife, such as bears, using the corridor for foraging, and the risk of potential health risks to humans using the corridor to gather country food is avoided.

Through adherence to the above regulations, there are no predicted environmental effects on wildlife, such as bears, using the corridor for foraging, or health risks to humans using the corridor to gather country food from herbicide application along the corridor.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.91**

Information Requested:

The Proponent is asked to provide:

d. the proposed means of public communication with respect to herbicide application in the corridor.

Response:

Nalcor will issue public advisories in compliance with the provincial regulations related to the application of herbicides. Such measures will include newspaper ads, and potentially radio announcements, to inform the public of herbicide application along the corridor. During application public notices will be posted along the right-of-way to inform land and resource users of the herbicide application activity.

IR# JRP.92

Moose Population Expansion

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Subject - Moose population expansion

References:

EIS Volume IIB, Section 5.7.2 (Change in Habitat – Existing Knowledge -Moose), Section 5.11.1.5 (Environmental Effects Assessment – Change in Habitat – Moose), Section 5.14.3 (Residual Environmental Effect – Moose), Section 7.2.3 (Residual Environmental Effects – Terrestrial Environment)

Related Comments / Information Requests:

CEAR # 206 (K. Lethbridge)

IR # JRP.9

Rationale:

The EIS concludes that the Churchill River valley is the most heavily used area of Labrador by Moose in the winter (p.5-21), and that this area has experienced a moose expansion over the past several decades (p.5-82). The EIS also states that the density of moose in the Muskrat Falls Moose Management Area is low in comparison with other populations in North America, likely as a result of moose being at the edge of the species' distribution (p.5-46) and hypothesizes that relatively low densities of the species in central Labrador reflect either a generally low quality of habitat and/or a population that is continuing to expand in distribution [from the Churchill Valley source]. Much of the forest in the Churchill River valley is comprised of mature and over-mature stands. These provide moose with critical shelter from deep snow in winter and are preferred winter habitat.

The EIS concludes that up to 25 percent of the Moose in the watershed may need to disperse over greater distances to find adequate resources for survival. There is some uncertainty of impacts to Moose populations in the valley: "[i]f the population is expanding, its densities in habitat (particularly of primary quality) adjacent to the reservoirs may stabilize at higher levels following impounding. However, if habitat is limiting, especially in terms of sheltered areas providing refuge from deep snow in winter, a reduction in abundance can be expected proportional to the loss of primary fall and winter habitat" (p.5-82).

There are discrepancies in the conclusions that the EIS draws concerning the impact of the Project on moose and moose habitat. In one section, the EIS concludes that the loss of primary wintering habitat would have a moderate adverse environmental effect on Moose in the Assessment Area but because a much lower proportion of primary spring and summer habitat would be affected, and because Moose has already shown "considerable adaptation to the Labrador winters during its recent population expansion", the population is expected to remain sustainable (p.5-82). In another section, the EIS anticipates that "moose will continue to increase and expand into the lower Churchill River watershed (and elsewhere)" (p.7-5).

The Proponent also suggests that in order to mitigate the impacts to moose in the assessment area "Nalcor Energy will attempt to limit its influence in the area, by limiting the physical footprint of the Project where possible, and not replacing wintering habitat in areas adjacent to those lost during impoundment" (p.7-5).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

a. a more detailed discussion of the Churchill River valley as the most productive moose habitat in Labrador and an important region for moose population dynamics;

Response:

A description of the information available on Moose and Moose habitat in the lower Churchill River valley is presented in Section 2.4.5.2, Volume IIA of the EIS. Additional data have been collected since the submission of the interim Environmental Baseline Report: Moose (*Alces alces)* (Minaskuat 2009). This information will be incorporated into the following sections of that report: Section 7.3.2 - Movements within and to/from the lower Churchill River valley; Section 7.3.3 – Habitat Associations and Section 8.0 - Discussion. As indicated in IR# JRP.9, the completed Environmental Baseline Report on Moose will be submitted to the Panel. The role of the Churchill River valley in Moose population dynamics in central Labrador is discussed below in part (b) of this response.

Reference:

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Moose (*Alces alces).* Interim Report prepared for the Lower Churchill Hydroelectric Generation Project.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

b. **a discussion of whether or not the Project may impact directly on the source population of the observed expansion;**

Response:

The result of the environmental assessment is that likely environmental effects of the Project on Moose in the lower Churchill River watershed (i.e., suggested 'source' population) are not significant. As indicated in Section 2.4.5.2 (Volume IIA), Moose now occur throughout forested regions of Labrador despite the fact that this area is at the northeastern extent of their range. Although the lower Churchill River valley has been described as having the best Moose habitat in central Labrador (Trimper et al. 1996) four surveys of 10.5 km^2 blocks over a 12 year period (Trimper et al. 1996, Jacques Whitford 1997, Northland and Jacques Whitford 2000, Minaskuat 2009) in this watershed indicated no consistent or obvious trend in abundance at these locations. Thus, Moose in Labrador are believed to be increasing through range expansion into new areas (e.g., via river valleys, linear developments), not necessarily from a 'source' location such as the lower Churchill River valley.

Despite the loss of wintering habitat due to impounding of the reservoirs, the Project is not likely to cause a decline in Moose populations within the lower Churchill River watershed. As identified in the EIS, Volume IIB, Table IIB-A-5, several Project activities are likely to result in the enhancement of Moose habitat through the establishment of primary succession vegetation that is suitable forage. For example, transmission line construction and reservoir preparation during the construction phase, and inspection, maintenance, repairs along the transmission line during the operation and maintenance phase will result in activities (e.g., cutting trees and shrubs) that will promote vegetation regeneration through suckering or better growing conditions (e.g., less shade), which is likely to provide quality foraging areas for moose.

References:

Jacques Whitford. 1997. Distribution of Wintering Moose within the Low-Level Training Area of Labrador and Northeastern Quebec, 1997. Jacques Whitford Environment report prepared for PMO Goose Bay, National Defence Headquarters, Ottawa, ON.

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Moose (*Alces alces).* Interim Report prepared for the Lower Churchill Hydroelectric Generation Project.

Northland and Jacques Whitford. 2000. Winter Moose Survey. Northland Associates (1995) Ltd and Jacques Whitford Environment Limited report prepared for Churchill River Power Project – 1999 Environmental Studies, LHP 99-25.

Trimper, P.G., E.A. Young and T.E. Chubbs. 1996. Distribution of moose in south central-Labrador and northeastern Quebec. Alces 32: 41-49.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

c. further evidence to support a continued moose population expansion or moose reduction, and a statement as to which scenario is more likely to occur in the Lower Churchill valley after impoundment;

Response:

As indicated in the Residual Cumulative Effects Section 5.15.4.3 (Volume IIB), an anticipated decline in the Moose population in the lower Churchill River valley in the short-term immediately following inundation, is anticipated to shift to a slight population increase once disturbed areas begin to revegetate.

Previous research has suggested that although there are signs of an expanding Moose population, the expansion potential for Moose in Labrador is limited by illegal harvest, predation, sparse habitat or a combination of these factors (Trimper et al. 1996, Chubbs and Schaefer 1997). In Section 2.4.5.2 of Volume IIA in the EIS, the seasonal nature of habitat use for Moose is described as mixed stands preferred in all seasons, as they provide a combination of shelter (from snow depths) and forage (Courtois et al. 2002). Moose feed primarily on deciduous species such as willow, birch and alder, occasionally supplementing their diet with conifers such as balsam fir during winter.

As indicated in Section 5.7.2 (Volume IIB of the EIS), primary succession deciduous vegetation will likely result at several areas of disturbance associated with the Project footprint (e.g., preparation of the reservoirs, access roads, transmission line route, other Project facilities). Additionally, deciduous hardwood habitat will be created in the Muskrat Falls Reservoir as indicated in IR# JRP.102. Where these activities occur in proximity to coniferous cover, they are likely to result (either by coincidence or design) in the creation of primary habitat for Moose in the lower Churchill River watershed. In other words, while it is not the intent of Nalcor Energy (Nalcor) to replace primary wintering habitat for Moose altered or lost as a result of the inundation, there will be new areas of similar quality habitat created.

Opposing pressures on the Moose population in terms of ongoing predation, illegal harvest, sparse habitat, and effects on primary wintering habitat as a result of the reservoirs will be offset by coincident and enhanced areas of primary succession vegetation from this Project and other surface disturbance activities (e.g., forest harvesting in Forest Management District 19 [Section 5.15.4.3 in Volume IIB of the EIS]). With the extension of the range of Moose into and throughout Labrador, it is clear that this animal can adapt to the climatic conditions and expand in areas of disturbance. Thus, Moose in the Assessment Area are predicted to continue to increase in abundance.

References:

Chubbs, T.E. and J.A. Schaefer. 1997. Population growth of moose, *Alces alces*, in Labrador. Canadian Field-Naturalist 111 (2): 238-242.

Courtois, R., C. Dussault, F. Potvin and G. Daigle. 2002. Habitat selection by moose (*Alces alces)* in clear-cut landscapes. Alces 38: 177-192.

Trimper, P.G., E.A. Young and T.E. Chubbs. 1996. Distribution of moose in south central-Labrador and northeastern Quebec. Alces 32: 41-49.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

d. a definition of "sustainable" for the moose population in the assessment area;

Response:

A sustainable population is defined as one where a population can continue to reproduce and persist in the Assessment Area. The effect of the Project was predicted to be not significant because the Moose population in question is predicted to remain sustainable. Thus, while adverse effects are expected at least in the short-term as a result of the Project (and other landscape pressures), Moose will continue to exist in the Assessment Area and are therefore considered a sustainable population.

As indicated in IR# JRP.4, the rationale for using this definition of a sustainable population is that it provides a measure of biodiversity and ecosystem function. As described in EIS Volume IIB, Section 7.4.2.2, "*…perhaps the issues of greatest importance for Innu and other persons who are concerned about the natural resources of the lower Churchill River watershed are whether these species will persist and whether such areas of abundance will continue*." Thus, the maintenance of regional biodiversity was an important criterion in the environmental effects analysis for Moose.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

e. **a discussion of the certainty and likelihood of the stated impacts given the variations in potential impacts (from reduction to expansion) presented in the EIS;**

Response:

The confidence in the certainty and likelihood of the environmental effects is high, as they consider regeneration of habitat following disturbance, which is a natural occurrence, and the ecology of Moose, which is also well understood. As discussed in the response to part (c) of this response, over the life of the Project, Moose will be exposed to adverse effects (e.g., habitat loss) and positive effects (e.g., habitat regeneration). There is a high degree of certainty regarding the environmental assessment prediction, as it considers changes in vegetation (i.e., habitat) as the Project transitions from construction through operation and maintenance (i.e., vegetation will regenerate on disturbed areas once construction is complete).

The appearance of primary succession vegetation will require several years to establish along the new shoreline, in areas targeted for enhancement, on the transmission line right-of-way, and at other areas of disturbance (e.g., laydown areas). Note that cutovers (with regenerating hardwood deciduous and balsam fir vegetation) in Newfoundland are deemed to be of highest use by moose at eight to 10 years of age (Parker and Morton 1978).

Reference:

Parker, G.R. and L.D. Morton. 1978. The Estimation of Winter Forage and Its Use by Moose on Clearcuts in Northcentral Newfoundland. Journal of Range Management 31(4): 300-304.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

f. **an explanation of how the precautionary approach was applied to impact assessment for moose;**

Response:

As indicated in IR# JRP.19, when considering the assumptions, uncertainties, and limitations in the EIS, it is important to understand how the Project was assessed in a careful and precautionary manner in accordance with Section 2.5 of the EIS Guidelines. For the Project and its EIS, a precautionary approach has been applied in order to be conservative in the assessment of environmental effects and design mitigative measures that will result in residual effects that are likely to be not significant. Discussion of this approach is also provided in Section 9.12 of Volume IA of the EIS.

The precautionary approach for Moose included the consideration that areas of primary habitat, as indicated by the Ecological Land Classification (Section 2.4.2 of Volume IIA), likely underestimates the amount available in the Assessment Area (i.e., outside the inundation area) and does not account for 'edge' features between habitats that may also provide forage and/or shelter during winter. Therefore, there is undoubtedly more habitat available for displaced moose than considered in the EIS.

The reservoir preparation and other forms of disturbance associated with the Project footprint will result in primary succession vegetation that is attractive for this species, as discussed in parts (c) and (e) of this IR response. Therefore, although mitigation was not required for Moose, areas of increased habitat quality are expected to result, as regeneration of vegetation occurs in disturbed areas. As follow-up, Nalcor has committed to conduct winter aerial and ground and/or GPS telemetry surveys as part of the Monitoring and Follow-up Program (Table 7-3 in Volume IIB; also please refer to IR# JRP.112).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

g. **a reassessment of other species inter-relationship predictions (e.g., wolf-moose-caribou) in light of moose population dynamics;**

Response:

It is not necessary to reassess inter-relationship predictions between wolf-moose-caribou.

As indicated in Section 5.7.1.3 (Volume IIB of the EIS) predation is considered the primary limiting factor for caribou populations in North America, particularly sedentary herds (Bergerud 1996). Wolf is the main predator of caribou (Miller 1983; Brown 1986; Stuart-Smith et al. 1997). Wolf densities are largely dependent on the density of their primary prey, Moose. As Moose populations increase, the density of wolves also increases, thereby potentially increasing the predation pressure on woodland caribou in the surrounding landscape (Fuller and Keith 1981; Seip 1991). It is thought that caribou select habitat (such as bogs and fens) that spatially separates them from moose and wolf (Cumming et al. 1996). Therefore, any disturbance that creates large scale habitat change (e.g., reservoir preparation and other areas of disturbance associated with the Project footprint), thereby increasing Moose and subsequently, wolf numbers, is expected to result in increased predation of caribou. Conversely, changes that decrease Moose abundance (e.g., alteration or loss of primary quality wintering habitat due to inundation) are likely to have the opposite effect.

References:

Bergerud, A.T. 1996. Evolving perspectives on caribou population dynamics, have we got it right yet? Rangifer 9: 95-116.

Brown, W.K. 1986. The Ecology of a Woodland Caribou in Central Labrador. M.Sc. thesis, University of Waterloo, Waterloo, ON.

Cumming, H.G. and B.T. Hyer. 1996. Experimental log hauling through a traditional caribou wintering range. Rangifer Special Issue 10: 241-258.

Fuller, T.K. and L.B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. Journal of Wildlife Management 45(1): 197-213.

Miller, F. 1983. Wolf-related caribou mortality on a calving ground in north-central Canada. In L.N. Carbyn (ed.). Wolves in Canada and Alaska: Their Status, Biology, and Management. Proceedings of the Wolf Symposium, Edmonton, Alberta. Canadian Wildlife Service Report Series Number 45.

Seip, D.R. 1991. Predation and caribou populations. Rangifer Special Issue 7: 46-52.

Stuart-Smith, A.K., C.J. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. Journal of Wildlife Management 61: 622-633.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.92**

Information Requested:

The Proponent is asked to provide the following information:

h. clarification and explanation of the statement (Volume IIB, Section 7.2.3 (Terrestrial Environment) that "Nalcor Energy will attempt to limit its influence in the area, by limiting the physical footprint of the Project where possible, and not replacing wintering habitat in areas adjacent to those lost during impoundment."

Response:

Replacing wintering habitat in areas adjacent to those lost during impoundment would have required disturbing additional areas unnecessarily. Despite the alteration and loss of primary winter habitat in the lower Churchill River valley due to inundation, there will be locations of coincidental (i.e., opportunistic mitigation for Moose) habitat enhancement associated with the reservoir preparation and other areas of disturbance within the Project footprint, as discussed in parts (c) and (e) of this IR response. In consideration of all Project activities, Moose will continue to persist within the Assessment Area.

From an ecosystem and biodiversity perspective, Nalcor has assessed the Project to determine if existing species would remain (post-construction) and that the consequences of the Project would not result, either directly or indirectly (through changes in other trophic levels), in the extirpation of any species from the lower Churchill River watershed. Consistent with the response in part (g) of this response, Nalcor recognized that its actions (along the new shoreline and other areas of disturbance in the Project footprint) would enhance the landscape for Moose in the long-term, thereby enhancing the abundance of wolf and leading to potentially greater predation on caribou. This consequence would be greatest on woodland caribou such as the Red Wine Mountains Herd (that is currently in decline to dramatically low levels [Section 2.4.4 in Volume IIA]). Therefore, in the interest of supporting the recovery of this caribou herd, Nalcor elected not to replace Moose wintering areas with adjacent habitat enhancement efforts.

IR# JRP.93

Red Wine Mountains Caribou

Requesting Organization – Joint Review Panel **Information Request No.: JRP.93**

Subject - Red Wine Mountains Caribou

References:

EIS Guidelines - Section 4.4.4.3 (Terrestrial Environment), Section 4.5.1 (Environmental Effects), Section 4.5.3 (Cumulative Effects), Section 4.6.1 (Mitigation Measures) & Section 4.7 (Residual Effects Significance)

EIS - Volume IIA, Section 2.4.4.2 (Baseline Conditions for Red Wine Mountains Caribou); Volume IIB, Section 5.10 (Environmental Effects Management), Section 5.14 (Residual Effects Significance), Section 5.15 (Cumulative Effects Significance), Table 5-30 (Summary of Residual Effects, RWM Caribou), Table 5-45 (Summary of Residual Cumulative Effects), Table IIB-A-3 (Summary of Effects on RWM Caribou)

Minaskuat Inc. (2009), Environmental Baseline Report: Caribou, prepared for the Lower Churchill Hydroelectric Generation Project (Large Mammal Component Study 4)

Related Comments / Information Requests:

CEAR # 145 (T. Bursey)
CEAR #181 (Protected Areas Association)
CEAR #184 (Sierra Club Atlantic)
CEAR #192 (E. Davis)
CEAR #197 (B. McGowan)
CEAR # 200 (Grand Riverkeeper Labrador Inc.)
CEAR # 205 (Government of Newfoundland and Labrador – Wildlife Division)

Rationale:

The EIS Guidelines require a complete assessment of environmental impacts for Red Wine Mountains Caribou as both a Key Indicator species and species of concern.

Regarding EIS, Volume IIA, p. 2-86, the Government of Newfoundland and Labrador Wildlife Division states that"[d]eficiencies in the habitat modelling for woodland caribou should be addressed to ensure that conclusions about habitat associations remain valid" (CEAR # 205). The modelling deficiencies referred to are itemized in comments by the Wildlife Division on the Large Mammal Component Study 4.

Regarding EIS Volume IIB, Table 5-10, p. 5-36 and Table IIB-A-3, Appendices p.11-15, the Wildlife Division states that "[m]itigation measures for Woodland caribou must be more stringent than for other big game species as they are protected under the *Endangered Species Act* as well as the *Wildlife Act* and cannot be disturbed."

The EIS (Volume IIB p. 5-80/81) makes a number of predictions regarding Project effects on RWM Caribou and determines with a high degree of certainty that effects are not significant. This determination is based on the following factors:

- little change in habitat availability;
- few impediments to movement;
- predation being limited by the dispersal of the herd across the landscape;
- little increase in access because access already exists (existing transmission line, TLH & logging roads), and
- effective mitigations limiting vehicle collisions and poaching.

However, comments received from intervenors and the public have suggested that there may be inherent uncertainty in the above predictions. For example, little information is presented in the EIS on:

- increased predation due to flooding of the river valley causing moose and wolves currently living in the riparian zone to move to the foraging grounds of the RWM Caribou;
- increased poaching due to increased access on new woods roads, transmission corridors and the reservoir itself;
- increased poaching due to an influx of construction workers; and
- vehicle collisions due to increased construction traffic on the TLH.

In considering the sensitivity of such a small herd to any adverse effects, further rationale is needed for the “not significant” residual effects determination for the RWM Caribou herd.

The EIS states “[t]here will be a significant cumulative environmental effect. Note that the effects of the Project are overall considered adverse but are not at a scale that would result in a decline to this Herd (Volume IIB p. 5-113)”. The projects and activities on which the cumulative effects prediction is based include: commercial forestry, cultural and recreation land use, TLH and additional transmission. All of these activities have a component related to the Project. Again in consideration of the sensitivity of such a small herd to any adverse effects, on what basis are cumulative effects determined to be significant and Project effects determined to be not significant.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.93**

Information Requested:

The Proponent is asked to:

a. **address deficiencies in the habitat modelling for RWM Caribou to ensure that conclusions about habitat associations remain valid;**

Response:

Although Nalcor Energy (Nalcor) disagrees with the contention that the modelling effort reported in the EIS was deficient, the specific comments of reviewers have been addressed. The seasonal RWM caribou models have been re-created and model output has been applied to quantify estimated changes in quality caribou habitat as a result of the Project. The following resource selection function (RSF) analysis was re-done for the RWM caribou. Output from this model was then applied for mapping relative habitat quality across the Forest Inventory (FI) area.

The application of disturbance zones of influence in the original assessment, as well as using the re-developed RWM caribou RSF models resulted in similar findings. Namely, there is an approximate doubling of potential disturbance predicted during the construction phase compared to the baseline, followed by a return to levels consistent with the baseline during the operation and maintenance phase of the Project. As in the original assessment, the residual environmental effect on the RWM Herd during Construction and during Operation and Maintenance was predicted to be not significant.

1 MODELLING APPROACH

An RSF is a particular class of habitat suitability model that is defined as any function that estimates probabilities of habitat use (Manly et al. 2002). Among the benefits of RSF analyses are that they take advantage of available data to estimate habitat associations and are relatively simple to apply. For these reasons, they are frequently used for estimating the habitat preferences of wildlife in general (Lemaitre and Villard 2005; Richardson et al. 2005; Sawyer et al. 2006; Psyllakis and Gillingham 2009) and caribou specifically (Johnson et al. 2004; Johnson et al. 2005; Lander 2006).

As wildlife distribution data are most often in the form of presence observations, logistic regression is used to produce predictive equations in RSF modeling. Logistic regression has numerous advantages as a statistical tool (Tabachnick and Fidell 2001) including the capability to utilize binary (i.e., presence) data to represent non-linear wildlife population responses to varying habitat quality (e.g., the sigmoidal form described by Hassell and May [1974] for explaining the numerical response of predators to changing prey densities).

When empirical data takes the form of presence observations, as it does with satellite collar data, random samples of “available” locations can be produced in a Geographic Information System (GIS) environment. Several conditions must be met when applying a “use versus available” sampling scheme (Manly et al. 2002). First, the number of “available” samples must be sufficient to describe pertinent landscape variability (Manly et al. 2002). Second, as used-available samples do not indicate the proportion of the landscape that is actually used, predictive output can only be in terms of relative probabilities of use. To accomplish this, coefficients estimated with logistic regression must be transposed into an exponential form (Manly et al. 2002). Estimates are then no longer constrained between 0 and 1, but as relative probabilities this is unimportant (Pearce and Boyce 2006).

1.1 Caribou Habitat Requirements

The RWM Herd is currently listed as threatened under the *Endangered Species Act* of Newfoundland and Labrador, and also under Schedule 1 of the federal *Species at Risk Act* (COSEWIC 2002). Although little information is available on habitat use and movement patterns of caribou in the lower Churchill River watershed (Section 2.4.4 of Volume IIA), much is known about the habitat associations of boreal woodland caribou in Labrador.

Well-informed consideration is an integral part of model construction, serving to reduce the incidence of spurious relationships in models (Anderson et al. 2001). Spurious relationships are those which are highly variable from one data set to the next and/or are biologically irrelevant, yet arise frequently when model construction is based primarily on data analysis alone. As such, available information regarding habitat associations of woodland caribou was carefully reviewed prior to model construction.

1.2 Data

Habitat Data

Two data sets were available to generate the habitat map for the area of interest: the Natural Resources Canada (NRCAN) Earth Observation for Sustainable Development of Forests (EOSD) classification (NRCAN, no date), and the Provincial Forest Inventory (FI) for Labrador. The EOSD data covers the entire range of the RWM Herd, but is divided into vegetation classes that were not necessarily meaningful in terms of defining seasonal caribou habitat selection (Section 2.4.4 of Volume IIA). In contrast, the FI data are limited in extent, but classify the landscape into categories that were determined to be more meaningful for describing caribou habitat preference, and resolved the landscape at a higher resolution than the EOSD data (Minaskuat2009). In total, the FI data covers only about 30 percent of the RWM range, and therefore reduces the number of collar observations available for model estimation and validation. Despite its limited extent, the classification structure and spatial resolution resulted in more accurate predictive models (Minaskuat 2009).

Complimenting the FI data was Ecological Land Classification (ELC) data, which matched the classification scheme of the FI data. The ELC was completed as part of the Lower Churchill Hydroelectric Generation Project to describe the ecological landscape of the lower Churchill River watershed (the watershed) (Minaskuat 2008a, 2008b). These data served to both provide estimates of lichen cover per FI forest cover class, and to increase the accuracy of vegetation mapping along the Churchill River, from Churchill Falls to Lake Melville. ELC data were used to replace FI data wherever both were available.

To reduce the number of potential land cover variables, the combined ELC and FI classes were recombined into 13 classes to retain the information likely to be most important for estimating caribou habitat preference (Table 1). When classifying habitats, it was assumed that terrestrial lichen cover in Labrador begins to peak 40 years following disturbance in coniferous stands (Foster 1985).

Table 1 Re-combined Provincial Forest Inventory Land Cover Classes

Forest Inventory Habitat Type	Habitat Description[(a)]
Coniferous-Dominated Forest	Coniferous (white spruce, pine and/or balsam fir) dominated upland forest; typically moderate to dense canopy cover; age >40 years; typically low lichen cover
Deciduous- Dominated Forest	Deciduous (aspen or birch) dominated upland forest habitat; typically dense canopy cover; age >40 years; little or no lichen cover
Black Spruce-Dominated Forest	Black spruce dominated upland forest habitat; typically dense canopy cover; age >40 years; typically low lichen cover and high feathermoss cover
Black Spruce (Softwood) Scrub	Stunted black spruce (non-merchantable); sparse or open canopy cover; typically high lichen ground cover; also includes young black spruce and balsam fir
Young Forest/ Hardwood Scrub	Includes all young forest habitats as well as deciduous dominated shrublands (excluding fires and cut blocks); age ≤40 years; typically low lichen cover
Bog	Lowland peatlands with little tree cover (scattered balsam fir, larch, birch and/or black spruce); low lichen cover
Treed Bog	Lowland black spruce dominated peatlands; typically open canopy cover; typically low to moderate lichen cover
Barren	Unvegetated land dominated by rock, soil and/or sand; no lichen cover
Cultural	Anthropogenic disturbance (e.g., cleared land, agriculture, residential)
Linear features	Roads, highways, transmission lines
Water	Water
Cutovers	Logging disturbance; age ≤20 years
Natural disturbance	Areas disturbed by fire, insect outbreaks, wind storms and disease; age ≤30 years

[(a)] Lichen cover estimates are based on Project Area ELC data (Minaskuat 2008a)

In addition to forest cover data, habitat variables were derived to describe terrain and landscape disturbances not contained within ELC and FI data. Road data were assembled from the Canadian National Topographic Data Base (NTDB; NRCAN 2009a) and the Canadian Council on Geomatics' (CGOC) GeoBase (NRCAN 2009b), and were included in the "linear features" class of the land cover data (Table 1). Hydrological data (i.e., streams, rivers and lakes) were assembled from National Hydro Network (NHN; NRCAN 2009c) datasets and were included in the "water" land cover class (Table 1). Slope was calculated from a digital elevation model (DEM) using Canadian Digital Elevation Data from GeoBase (NRCAN 2009d). A cut-block and fire data layer was obtained from the Province of Newfoundland and Labrador and merged with the land cover data to be included in the "cutovers" and "natural disturbance categories" (Table 1).

Caribou Collar Data

Approximately 6,688 VHF and satellite telemetry locations are available on the RWM Herd from 1982 to 2007. The province of Newfoundland and Labrador accesses this data through the Argos internet site (CLS 2008)Telemetry locations considered for the RSF analyses were reduced to those satellite locations having an error class of 2 or 3 (i.e., accurate to within 350 m and 150 m, respectively; CLS 2008). The remaining satellite locations were not used because they have an error estimate of 500 m to 1,000 m or more, and the VHF have an undefined error estimate. High degrees of observation location error have the potential to risk confounding the measurement of habitat associations (White and Garrott 1986; Nams 1989). The 4,479 class 2 and 3 telemetry points retained were further reduced because many of these points were outside of the boundary of the FI area. When the study area was reduced to the boundaries of the FI area, a total of 710 class 2 and 3 satellite telemetry points were available for analysis (Table 2). RWM caribou telemetry locations were analyzed for three seasons (Minaskuat 2009), during which caribou are considered most sensitive to disturbance (Table 2).

Table 2 Caribou Satellite Collar Observations Per Season

Season	Dates	Observations	Individuals
Calving	May 28 – July 1	179	24
post-calving	July 2 – September 20	180	18
Winter	December 12 - April 1	351	21

Caribou collar observations were pooled across individuals within each season. Pooling removes inter-animal variation from explicit consideration, but increases the sample size to allow for more complex models (Marzluff et al. 2004, Johnson et al. 2005).

1.3 Statistical Model Building

Defining "Available" Points

When wildlife observations to be used for modeling take the form of presence data (i.e., satellite collar data), "available" points must be selected to facilitate the definition of a RSF (Manly et al. 2002).

Methods used for "available" point selection were similar to those outlined by Arthur et al. (1996) and Johnson et al. (2005). Collar relocation distances and intervals were defined for each pairing of a telemetry location and the subsequent location for that animal within the same season within the extent of the FI data. Segments were then grouped into similar relocation intervals within each season, and 95th percentile distances were defined for each interval grouping in SAS (SAS Systems 2002). Different relocation intervals represent different scales of measuring caribou movement, and must therefore be dealt with separately. Buffers were then defined around each telemetry location with a radius equal to the 95th percentile distance for the relocation interval existing from that location to the next. Five "available" points were placed randomly within each buffer and associated with the next collar location of that animal by way of a unique identifier number (Johnson et al. 2005; Johnson and Gillingham 2008). As a result, telemetry locations, which represent the chosen destination of the animal from its preceding location, are linked to the "available" points that represent a random selection of destinations the animal could have chosen but did not.

Defining Variables

Based on an understanding of caribou habitat associations (Section 1.1 of this response) and the availability of data, numerous habitat variables likely to affect caribou habitat selection were defined for the study area. Variables were defined in a 10 m cell-size raster format within a GIS environment using ESRI ArcGIS 9.2.

Since the least accurate satellite observations used for modeling were accurate within 350 m, the amount of each habitat class was calculated for each location as a percentage of a 350 m radius circle. This produced 13 original land cover variables (Table 1). In addition, land cover variables could be re-combined to reduce the number of variables considered in each model. For example, a general disturbance class was produced that combined the cultural, linear features, cutovers, and natural disturbance classes. Also, a general bog class was produced that combined the bog and treed bog classes.

Slope was calculated for each pixel using a DEM. Also, because caribou habitat selection is likely to vary with distance from some landscape features, distance variables were produced. Distances were measured from each point on the landscape to the nearest disturbance feature, the nearest stream, and the nearest large river or lake, respectively. As relationships between caribou and distances to human disturbances may be non-linear, a polynomial form was investigated by incorporating a squared distance to disturbance variable (Johnson et al. 2005).

Statistical Model Definition

Lists of continuous variables considered for use in the models for each season were assembled and then assessed for collinearity (i.e., high univariate correlations) and multicollinearity (i.e., linear redundancy of variables; SAS Systems 2002). Highly correlated variables must be excluded from final models, or redundancy would increase error terms and produce less reliable predictive equations (Hocking 1976).

Model selection based on data analysis is more likely to incorporate spurious relationships (Anderson et al. 2001). However, strong trends that lie within the data may hold important information. Therefore, a candidate model set was first constructed first based on knowledge of caribou ecology, while a cautiously iterative process was later pursued to investigate possible model improvements (Burnham and Anderson 2002). Investigative techniques included examining univariate relationships and the use of stepwise logistic regression.

Model coefficients were estimated using conditional fixed-effects logistic regression, wherein strata were defined by each combination of telemetry location and associated “available” points. Conditional fixed-effects logistic regression has the advantage of more precisely accounting for variation in the availability of habitat features across the study area (Johnson et al. 2005; Mao et al. 2005; Johnson and Gillingham 2008).

Excessively complex or simplistic models can be problematic. Therefore, candidate models were scored and ranked according to how well they fit the data, while taking model size and complexity into account (Cavanaugh 2004). This approach, most commonly known as the information-theoretic approach (Burnham and Anderson 2002), is based on Chamberlin’s (1890) theory of multiple working hypotheses and Akaike’s information criterion or AIC (Akaike 1973). The AIC, in turn, is based on the theory of maximum likelihood and the Kullback-Leibler measure of information (Kullback and Leibler 1951). Criteria from the AIC family are believed to function optimally when scoring models that describe aspects of systems that are of near infinite complexity, such as ecological systems (Hurvich and Tsai 1989). However, AIC tends to overfit in situations where sample size is small, or when the number of parameters is a large fraction of the sample size (Hurvich and Tsai 1989). As the ratio of sample size to number of parameters is less than 40 for some of the more complex models considered, AIC_C was used to correct for small sample bias in AIC (see Burnham and Anderson [2002] for a detailed discussion). The particular version of the AIC_C equation used follows Hurvich and Tsai (1989). AIC_C functions well for less complex models in the candidate set as well, because AIC_C converges with AIC as model complexity decreases (Burnham and Anderson 2002). The model selected as best was the one with the lowest AIC_C score.

Once models were identified, estimates of relative probabilities of use were produced by inserting coefficients estimated from logistic regression into the following log-linear form of an RSF, following Manly et al. (2002):

$$w(x) = \exp(B_1 x_1 + \ldots B_p x_p)$$

Variables present in the selected models are listed and explained in Table 3. Final models and their associated coefficients are presented in Table 4 and described below. The sign of the coefficients (i.e., positive or negative) corresponds to the direction of the relationship between the variable and the relative probability of caribou habitat selection. For example, in the calving season, caribou habitat selection was primarily affected by an avoidance of young forest stands, deciduous dominated stands and open water, and a preference for softwood (black spruce dominant) scrub stands and non-treed bogs. In the post-calving season, caribou tended to avoid young forest stands, deciduous dominated stands and areas with steep slopes, while they preferred treed and non-treed bogs and areas distant from human and natural disturbances. Caribou habitat selection in winter was primarily driven by avoidance of all bogs and disturbed areas, and a preference for softwood scrub stands and areas near streams.

Seasonal spatial model output across the FI extent at baseline is shown in Figures 1 through 3.

Table 3 Variables Present In Final Selected Models

Model Variable[a]	Model Variable Description
hab_hyng	Hardwood-dominated stands and young stands
hab_ss	Softwood scrub stand (black-spruce dominated)
hab_bog	Non-treed bog
hab_allbog	Combined Non-treed and treed bog
hab_wat	Water
hab_dist	Disturbance (includes linear features, cultural features, natural disturbance, cut-overs)
dist_wline	Distance to the nearest stream
dist_dist	Distance to the nearest natural of human disturbance
slope_per	Percent slope (on a 0-100 scale)

[a]Model variable names starting with "hab_" represent a percentage (on a 0-100 scale) of a given habitat type within a 350 m radius circle around each location.

Table 4 Final Season Caribou RSF Models

Season	Model Variables	Model Coefficients
calving	hab_hyng	-0.19117
	hab_ss	0.01037
	hab_bog	0.02225
	hab_wat	-0.01073
post-calving	hab_hyng	-0.15490
	hab_allbog	0.01568
	slope_per	-0.02966
	dist_dist	0.0002419
	$dist\_dist^2$	-1.0657×10^{-8}
winter	hab_ss	0.02543
	hab_allbog	-0.01673
	hab_dist	-0.19569
	dist_wline	-0.000547

Figure 1 Red Wine Mountains Caribou Calving Habitat Suitability in the Forest Inventory Area

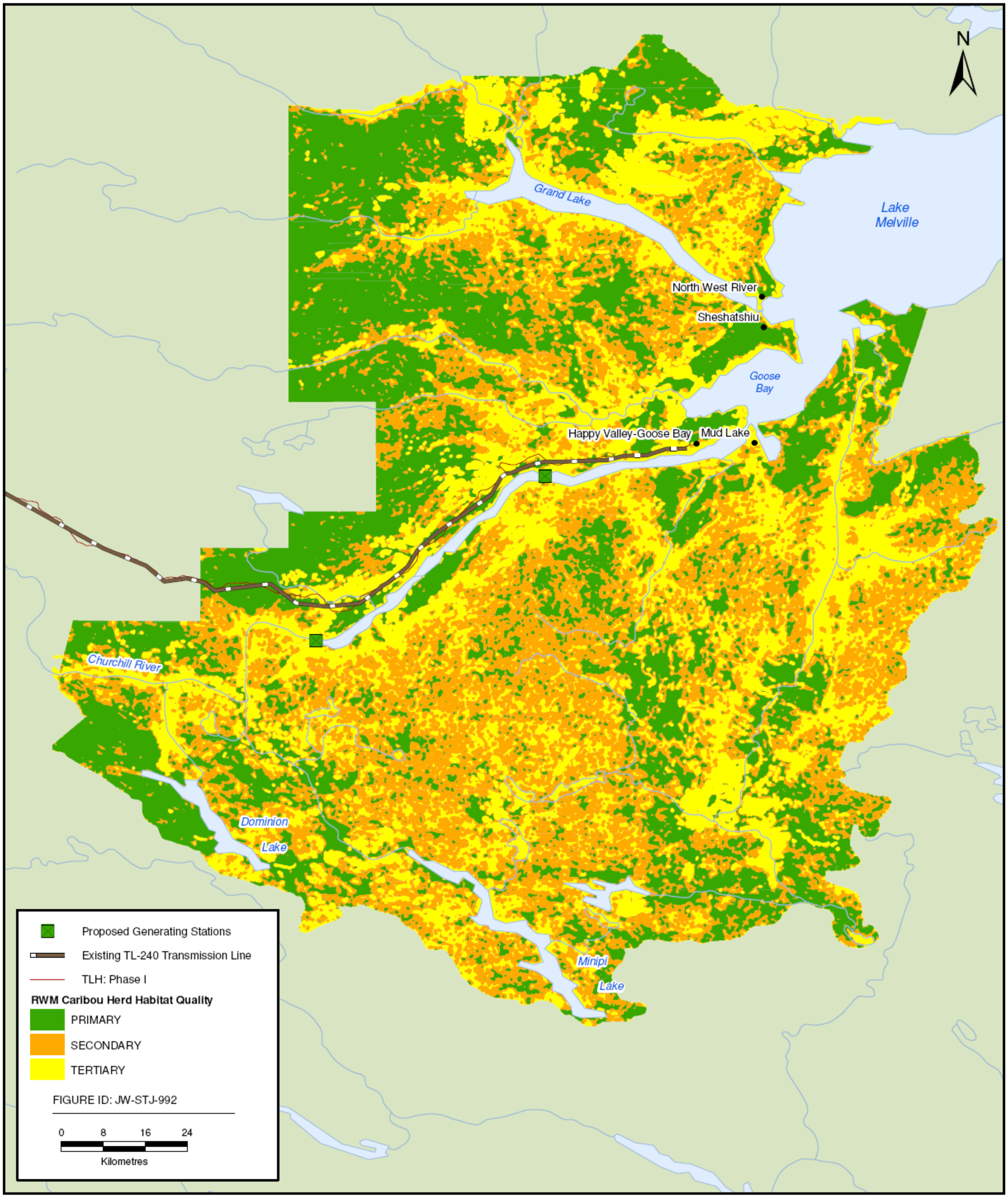


Figure 2 Red Wine Mountains Caribou Post-Calving Habitat Suitability in the Forest Inventory Area

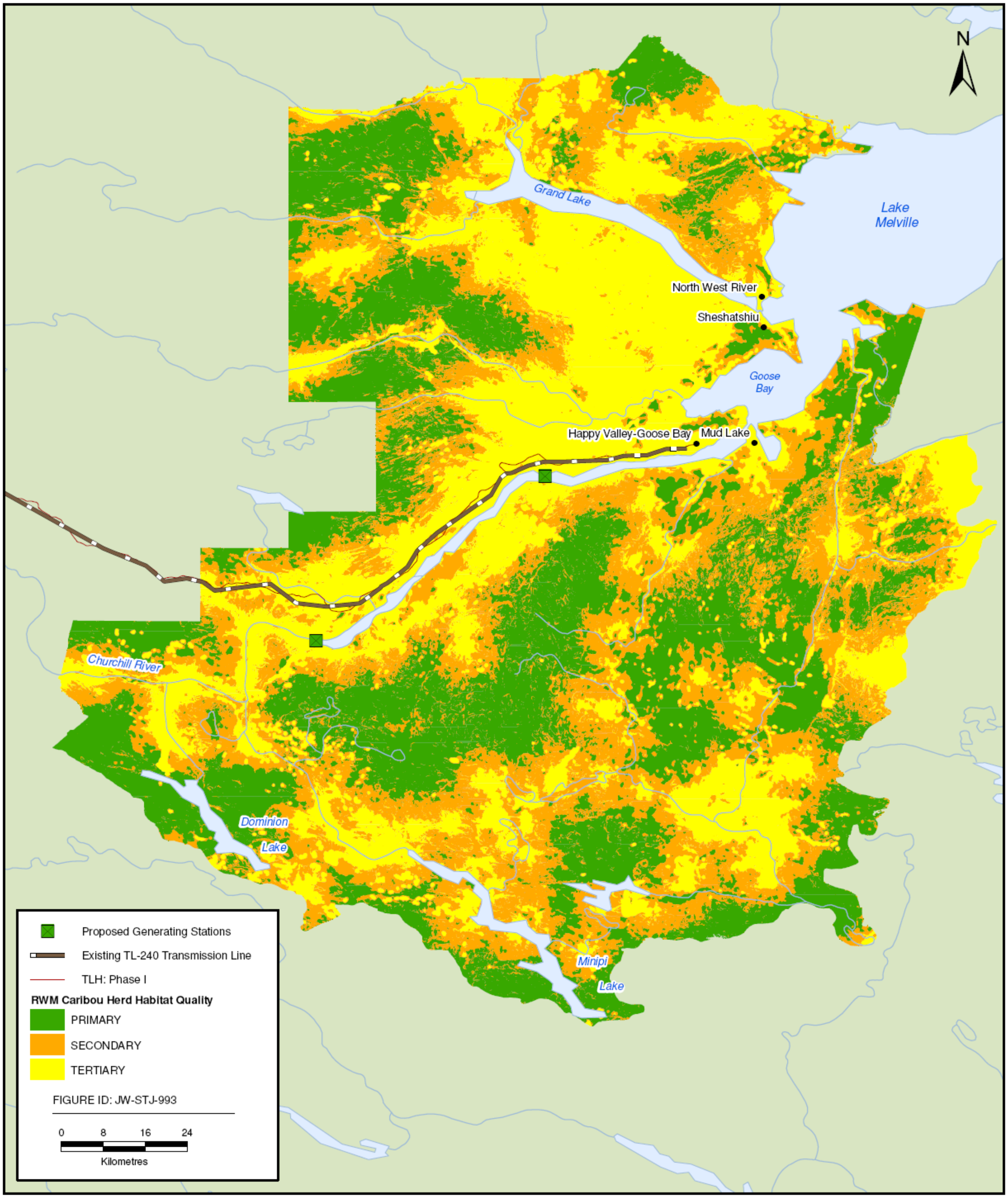
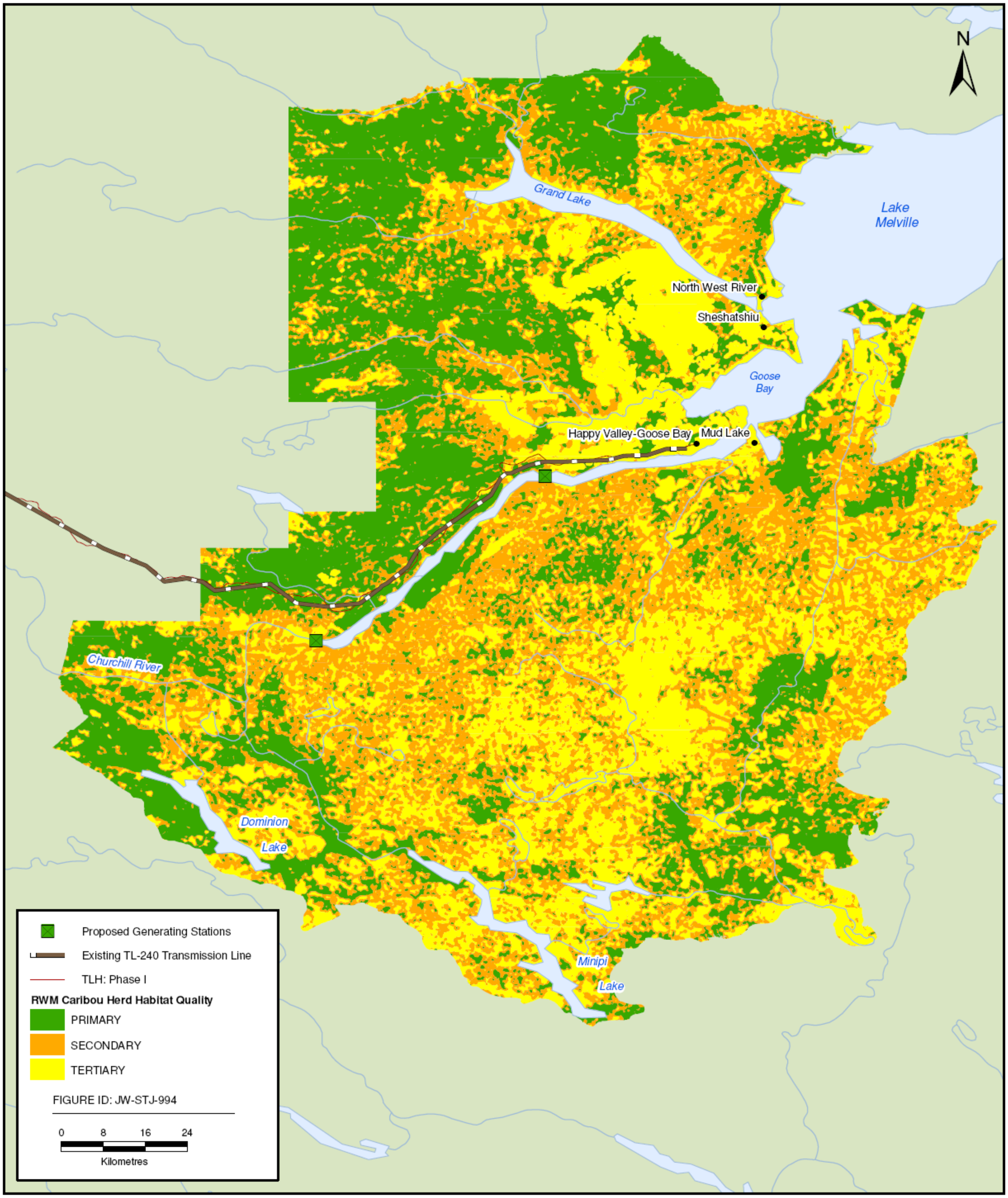


Figure 3 Red Wine Mountains Caribou Winter Habitat Suitability in the Forest Inventory Area



1.4 Model Validation

Models must be evaluated for reliability in a process generally referred to as model validation (Marcot et al. 1983). Validation was conducted on final models to evaluate reliability and establish credibility. Due to the lack of available independent data, a cross-validation approach was applied using k-fold partitioning (Fielding and Bell 1997; Boyce et al. 2002; Johnson et al. 2006). Huberty's (1994) "rule of thumb" was used to guide the number of partitions and the number of observations to go into each. Each seasonal data set was split into three parts, iteratively using two thirds of the telemetry locations and associated "available" points for coefficient estimation and one third for testing.

After test models were fit, predictive output was projected onto a rasterized GIS surface across the FI data extent. Predictions were split into ten equal-area divisions, known as "bins". Ten bins were used because recent investigations have revealed that more numerous divisions result in high variance in estimates of predictive accuracy, and lower divisions result in underestimations of model accuracy (Hirzel et al. 2006). The proportion of satellite collar observations per bin were divided by the areal extent per bin and compared to bin ranks. Model validation was then conducted.

Validation follows an approach similar to that outlined by Boyce et al. (2002). Area adjusted frequencies of occurrence per bin were converted to rank scores and relationships with bin number were quantified using Spearman-rank correlations in SAS (SAS Systems 2002). Spearman-rank correlations range from -1 for perfectly reversed rank pairings to 1 for perfectly matched ranks (Kutner et al. 2005). Statistically significant, strong positive correlations between area-adjusted location frequencies represent evidence that models perform well at this level of precision. Validation results for each model are expressed in terms of Spearman rank correlations for each validation model, and as an average of those correlations (Table 4). An average of Spearman rank correlations describes the overall expected correlation between bin and area-adjusted observation ranks (e.g., Johnson et al. 2005). The calving, post-calving, and winter caribou RSF models all displayed strong, significant Spearman-rank correlations, suggesting that these models are strong predictors of relative caribou habitat preference across the study area (Table 5).

Table 5 Spearman-Rank Correlations between Bin and Associated Area-Adjusted Observation Ranks for the Seasonal Caribou RSF Models

Species	Validation Model	Spearman-Rank Correlation	Average of Correlations Per Seasonal Model
Calving	A	0.976, p<0.0001	0.865
	B	0.914, p=0.0002	
	C	0.705, p=0.0227	
post-calving	A	0.964, p<0.0001	0.911
	B	0.867, p=0.0012	
	C	0.903, p=0.0003	
Winter	A	0.976, p<0.0001	0.938
	B	0.879, p=0.0008	
	C	0.960, p<0.0001	

2 SUMMARY

Based on the re-developed RSF models, caribou habitat selection during the calving season was primarily affected by an avoidance of young forest stands, deciduous dominated stands and open water, and a preference for softwood (black spruce dominant) scrub stands and non-treed bogs. In the post-calving season, caribou tended to avoid young forest stands, deciduous dominated stands, and areas with steep slopes, while they preferred treed and non-treed bogs and areas distant from human and natural disturbances. Caribou habitat selection in winter was determined to be primarily driven by avoidance of all bogs and disturbed areas, and a preference for softwood scrub stands and areas near streams. The re-developed models suggest patterns of RWM caribou habitat preference and avoidance that have many similarities to those suggested by the RSF models developed for the original EIS (Sec 2.4.4.3 in Volume IIA).

Models were constructed with an emphasis on *a priori* information on caribou habitat associations, and parsimonious models were selected using AIC_C (Burnham and Anderson 2002). Model coefficients were estimated using conditional fixed-effects logistic regression of caribou telemetry collar data and landscape data (i.e., water, disturbance, terrain, and vegetation variables). Validation of each seasonal model was conducted using k-fold cross validation. The predictive accuracy of models was quantified using Spearman-rank correlations between the ranks of bins and those of area-adjusted observation frequencies, following Boyce (2002). Overall, results suggest that all three seasonal caribou RSF models are effective at estimating the relative habitat preferences of RWM caribou and for estimating the relative quality of habitat affected by the Project (Table 5). The redeveloped RSF model completed for this response uses presence-only data (i.e., such as telemetry collars), such that all habitat quality/preference predictions are based on a relative scale. Absolute probability of use cannot be calculated without also having “absence” points. The model in this response predicts that caribou prefer primary habitat over secondary habitat, and secondary habitat over tertiary habitat (relative preference), but not precisely by how much (absolute preference/probability). Each of the three quality classes comprise approximately equal areas within the FI area.

Predictions of caribou habitat quality cannot be extrapolated across the entire Assessment Area, as the models were built on and rely on FI data. Model output is therefore limited to the extent of the FI data. Although restricted to this area, applying the same disturbance zones of influence (Table 5-13 in Volume IIB) resulted in relatively similar total areas of influence (Tables 5-14 and Table 5-28 in Volume IIB) as presented in Table 6. Namely, there is an approximate doubling of potential disturbance predicted during the construction phase compared to the baseline, followed by a return to levels consistent with the baseline during the operation and maintenance phase of the Project.

Table 6 Amount of Caribou Habitat within Disturbance Zones of Influence in the Forest Inventory Area – Redeveloped RSF Models

Seasonal Home Range	Potential Disturbance (km^2)		
	Baseline	Construction	Operation and Maintenance
Calving			
Primary	481.7	725.2	525.0
Secondary	650.2	876.1	660.0
Tertiary	831.2	1,283.4	860.6
Total			
Post Calving			
Primary	7.4	19.4	8.2
Secondary	48.2	275.2	57.3
Tertiary	1,076.6	1,696.7	1,144.2
Total			
Winter			
Primary	539.2	1,193.0	570.8
Secondary	549.2	1,036.6	575.3
Tertiary	1,472.3	1,709.4	1,493.7
Total			

Modelling results reinforce the validity of the caribou habitat associations used in the EIS for assessing Project effects on the RWM Herd. In addition, estimates of habitat loss produced using the re-developed caribou RSF models reinforce the conclusion, as stated in the EIS, that the effects of the Project on habitat for the RWM Herd will be adverse but not significant.

References:

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle, pp. 267-281. In B.N. Petrov and F. Csaki, (ed.) Second International Symposium on Information Theory. Akademiai Kiado, Budapest.

Anderson, D.R., K.P. Burnham, W.R. Gould and S. Cherry. 2001. Concerns about finding effects that are actually spurious. Wildlife Society Bulletin. 29(1): 311-316.

Arthur, S.M., B.F.J. Manly, L.L. McDonald and G.W. Garner. 1996. Assessing habitat selection when availability changes. Ecology 77: 215-227.

Boyce, M.S., P.R. Vernier, S.E. Nielsen and F.K.A. Schmiegelow. 2002. Evaluating resource selection functions. Ecological Modelling 157: 281-300.

Burnham, K.P. and D.R. Anderson. 2002. Model Selection and Multimodel Inference. Springer, NY.

Chamberlin, T.C. 1890. The method of multiple working hypotheses. Science 15(366): 92-96.

CLS (Collecte Localisation Satellites). 2008. *Argos User Manual.* Available at: http://www.argossystem.org/documents/userarea/argos_manual_en.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. COSEWIC assessment and update status report on the woodland caribou Rangifer tarandus caribou in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi+98 pp.

Fielding, A.H. and J.F. Bell. 1997. A review of methods for the assessment of prediction errors in conservation presence/absence models. Environmental Conservation 24(1): 38-49.

Foster, D. R. 1985. Vegetation development following fire in Picea mariana (black spruce)-Pleurozium forests of south-eastern Labrador, Canada. Journal of Ecology 73: 517-534.

Hassell, M.P. and R.M. May. 1974. Aggregation of predators and insect parasites and its effect on stability. The Journal of Animal Ecology 43(2): 567-594.

Hirzel, A.H., G. Le Lay, V. Helfer, C. Randin and A. Guisan. 2006. Evaluating the ability of habitat suitability models to predict species presences. Ecological Modelling 199: 142-152.

Hocking, R.R. 1976. The analysis and selection of variables in linear regression. Biometrics 32(1): 1-49.

Huberty, C.J. 1994. Applied Discriminant Analysis. Wiley Interscience. New York, NY.

Hurvich C.M. and C.L. Tsai. 1989. Regression and time series model selection in small samples. Biometrika 76(2): 297-307.

Johnson, C.J. and M.P. Gillingham. 2008. Sensitivity of species-distribution models to error, bias, and model design: an application to resource selection functions for woodland caribou. Ecological modeling 213: 143-155.

Johnson, C.J., D.R. Seip and M.S. Boyce. 2004. A quantitative approach to conservation planning: using resource selection functions to map the distribution of mountain caribou at multiple spatial scales. Journal of Applied Ecology 41: 238-251.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn and R. Mulders. 2005. Cumulative Effects of Human Developments on Arctic Wildlife. Wildlife Monographs 160:1-36.

Johnson, C.J., S.E. Nielsen, E.H. Merrill, T.L. McDonald and M.S. Boyce. 2006. Resource selection functions based on use-availability data: theoretical motivation and evaluation methods. Journal of Wildlife Management 70(2): 347-357.

Kullback, S., R.A. Leibler. 1951. On information and sufficiency. The Annals of Mathematical Statistics 22(1): 79-86.

Kutner, M.H., C.J. Nachtsheim, J. Neter and W. Li. 2005. Applied Linear Statistical Models: Fifth Edition. McGraw Hill. Boston, MA.

Lander, C-A. 2006. Distribution and movements of woodland caribou on disturbed landscapes in west-central Manitoba: implications for forestry. Master of Natural Resources Management Thesis. University of Manitoba. 130 pp.

Lemaitre, J. and M.A. Villard. 2005. Foraging patterns of pilieated woodpeckers in a managed Acadian forest: a resource selection function. Canadian Journal of Forest Research 35: 2387-2393.

Manly, B.F.J., L.L. Macdonald, D.L. Thomas, T.L. McDonald and W.P. Erickson. 2002. Resource selection by animals. Kluwer Academic Publishers, Netherlands.

Mao, J.S., M.S. Boyce, D.W. Smith, F.J. Singer, D.J. Vales, J.M. Vore and E.H. Merrill. 2005. Habitat selection by elk before and after wolf reintroduction in Yellowstone National Park. Journal of Wildlife Management 69(4): 1691-1707.

Marcot, B.G., M.G. Raphael and K.H. Berry. 1983. Monitoring wildlife habitat and validation of wildlife-habitat relationships models. Transactions of the North American Wildlife and Natural Resources Conference 48: 315-329.

Marzluff, J.A., J.J. Millspaugh, P. Hurvitz, and M.S. Handcock. 2004. Relating resources to a probabilistic measure of space use: forest fragments and Steller's Jays. Ecology 85: 1411–1427.

Minaskuat Inc. 2008a. Project Area Ecological Land Classification. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2008b. Regional Ecological Land Classification. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Caribou (Rangifer tarandus caribou). Prepared for the Lower Churchill Hydroelectric Generation Project.

Nams, V.O. 1989. Effects of radiotelemetry error on sample size and bias when testing for habitat selection. Canadian Journal of Zoology 67: 1631–1636.

NRCAN (Natural Resources Canada). 2009a. Canadian National Topographic Data Base (NTDB), Canada. Available at: http://geogratis.cgdi.gc.ca/geogratis/en/product/search.do?id=8147 . Accessed July 17, 2009

NRCAN (Natural Resources Canada). 2009b. Canadian Council on Geomatics (CGOC) GeoBase. Available at: http://geogratis.cgdi.gc.ca/geogratis/en/product/search.do?id=8147 . Accessed July 17, 2009.

NRCAN (Natural Resources Canada). 2009c. National Hydro Network (NHN). Available at: http://www.geobase.ca/geobase/en/data/nhn/index.html . Accessed July 17, 2009.

NRCAN (Natural Resources Canada). 2009d. Canadian Digital Elevation Data. Available at: http://www.geobase.ca/geobase/en/data/cded/index.html . Accessed July 17, 2009.

NRCAN (Natural Resources Canada). no date. EOSD internet site: http://cfs.nrcan.gc.ca/subsite/eosd

Pearce, J.L. and M.S. Boyce. 2006. Modelling distribution and abundance with presence-only data. Journal of Applied Ecology 43: 405-412.

Psyllakis, J.M. and M.P. Gillingham. 2009. Using forest structure and compositions to predict occurrence of vertebrate species in Douglas-fir forests of British Columbia. Biological Conservation 142: 1427-1441.

Richardson, E, I. Striling and D.S. Hik. 2005. Polar bear (Ursus maritimus) maternity denning habitat in western Hudson Bay: a bottom-up approach to resource selection functions. Canadian Journal of Zoology 83: 860-870.

SAS Systems. 2002. SAS/STAT Release 9.1.3. SAS Institute. Cary, NC.

Sawyer, H., R.M. Nielson, F. Lindzey and L.L. McDonald. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. Journal of Wildlife Management 70(2): 396-403.

Tabachnick, B.G. and L.S. Fidell. 2001. Using multivariate statistics. Allyn and Bacon. Boston, MA.

White, G.C. and R.A. Garrott. 1986. Effects of biotelemetry triangulation error on detecting habitat selection. Journal of Wildlife Management 50: 509–513.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.93**

Information Requested:

The Proponent is asked to:

b. **identify any specific mitigation measures planned to avoid disturbing the RWM Caribou, in addition to the standard mitigation measures listed in the EIS for all big game species;**

Response:

Clarification is provided in Table 7 below as to how the proposed mitigation relate to the RWM herd (from Table 7-1 of the EIS, Volume IIB). Proposed mitigation measures that relate to caribou in general will be effective in mitigating Project effects on the RWM caribou herd. No additional measures specific to the RWM herd have been identified.

Table 7. Clarification of Disturbance-Related Mitigation Measures for the Red Wine Mountains Caribou Herd

Environmental Effects Management Measures related to Disturbance (from Table 7-1 in Volume IIB)	Clarification for Red Wine Mountains Caribou Herd
No harvesting policy and no harassment of wildlife, and no possession of firearms or pets by Project personnel	Applicable to all sightings of caribou
Implement environmental awareness training and regular briefings for all personnel	Would include the threatened status of this herd and efforts by Nalcor and others regarding its recovery
Oversee EPP using environmental monitors; use existing roads, quarries and other areas where possible	Activities that would pose disturbance or possible mortality for caribou in an area would be reduced or modified as appropriate
Restrict access to temporary roads and work areas; post speed limits	Reduces opportunities for poaching or vehicle collisions, respectively
Locate construction and reservoir clearing roads within the reservoirs where possible	Limits landscape alteration or loss above the reservoirs that would adversely affect caribou habitat quality
Rehabilitate work areas and access roads no longer required in accordance with the EPP to encourage formation of natural conditions	Accelerate return to original forest conditions, deters access
Undertake blasting in accordance with permits and standard procedures	Animals sighted within 3 km of such locations would result in the delay of blasting until caribou have left the area
Environmental Effects Management Measures related to Disturbance (from Table 7-1 in Volume IIB)	Clarification for Red Wine Mountains Caribou Herd
Remove trees during reservoir preparation such that surface will provide unimpeded access for wildlife	Enhances opportunities and locations for infrequent crossings when they occur (refer to Figure 2-25 in Volume IIA)
Continue participation as member of the Labrador Woodland Caribou Recovery Team and support research and other management initiatives	As a corporate stakeholder in this watershed, Nalcor will continue to assist, support and complement Recovery Team efforts
Avoid disturbing and/or clearing sensitive wildlife areas during reservoir preparation	Wetland areas (that may be used as calving habitat) will have a 20 m riparian buffer that will remain during reservoir preparation.
Use existing right-of-way corridors for construction of transmission line where possible	Limits access and may (conflicting information presented in Section 5.7.1.2 in Volume IIB) reduce perception of altered habitat by caribou in the area

Requesting Organization – Joint Review Panel **Information Request No.: JRP.93**

Information Requested:

The Proponent is asked to:

c. **provide further rationale for the "not significant" Project effects determination for RWM Caribou; and**

Response:

As indicated in the EIS, Volume IIB, the residual environmental effect on the RWM Herd during Construction (Section 5.14.2.1) and during Operation and Maintenance (Section 5.14.2.2) was predicted as not significant. The following points support the rationale for this conclusion and explain why this prediction has not changed as a result of the RSF completed in part (a) of this IR response.

- Primary quality habitat within the Forest Inventory area that overlapped the RWM Herd range amounted to 11,551.3 km^2 (82.5 percent) during calving, 10,135.0 km^2 (84.6 percent) during post-calving, and 3,913.7 km^2 (25.1 percent) during winter following Minaskuat (2009). Disturbance zones of influence were applied around proposed disturbances to reflect the amount of caribou habitat that may be directly or indirectly affected. Compared to baseline conditions, construction may result in disturbance increases during calving (4.9 percent increase), post-calving (4.4 percent increase) and winter (8.3 percent increase) seasons (see the EIS, Sec 5.14.2.1 in Volume IIB). Sorensen et al. (2008) reported declines in woodland caribou populations in Alberta when greater than 61 percent of a herd's range occurred within 250 m of development. The amount of the RWM Herd seasonal ranges possibly affected by zones of influence is much lower than 60 percent [i.e., approximately 14.7 percent or less (Table 5-14 in Volume IIB)], suggesting that existing disturbance levels are well below the threshold that may trigger population effects.
- The estimated zones of influence for caribou around existing disturbance features in the Forest Inventory Area based on Minaskuat (2009), will involve an approximate doubling during construction within each of the seasonal ranges compared to baseline (Table 5-14 in Volume IIB) followed by a return to baseline levels during operation and maintenance (Table 5-28 in Volume IIB). The greatest amount of potential disturbance is predicted as 14.7 percent of the winter range during construction.
- The redeveloped RSF models prepared to provide the response in part (a) present a different perspective on caribou use of a portion of the Assessment Area but do not change the conclusions in terms of zones of influence and potential disturbance.
- Although there will likely be local disruptions of movement around construction sites, and a potential reduction in crossing the TLH as a result of increased Project traffic, regional movements are expected to be maintained.
- Low speed limits on access roads, education of Project personnel, zero tolerance for wildlife harassment and reclamation of access roads, will reduce the likelihood of mortality caused by vehicle collisions and poaching.
- The main causes of decline affecting the RWM Herd are predation, poaching, and possible emigration to the George River (GR) Herd (Schaefer et al. 1999, 2001; Schmelzer et al. 2004).

- The Labrador Woodland Caribou Recovery Strategy identified the need to quantify high value habitat so that risk areas can be identified, and potential environmental effects or threats determined (Schmelzer et al. 2004). This requirement was incorporated into the environmental baseline report (Minaskuat 2009) and this response.

These points represent the main considerations employed by Nalcor in reaching the conclusion of not significant environmental effects regarding Project effects on the RWM herd.

References:

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Caribou (*Rangifer tarandus caribou).* Prepared for the Lower Churchill Hydroelectric Generation Project.

Schaefer, J.A., A.M. Veitch, F.H. Harrington, W.K. Brown, J.B. Theberge and S.N. Luttich. 1999. Demography of decline of the Red Wine Mountains caribou herd. Journal of Wildlife Management 63: 580-587.

Schaefer, J.A., C.M. Bergman and S.N. Luttich. 2000. Site fidelity of female caribou at multiple spatial scales. Landscape Ecology 15: 731-739.

Schmelzer, I., J. Brazil, T. Chubbs, S. French, B. Hearn, R. Jeffery, L. LeDrew, H. Martin, A. McNeil, R. Nuna, R. Otto, F. Phillips, G. Mitchell, G. Pittman, N. Simon and G. Yetman. 2004. Recovery Strategy for the Three Woodland Caribou Herds (*Rangifer tarandus caribou*; Boreal Population) in Labrador. Department of Environment and Conservation, Governement of Newfoundland and Labrador, Corner Brook, NL.

Sorensen, T., P.D. McLoughlin, D. Hervieux, E. Dzus, J. Nolan, B. Wynes and S. Boutin. 2008. Determining sustainable levels of cumulative effects for boreal caribou. Journal of Wildlife Management 72: 900-905.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.93**

Information Requested:

The Proponent is asked to:

d. **provide the justification for its position that cumulative effects are determined to be significant but Project effects are determined to be not significant, given the sensitivity of such a small herd to any adverse effects.**

Response:

Section 2.4.4 in Volume IIA describes the RWM Herd as undergoing dramatic decline from the 1980s to 1997 (Schaefer et al. 1999), and to about 87 in 2003 (Schmelzer et al. 2004). Due to the present status of this Herd, and that other pressures such as poaching and predation are ongoing, the overall fate regarding this KI is likely one of continued decline – without the Project. If these existing (pre-project) factors remain unchecked, the cumulative environmental effects are predicted to be significant. As indicated in the response to part (c) of this response, Project effects (primarily associated with habitat alteration or loss) are adverse but their specific contribution to the RWM Herd is not significant. While some adjustment in movement of animals may occur, habitat will not be limiting and mortality related to the Project is unlikely.

References:

Schaefer, J.A., A.M. Veitch, F.H. Harrington, W.K. Brown, J.B. Theberge and S.N. Luttich. 1999. Demography of decline of the Red Wine Mountains caribou herd. Journal of Wildlife Management 63: 580-587.

Schmelzer, I., J. Brazil, T. Chubbs, S. French, B. Hearn, R. Jeffery, L. LeDrew, H. Martin, A. McNeil, R. Nuna, R. Otto, F. Phillips, G. Mitchell, G. Pittman, N. Simon and G. Yetman. 2004. Recovery Strategy for the Three Woodland Caribou Herds (*Rangifer tarandus caribou*; Boreal Population) in Labrador. Department of Environment and Conservation, Governement of Newfoundland and Labrador, Corner Brook, NL.

IR# JRP.94

Migratory Birds – Interactions with Power Lines

Requesting Organization – Joint Review Panel **Information Request No.: JRP.94**

Subject - Migratory Birds – Interactions with Power Lines

References:

EIS Guidelines 4.5.1 (Environmental Effects – General)

EIS Volume IIB Section 5.9 (Mortality -Existing Knowledge) pg. 5-31

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. *Biological Conservation* 86: 67-76

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R.E. Good. 2001. Avian Collision with Wind Turbines: *A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*. National Wind Coordinating Committee (NWCC) Resource Document

Environment Canada has recommended the following additional documents as guidance in addressing this issue:

Avian Power Line Interaction Committee (APLIC). 1994. *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994*. Edison Electric Institute. Washington, D.C.

Avian Power Line Interaction Committee (APLIC). 1996. *Suggested Practices for Raptor Protection on Power Lines*: *the State of the Art in 1996*. Edson Electric Institute and the Raptor Research Foundation. Washington, D.C.

Avian Power Line Interaction Committee (APLIC). APLIC "2 hour" short course. Power Point presentation at http://www.aplic.org/resources.htm

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines: the State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136: 412-433

Manville, A.M. 2005. *Bird Strikes and Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State of the Art and State of the Science -Next Steps Towards Mitigation.* USDA Forest Service Gen Tech Rep PSW-GTR-191

Related Comments / Information Requests:

CEAR # 173 (Environment Canada)

IR # JRP.65

Rationale:

Environment Canada has indicated that impacts on birds through collisions with power lines or electrocution are not adequately considered in the EIS. Bird collisions with overhead lines have been noted since the late nineteenth century, and collisions with power lines were noted as early as 1904 (CEAR# 173 – Environment Canada). Since then, the number of power lines has increased significantly throughout the world. Erickson et al. (2001) estimated the number of bird collisions with power lines in the United States of America at somewhere between tens of thousands to several million per year. Bevanger (1998) listed 245 species of birds recorded as victims of power lines, with numbers of collisions ranging from 1 to 2,983 in documented studies. Power lines also pose a risk of electrocution for birds, which may occur if a bird touches two phase conductors simultaneously, or one conductor and a ground device. Bevanger (1998) also listed 34 species of documented electrocution victims, with raptors being the most susceptible group of species.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.94**

Information Requested:

The Proponent is asked to provide:

a. **an evaluation of the risk of collision by birds in the area, based on the use of the area by birds including:**

   i. **birds crossing the path of the power line during spring and fall migration in terms of flight height, numbers and species**

   ii. **movement of birds between sections of wetland potentially bisected by the transmission line**

   iii. **movement of birds between wetland areas and upland areas height of transmission line in relation to heights of trees in adjacent forested habitat**

Response:

The risk of collision by birds in the area with the transmission lines is low (i.e., low numbers of birds with limited opportunity for contact). The evaluation of the risk of collision by birds in the area, incorporates the information provided in parts (a), (b), and (c) of this response, and incorporates the study team's experience with the avifauna in the region, and similar types of projects.

i. As per the EIS Guidelines, Nalcor Energy (Nalcor) used Valued Environmental Components (VECs) to focus the environmental assessment. Subsequently, Key Indicators (KI) were selected as representative of the Terrestrial Environment VEC; representative bird species/groups selected included Canada Goose, Surf Scoter, Ruffed Grouse, Osprey, Wetland Sparrows, Harlequin Duck, and Other Species of Concern. The Other Species of Concern included Common Nighthawk, Olive-sided Flycatcher, Rusty Blackbird, and Grey-cheeked Thrush. Of these species only the Ruffed Grouse is considered a resident bird, and the rest migrate. Information related to populations for these species is provided in Volume IIB, Sections 5.2 and 5.7.

   No published information is available on numbers of birds or flight heights over the Project area; the Project area is not within a major flyway. Results of field surveys and their description during the migration season (e.g., AMEC 2008 (constraint mapping), Minaskuat 2008a (songbirds), Minaskuat 2008b (raptors) and LGL 2009 (waterfowl)) and other sources of information such as IR# JRP.14 did not identify concentrations of migrating birds passing through the Project area. The proposed transmission route does not cross unique habitat and the habitat crossed is considered representative of the region. Further, there are no documented areas of waterfowl concentration (staging areas) or no known traditional flight routes of avifauna along the transmission corridor.

   In general, nocturnal migrants (i.e., passerines) are high-flyers and are not prone to collision during flight. Generally, diurnal migrants' (i.e., waterfowl, waterbirds, and raptors) migratory flight heights vary more than the nocturnal migrants. However, at least for waterfowl, the species group most susceptible to wire collision (Erickson et al. 2001), unless there are distinct features to draw them in (i.e., wetlands, and lakes) for staging purposes, they are likely flying higher than 50 m.

ii. Wetlands have been identified within and adjacent to the preferred corridor for avoidance during final route selection. As such, the number of wetlands intersected by the transmission line will likely be limited.

Further, LGL (2009) found that all waterfowl species occur in low numbers on wetlands along or adjacent to the transmission line corridor.

Movement of birds between wetlands crossed by the final transmission line route (refer to IR# JRP.30) can be assumed, and likely restricted to those species that use wetlands (i.e., waterfowl and waterbirds). Flights at these locations are expected to be low-level (i.e., below the power lines), as the separation distance (i.e., between portions of the same wetland) and bird flight behaviour typically results in low flight heights at these types of locations.

iii. Movement of birds from wetlands to uplands is generally limited to those species that occupy both habitats, not just one, so the waterfowl/waterbirds species list can be narrowed down further (i.e., upland nesting waterfowl/waterbirds such as American Black Duck (*Anas rubripes*) or Northern Waterthrush (*Seiurus noveboracensis*)). As noted in part (a) ii of this response, the separation distance and bird flight behaviour would typically result in low flight heights at these locations (e.g., upland areas adjacent to wetlands) and in close association with the height of the trees being flown to, or from. The right-of-way (ROW) provides a set-back opportunity for the birds to observe the conductor wires from their upland ground perches, or adjacent tree perches (i.e., there is a vertical and horizontal separation between the lines and the trees).

References:

AMEC Earth and Environmental. 2008. Interconnecting Transmission Line Constraint Mapping Atlas. Component Studies – Air Quality, Timber Resources and Other (Report 4 of 5).

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R.E. Good. 2001. Avian Collision with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. National Wind Coordinating Committee (NWCC) Resource Document.

LGL Limited. 2008. Waterfowl in the Lower Churchill River Area. Report prepared for Minaskuat Inc. and Newfoundland and Labrador Hydro, Lower Churchill Hydroelectric Generation Project, St. John's, NL.

Minaskuat Inc. 2008a. Forest Songbird Surveys. Component Studies – Terrestrial Environment Avifauna (Report 1 of 5). Lower Churchill Hydroelectric Generation Project, St. John's, NL.

Minaskuat Inc. 2008b. Inventory of Osprey, Bald Eagle and Golden Eagle Nest Sites in the Lower Churchill River Valley and Area. Component Studies – Terrestrial Environment Avifauna (Report 3 of 5).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.94**

Information Requested:

The Proponent is asked to provide:

b. **proposed measures to avoid bird collisions and electrocution, including line placement and orientation, marking of lines (e.g., bird flight diverters), and design of structures (e.g., preferable to have a horizontal rather than vertical conductor configuration, ensure that the new power lines are at even heights with existing adjacent power lines);**

Response:

No likely effects related to bird collisions or electrocution is predicted for this Project.

Routing was a primary mitigation technique used by Nalcor, and the preferred route has been selected with limiting potential disturbance to wildlife, including birds, in mind. For example, the preferred route follows, to the extent practical, the existing 138 kV transmission line right-of-way (ROW). This relates to the optimal line placement and orientation, in consideration of existing disturbance corridors. Further, the final routing will avoid wetlands to the extent practical which will limit likely effects to bird species using wetlands within and along the ROW.

No staging areas were identified along the preferred route, and considering the information in part (a) related to flight heights during migration, no areas are expected to pose higher risks for bird collisions than the existing 138 Kv line currently in place. Therefore, Nalcor is not proposing to establish bird flight diverters at any locations at this time.

The design of the transmission structures will likely prevent avian collisions with conducting wires because both the 735 kV structures and 230 kV double circuit structures have multiple sets of conducting wires at the same height from ground level, improving visibility of the conductors.

Avian electrocution is not considered a substantial risk on high voltage power lines such as the 230 kV and 735 kV lines proposed for this Project. The clearance between grounded and conducting equipment on the proposed 230 kV and 735 kV transmission towers is larger than the maximum wing span of birds found within the study area (maximum wing span is 2 m for Bald Eagle). Avian electrocution is typically a greater risk on low voltage transmission systems (72 kV and lower) and distribution systems because clearances between electrical components are smaller, making it possible for birds to contact two conducting elements or one grounded and one conducting element at the same time.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.94**

Information Requested:

The Proponent is asked to provide:

c. **proposed monitoring plan to evaluate the effectiveness of these measures (focusing on mountain passes and areas of higher elevation).**

Response:

Considering the mitigation (e.g., routing to follow an existing disturbance corridor) undertaken for the transmission line, and that there is limited potential for interaction with migrating birds and local breeding birds, Nalcor is not proposing any monitoring, as no additional deterrent measures are warranted.

IR# JRP.95

Impact of Vegetation Clearing on Land Birds

Requesting Organization – Joint Review Panel **Information Request No.: JRP.95**

Subject - Impact of Vegetation Clearing on Land birds

References:

EIS Guidelines Section 4.5.1 (Environmental Effects – General)

EIS Volume IIB, Section 5.11.1.14 (Environmental Effects Assessment -Change in Habitat)

Related Comments / Information Requests:

CEAR # 173 – Environment Canada

IR # JRP.68

Rationale:

Clearing trees and flooding the Gull Island and Muskrat Falls Reservoirs will result in the loss of over 126 km^2 of forest and riparian habitat for land birds (forest songbirds). The impoundment associated with the Project will affect 12 percent of the land area of the Lower Churchill River Valley and 60% of riparian/wetland habitat. Clearing trees along the right-of-way for the transmission lines will result in the loss of 21 km^2 of mainly forest habitat for birds. Clearing vegetation during the breeding season would cause direct bird mortality.

Riparian/wetland habitat will be the most heavily impacted habitat type within the Project area. The maintenance of existing riparian vegetation during construction and the creation of alternative riparian and wetland habitat post construction in the Churchill River Valley would help mitigate the effects of flooding on riparian and wetland specific bird species; however conducting follow-up surveys to determine the success of riparian habitat creation would be important.

The Canadian Wildlife Service has indicated (CEAR# 173 – Environment Canada) that in order to avoid direct bird mortality, all vegetation clearing activities should occur outside of breeding season for land birds in Labrador (early May to August).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.95**

Information Requested:

The Proponent is asked to provide:

a. **a schedule for vegetation clearing, both for the reservoir and the Project site itself. The schedule should specify whether or not any vegetation clearing will be undertaken between early May to August. This information should be updated in Table 5-10, the Migratory Birds Effects Management Measures;**

Response:

Vegetation clearing for both the reservoir and Project site is planned to take place year round during the construction phase. Table 5-10 (expanded from Volume IIB of the EIS) provides additional explanation of planned mitigation measures for migratory birds concerning reservoir and Project clearing activities.

Table 5-10 Expanded from Volume IIB of the EIS - Additional Specific Effects Management Measures

Key Indicator	Effects Management Measures
Migratory Birds - Canada Goose, Surf Scoter, Osprey, Wetland Sparrows, Harlequin Duck, Other Species of Concern	Consistent with the *MBCA* and associated Regulations, a management plan will be developed and implemented to reduce risk and mitigate disturbance to nests and young of these species. The current Project schedule for impoundment avoids breeding season for both reservoirs Table 7-1 (Volume IIB) provides a summary of specific environmental effects management measures for the Terrestrial Environment VEC which includes migratory birds. This specifically mentions the avoidance of disturbing and/or clearing sensitive wildlife areas during reservoir preparation. Table 5-8 identifies the first of May to the end of July as being the period of highest vulnerability for reservoir preparation and these species in question. Table 7-1 also indentifies reducing the risk of disturbance to avifauna nests through the preparation of an avifauna environmental management plan. The management plan will be designed and implemented to reduce the possibility of incidental take to active nests, regarding all habitat clearing consistent with Environment Canada (2007)
Wetland Sparrows and Other Species of Concern	Nalcor Energy will encourage formation of riparian marsh (wetland) at selected locations adjacent to the reservoirs. This will provide habitat for Wetland Sparrows, Rusty Blackbird, Olive-sided Flycatcher and other wildlife (herpetiles). Riparian vegetation approximately 30 m in width will be left in place during the Muskrat Falls Reservoir preparation, allowing time for replacement areas to become established. Larger trees will be selectively cleared from this buffer Table 7-1 (Volume IIB) provides a summary of specific environmental effects management measures for the Terrestrial Environment VEC which includes Wetland Sparrows and Other Species of Concern. This specifically mentions clearing of vegetation at FSL to encourage development of a new riparian zone, encouraging the formation of riparian marsh wetland at selected locations in the watershed and leaving riparian vegetation in place at selected areas during reservoir preparation

Nalcor Energy (Nalcor) is aware of the requirements of the *Migratory Birds Convention Act* and its regulations and is consulting with Environment Canada (Canada Wildlife Service) on this issue. As well, Table 7-3 (of Volume IIB of the EIS) identifies requirements related to Follow-up and Monitoring and these will be developed further in compliance with the approach outlined in IR# JRP.112 which includes the requirement for adaptive management.

Reference:

Environment Canada. 2007. Environment Canada Background Document on the Management of Incidental Take of Migratory Birds: Towards an Updated Regulatory Approach. (25 October) Ottawa, ON.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.95**

Information Requested:

The Proponent is asked to provide:

b. an assessment of the impacts of vegetation clearing on land birds and their habitat.

Response:

The assessment of the effects of vegetation clearing (and other aspects of the Project) was completed for several Key Indicators (KI) of land birds namely Ruffed Grouse, Wetland Sparrows (Lincoln's Sparrow, Song Sparrow, Swamp Sparrow, and Savannah Sparrow), and Other Species of Concern (Common Nighthawk, Grey-cheeked Thrush, Olive-sided Flycatcher and Rusty Blackbird). The species selected for the assessment were included as they are considered most at risk in terms of their distribution within the lower Churchill River watershed and/or because of federal and provincial legislation. The analysis is presented in Volume IIB of the EIS and results of the assessment indicated that environmental effects of the Project activities on these KIs were predicted to be not significant.

IR# JRP.96

Inundation and Flood Mapping

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Subject - Inundation and Flood Mapping

References:

EIS, Volume IA, Section 4.5.1.1, 4.5.2.1 (Project Description – Operating Regime) & Section 4.11.3 (Accidents and Prevention – Dam Failure)

Related Comments / Information Requests:

CEAR # 183 (Central Labrador Environmental Action Network)
CEAR # 192 (E. Davis)
CEAR # 200 (Grand Riverkeeper Labrador Inc.)
CEAR # 205 (Government of Newfoundland and Labrador – Water Resources Management Division)

IRs # JRP.6, 28, 33, 34, 35, 36, 37, 71, 72

Rationale:

The EIS Guidelines Section 4.5.2 on Accidents and Malfunctions require the Proponent to provide "(d)etailed plans, measures and systems to reduce the potential occurrence of an accident or malfunction". The Guidelines also indicate that the plans "(s)hall indicate how they will reduce the effects or consequences of an accident or malfunction, should it occur". There is minimal information in the EIS on the inundation and flooding that might result downstream from failure of a dam along the Churchill River.

EIS Volume III, Section 7.5.3 (Community Health) mentions that "(I)n the event of a double breach at Gull Island and Muskrat Falls, flood waters would affect approximately 380 homes in the Happy Valley-Goose Bay/Mud Lake area." The EIS also states that "An Emergency Preparedness Plan will be developed by Nalcor Energy in consultation with potentially affected communities. The purpose of the Plan will be to minimize loss of life through the development of community evacuation procedures. In the event of a dam failure, evacuation and other emergency response procedures will be implemented."

The EIS indicates both that "(i)n order to maximize power and energy output, Gull Island Reservoir will be operated as close to FSL (125 m) as possible" (p. 4-59) and that "(t)he reservoir has the capacity for additional storage in order to handle extreme flood events up to a maximum flood elevation of 127 m" (p. 4-59). Similarly, the EIS indicates that the operating level for Muskrat Falls will be 39 m with additional storage capacity to 44 m during extreme flood events.

With regards to dam failure, the EIS refers to a dam breach study that details the potential consequences of a dam failure at one or both projected sites on various low-lying terrestrial environment habitat and inhabited areas (Happy Valley-Goose Base, Mud Lake) and on transportation and community infrastructure including Black Rock Bridge, water, sewer, power and communications infrastructure) (p. 4-86). In addition, some residents have expressed concerns over the possibility of a "cascading" failure resulting from the breach of the Jakopi structure or other structures associated with Upper Churchill.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

a. **clarification as to whether the flood lines that are plotted in the inundation maps provided as Appendix IB-C show the Full Supply Level (125 meters for Gull Island or 39 metres for Muskrat Falls) or Maximum Flood Elevation (127 metres or 44 metres);**

Response:

The flood lines that are plotted in the inundation maps provided as Appendix IB-C, Volume IB of the EIS show the Full Supply Level.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

b. explanation of how the differential between Full Supply Level and Maximum Flood Elevation was considered when assessing the Project's environmental effects;

Response:

The Full Supply Level is the normal operating level of the reservoir and was assessed as part of the operational phase of the Project. The maximum flood level is associated with a specific event, the Probable Maximum Flood (PMF) and is therefore assessed as part of accidental events, i.e., flooding and subsequent dam break analysis.

PMF is discussed further in the response to IR# JRP.96(c).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

c. **an explanation of the analytical methods and any assumptions used to determine the maximum flood elevation and maximum area flooded for both the Gull Island and Muskrat reservoirs;**

Response:

The maximum flood level (MFL) on a reservoir is based on the inflow design flood and the reservoir's flood storage and spill capacities. The Canadian Dam Association (CDA) Guidelines (2007) recommend inflow design floods for dams based on the consequence of dam failure. The inflow design flood is subsequently used in the design of hydraulic facilities, e.g., dams and spillways, and for dam safety studies. Additionally, the reservoir's storage and spill capacities are optimized based on technical, environmental and economic considerations, including dam height, flooded area and gate size.

Under the CDA guidelines, it was determined that the appropriate inflow design flood at Gull Island and Muskrat Falls is the PMF. A PMF is defined by the CDA (2007) as the: "Estimate of hypothetical flood (peak flow, volume and hydrograph shape) that is considered to be the most severe 'reasonably possible' at a particular location and time of year, based on relatively comprehensive hydro-meteorological analysis of critical runoff-producing precipitation (snowmelt if pertinent) and hydrologic factors favourable for maximum flood runoff".

As part of several engineering studies initiated by Nalcor Energy (Nalcor) in 2007, a study was conducted to determine the PMF for the Lower Churchill Project sites. The investigation included a meteorology study to estimate the contributors to the PMF, and detailed hydrologic modeling of the entire Churchill River Basin to estimate Gull Island and Muskrat Falls PMF peaks.

Watershed models for the Upper and Lower Basins were created using the SSARR (Streamflow Simulation and Reservoir Regulation) model. The model uses precipitation, temperature, snowpack information and relationships that define runoff response to predict flows in the Churchill River. Input data were gathered from a variety of sources and included meteorological data from Atmospheric Environment Branch, Environment Canada climate stations at Goose Bay, Churchill Falls, Schefferville and Wabush, snow course, precipitation and lake level data from CF(L)Co. and hydrometric data from 11 Water Survey of Canada (WSC) streamflow stations. The model was then used to test the various combinations of extreme rainfall, temperature and snowpack recommended by the CDA to determine the governing PMF scenario.

Inflow hydrographs generated in SSARR were subsequently routed through the Acres Reservoir Simulation Package (ARSP) operational model. This methodology, applied to the Upper Basin, resulted in the determination of contributory outflows from the Upper Basin. Similarly, SSARR was used to generate PMF inflow hydrographs for the Lower Basin.

The final step in determination of the MFL and the spillway design capacity at each site was the creation of a dynamic HEC-RAS (Hydrologic Engineering Center – River Analysis System) hydraulic model of the Lower Churchill River. This model was used to route the contributory outflows from the Upper Churchill Basin (determined using ARSP) and the Lower Churchill PMF inflow hydrographs (generated by the SSARR model) through the Gull Island and Muskrat Falls reservoirs. With either of the MFL or the spillway capacity fixed, the HEC-RAS model will determine the other. At Gull Island and Muskrat Falls, the MFLs had been pre-determined in other studies, as described below. The spillway design capacity at each site was then obtained from the HEC-RAS model to correspond to the selected MFL.

In 1998 the MFL for Gull Island was set at 127 MASL to respect CDA criteria for a minimum of 2 m between the crest level of the dam and the MFL for protection against frost action in the dam during maximum extreme flood conditions.

The FSL of the reservoir for Muskrat Falls was set at 39 m, for optimum utilization of the available head on the River, without negative impact on the Gull Island plant. As a result, six options for spillage of the PMF were considered for Muskrat Falls. The six options included different MFLs (based on HEC-RAS flood routing). The two lowest cost options included a MFL of 44 m.

The maximum areas flooded for the Gull Island and Muskrat Falls Projects were determined by superimposing the reservoir FSLs on detailed LiDAR mapping of the Project areas. The maximum flooded area for each project was calculated by subtracting the area of the original river surface from the reservoir surface area bounded by the FSL contour.

Reference:

Canadian Dam Association. 2007. Dam Safety Guidelines 2007.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

d. a map of the area(s) to be flooded following a possible dam failure, as detailed in the dam breach study;

Response:

A map of the areas that would be flooded following a possible dam failure, as detailed in the Dam Breach Study (Hatch 2008) (Attachment A). Due to the size, Attachment A is provided electronically.

Reference:

Hatch Ltd. 2008. The Lower Churchill Project: Dam Break Study - Volumes 1 and 2. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

e. a copy of the Dam Breach Study;

Response:

A copy of the Dam Break Study (Hatch 2008) is provided in electronic format (due to the size of the report) (Hatch 2008), as part of this response. The consequences of a dam failure at Gull Island or Muskrat Falls, or both, have been presented in Volumes 1 and 2 of the 2008 report GI1190 - Dam Break Study (Hatch 2008) for several failure scenarios. Volume 1, Part 7, lists the consequences with respect to potential loss of life, as well as economic, environmental and cultural losses for incrementally inundated areas, for each scenario. Volume 2 presents the flood inundation mapping, including the flood levels that would naturally occur and the incremental flood levels that would result from a dam failure, for each scenario. The inundation mapping shows extensive flooding as far downstream as Hamilton Inlet but little flooding further out into Lake Melville, beyond Sandy Point. Little, if any incremental flooding would be anticipated in the area of the communities of Northwest River and Sheshatshiu.

Reference:

Hatch Ltd. 2008. The Lower Churchill Project: Dam Break Study - Volumes 1 and 2. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

f. **an evaluation and description of the risks and impacts associated with a potential cascade failure involving the Churchill Falls installation/dams. This should include considerations of the potential effects on the communities of Happy Valley-Goose Bay and Mud Lake and associated infrastructure and a map of the area that would be flooded;**

Response:

Construction of the Churchill Falls development was completed 38 years ago in 1971, and the dams and dykes associated with the development have been closely monitored since then. CF(L)Co. has retained a consultant to complete a dam failure analysis using the same tools as were used for the dam breach analysis for the Project. Once complete, the results will be integrated with the model used for the Project, and an integrated analysis will be completed for downstream communities, including Happy Valley-Goose Bay, Mud lake, Northwest River and Sheshatshui. Inundation mapping will then be provided for any cascade failure scenarios. This is expected in early 2010.

The results of this follow-up analysis will be provided to appropriate regulators and stakeholders when it is available.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

g. the mitigation measures proposed to reduce the effects or consequences of a possible dam break on the communities of Happy Valley-Goose Bay and Mud Lake and associated infrastructure; and

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Response:

The dams and associated spillways for the Lower Churchill project will be designed and built to very high standards. This includes being designed, by eminently qualified engineering consultants, to pass inflow design floods equal to the PMF, which, in Canada, is a criteria set by the CDA for dams with high consequences of failure. Further, it includes construction of the dams, by eminently qualified contractors, in accordance with rigorous quality control procedures.

In addition, during the operational lives of the structures, they will be monitored closely through extensive internal geotechnical instrumentation, together with external quantitative and qualitative surveys and in accordance with a proactive corporate dam safety program, following the Dam Safety Guidelines published by the CDA.

Nalcor has a pro-active dam safety program which follows the CDA Dam Safety Guidelines for inspections and maintenance of its structures. Nalcor retains a Dam Safety Review Board of engineers recognized as experts in the field of dam engineering to oversee its dam safety program.

Prior to the first filling of each reservoir, an effective emergency management process will be in place. The emergency management process will include, for each of the Gull Island and Muskrat Falls developments, an Emergency Response Plan (ERP) and an Emergency Preparedness Plan (EPP). The process will be continuously updated over the life of the dams. Nalcor Energy will prepare the ERPs and the EPPs with full involvement of the communities downstream of the reservoirs.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.96**

Information Requested:

The Proponent is asked to provide:

h. **additional information on the Emergency Preparedness Plan (EPP), emergency response procedures and community evacuation procedures including information on the local administrative/community capacities in supporting or participating in emergency response procedures related to such event.**

Response:

An ERP will be prepared for each development to document the procedures that the plant operating staff should follow in the event of an emergency at the dam. The ERP will also outline the key emergency response roles and responsibilities, as well as the required notifications and contact information.

The EPP is required for use by external agencies where a dam failure or passage of a major flood could cause loss of life. Nalcor will prepare and maintain an EPP for each development which will describe the various hazards associated with the dams, the associated notifications to be issued and the actions expected of other responders. They will contain inundation maps and flood arrival times and water levels so that local authorities can develop their own response plans.

A sample table of contents for an EPP is included as Attachment B.

NOTE:

Please see accompanying CD for Digital File.

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

JOINT REVIEW PANEL

Attachment A

Dam Break Study Final Report - Volume 1&2

IR# JRP.96

October 2009

nalcor energy
LOWER CHURCHILL PROJECT

JRP.96
Dam Break Study, Vol. I

(Click above link to go to file)

JRP.96
Dam Break Study, Vol. II

JRP.96
Dam Break Study, Vol. II
Part 1

(Click above link to go to file)

JRP.96
Dam Break Study, Vol. II
Part 2

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JRP.96
Dam Break Study, Vol. II
Part 3

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Dam Break Study, Vol. II
Part 4

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Dam Break Study, Vol. II
Part 5

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Dam Break Study, Vol. II
Part 6

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Dam Break Study, Vol. II
Part 7

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Dam Break Study, Vol. II
Part 8

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Dam Break Study, Vol. II
Part 9

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Dam Break Study, Vol. II
Part 10

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Dam Break Study, Vol. II
Part 11

(Click above link to go to file)

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

JOINT REVIEW PANEL

Attachment B

Emergency Preparedness Plan Table of Contents

IR# JRP.96

October 2009

nalcor energy
LOWER CHURCHILL PROJECT

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SECTION 7 Warning Systems

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SECTION 9 Communications Directory

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Appendix A Notification of Emergency Response Form
Appendix B List of Registered EPP Holders
Appendix C Revision Form
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Appendix E Outside Agencies Involved in Emergency Procedures
Appendix F Letter of Understanding

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IR# JRP.97

Cumulative Effects Methodology and Analysis

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Subject - Cumulative Effects Methodology and Analysis

References:

EIS Guidelines, Section 4.5.3 (Cumulative Effects)

EIS Volume 1A, 9.2 (Cumulative Environmental Effects)

EIS Volume IIA, Section 3.11 (Cumulative Environmental Effects – Air Quality), & Section 4.1.6 (Cumulative Environmental Effects – Aquatic Environment)

EIS Volume IIB, Section 5.15 (Cumulative Environmental Effects – Terrestrial Environment).

CEAA. Cumulative Effects Assessment Practitioners Guide, Section 3.2.3.1. Accessed: http://www.ceaa.gc.ca/013/0001/0004/3_e.htm#2-3-1

Related Comments / Information Requests:

CEAR # 170 (Fisheries and Oceans Canada)
CEAR # 169 (A. Lutterman)
CEAR # 184 (Sierra Club Atlantic)
CEAR # 199 (S. Davis)
CEAR # 200 (Grand Riverkeeper Labrador Inc.)
CEAR # 203 (Hydro-Québec)

Rationale:

The EIS Guidelines (Section 4.5.3) define cumulative effects as "changes to the environment due to the Project where those overlap, combine or interact with the environmental effects of other existing, past or reasonably foreseeable projects or activities". The Proponent is instructed to identify and assess the Project's cumulative environmental effects on this basis.

In addition to identifying and justifying the VECs that will constitute the focus of the cumulative effects assessment the Proponent is to justify the spatial and temporal boundaries of the cumulative effects assessment. The Guidelines suggest that the boundaries for the cumulative effects assessment will depend on the effects being considered (e.g., will generally be different for different effects) and will generally be different from (larger than) the boundaries for the corresponding Project effects. At present the Proponent's cumulative effects assessment uses the same boundaries as for the assessment of each individual VEC with little justification or reasoning.

The EIS Guidelines indicate that it may be appropriate, during the course of the environmental assessment, to refine the definition of the VECs selected for cumulative effects assessment. Because the Proponent has chosen broad VECs and none of the selected KIs for aquatic and terrestrial environments cover the physical aspects of these environments (deltas, sedimentation, *ashkuis*, etc.) it may be appropriate to re-define the VEC/KI so that cumulative impacts on these components can be examined.

At present the Proponent excludes or omits many past activities and projects, those being carried out and future projects or activities likely to be carried out based on the screening process applied in Volume IA, Figure 9.2.The Proponent's own Labrador-Island Transmission Link project, dated January 29, 2009, appears to fit the criteria of a project with spatial and temporal overlap however it has not been specifically addressed in the cumulative impacts assessment.

Because projects that, according to the Proponent, are taken into account in the baseline are screened out immediately, none of the other Churchill River hydroelectric projects, or other projects and activities that occurred in the past is taken into account in the cumulative effects assessment. As a result of this limited analysis, there is no understanding of the incremental effects of hydroelectric development within the watershed or in adjacent watersheds that were affected by the existing developments.

The list of inclusions for the cumulative effects assessment is further reduced by the Proponent due to the following considerations:

- The Voisey's Bay mine project and Labrador West mining developments are immediately excluded, in terms of effects on the biophysical environment, due to their physical distance (Table 9-7 of Volume IA), even though the study area for atmospheric GHG emissions may be much larger and they may draw on the same labour pool for workers;
- Infrastructure development projects are immediately excluded from the assessment of effects on the biophysical environment ("due to limited physical nature of this activity," Table 9-7 of Volume IA);
- Only the effects of work on the TLH and boating and fishing activities are considered in the assessment of cumulative effects on the aquatic environment (Table 4-23 of Volume IIA), logging and infrastructure are not included;
- Mining and infrastructure construction are not included in the assessment of cumulative effects on wildlife with respect to habitat disruptions, division and losses.

In considering the significance of impacts, the Proponent should use criteria applied elsewhere to measure environmental effects, i.e., nature, magnitude, duration, geographical extent, frequency, reversibility, and certainty of knowledge and provide an assessment as appropriate. Rationales behind the determinations of significance for the cumulative effects analysis are not clearly presented in the EIS.

Given that the cumulative effects assessments are completed independently for each VEC/KI it is very difficult for the reviewer to grasp the full picture with respect to potential and residual cumulative impacts.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

a. **review the appropriateness of the screening process used for cumulative effects and the selection of other projects, given directions in the guidelines;**

Response:

The screening process used for the Cumulative Effects Assessment (CEA) in the Environmental Impact Statement (EIS) is appropriate, and addresses the requirements in the Guidelines. In framing the CEA, the study team considered the following:

- whether there are likely Project-related environmental effects
- whether Project-related environmental effects are likely to overlap on a spatial and temporal basis with those of other past, present and reasonably foreseeable future projects
- the significance of likely cumulative effects

The screening criteria and process used to identify projects and activities for inclusion within the CEA for this Project is outlined in Figure 9-2 and Table 9-6 of Volume IA in the EIS (reproduced below).

The information request, and comments provided on the EIS by interested parties, suggest that the CEA for the Project failed to properly consider the effects of past, present and reasonably foreseeable projects.

The development of the criteria and process used in the CEA for the EIS, outlined in the three steps below, considered the Canadian Environmental Assessment Agency (CEA Agency) guidance on cumulative environmental effects assessment (CEA Agency 1994, 1999, 2007), the requirements of the *Canadian Environmental Assessment Act*, requirements of the EIS Guidelines (Section 4.5.3) and standard environmental assessment (EA) practice in Canada.

1. First, the effects of past and present projects and activities are captured in the baseline studies for the EIS. These studies (i.e., studies associated with the Panel review of the Project in 1979-80, baseline studies conducted in 1998-2000, and again in support of this EIS in 2005-2008) provide a comprehensive picture of the existing environment in the CEA Area that has been, in part, influenced by the construction and operation of all past and present projects as described extensively in the EIS. The baseline conditions reflect the state of the existing environment, supported by extensive long-term data from the previous panel review (LCDC [Lower Churchill Development Corporation] 1980a, 1980b), and subsequent studies over the past 25 to 30 years. For many of the natural and human systems, the VEC and KIs, if affected by major developments (e.g., Churchill Falls) have adjusted in response to those residual effects and are reflected in the baseline.
2. Second, the Project activities were assessed against this existing environment described in the baseline studies (i.e., resulting from past and present projects and activities) together with proposed mitigation measures to predict likely residual Project effects. Indeed, past and present activities are incorporated in the Project-related effects assessment at various stages including:
   - description of baseline conditions;

- selection of KIs (e.g., Key Indictors (KIs) that are under threat from existing stresses, and species of concern);
- forming the basis for assessing habitat (e.g., current vegetation conditions result from a combination of previous human activities and natural events);
- consideration of thresholds exceeded (e.g., existing hg levels must be known to understand how the project will contribute to the aquatic system); and
- forming the basis from which social effects can be understood (e.g., current socio-economic conditions are reflective of effects from other industries and activities).

Examples of how the environmental effects of past and present projects have been incorporated in predicting Project effects, and the CEA, include the following:

- the existing environmental conditions include the environmental effects associated with the Churchill Falls Power Station, which has been in operation for over 35 years;
- the existing environmental conditions consider that the Twin Falls Generating Station was decommissioned in 1972, allowing 37 years of adjustment;
- in many cases, the current threatened status of a species is a reflection of anthropogenic activities such as over-harvesting or alteration of habitat. Therefore, in describing the baseline conditions for these species, the environmental effects of these past activities are already captured; and
- the existing economic conditions of a community like Happy Valley-Goose Bay have been shaped by past projects and activities, including those of the Department of National Defence, Vale-Inco Newfoundland and Labrador Ltd., and government infrastructure projects, such as the Trans Labrador Highway (Phases I, II and III).

3. Finally, predicted Project effects are then considered on a cumulative basis with effects of reasonably foreseeable future projects that will overlap with likely Project effects on both a temporal and spatial basis.

This well accepted approach integrates, in a logical progression, the consideration of the Project environmental effects cumulatively with those of past, present and reasonably foreseeable projects and activities. By using this stepwise approach, all existing (i.e., past and present) and reasonably foreseeable projects and related effects are considered in the CEA to provide a prediction of likely cumulative effects.

It is also important to note that a precautionary approach was employed in the Project CEA such that, even though some predicted effects from other projects are likely to be negligible (and not likely to interact with residual effects of the Project in a measurable way), they were still carried forward in the CEA so that conservative and reliable CEA predictions were made. For example, the effects resulting from general road improvements in the Upper Lake Melville area were considered in the CEA for the Economy, Employment and Business, and Community VECs even though the cumulative effects would likely not be measurable.

Figure 9-2 (reproduced from the EIS) Cumulative Environmental Effects Assessment Screening Process

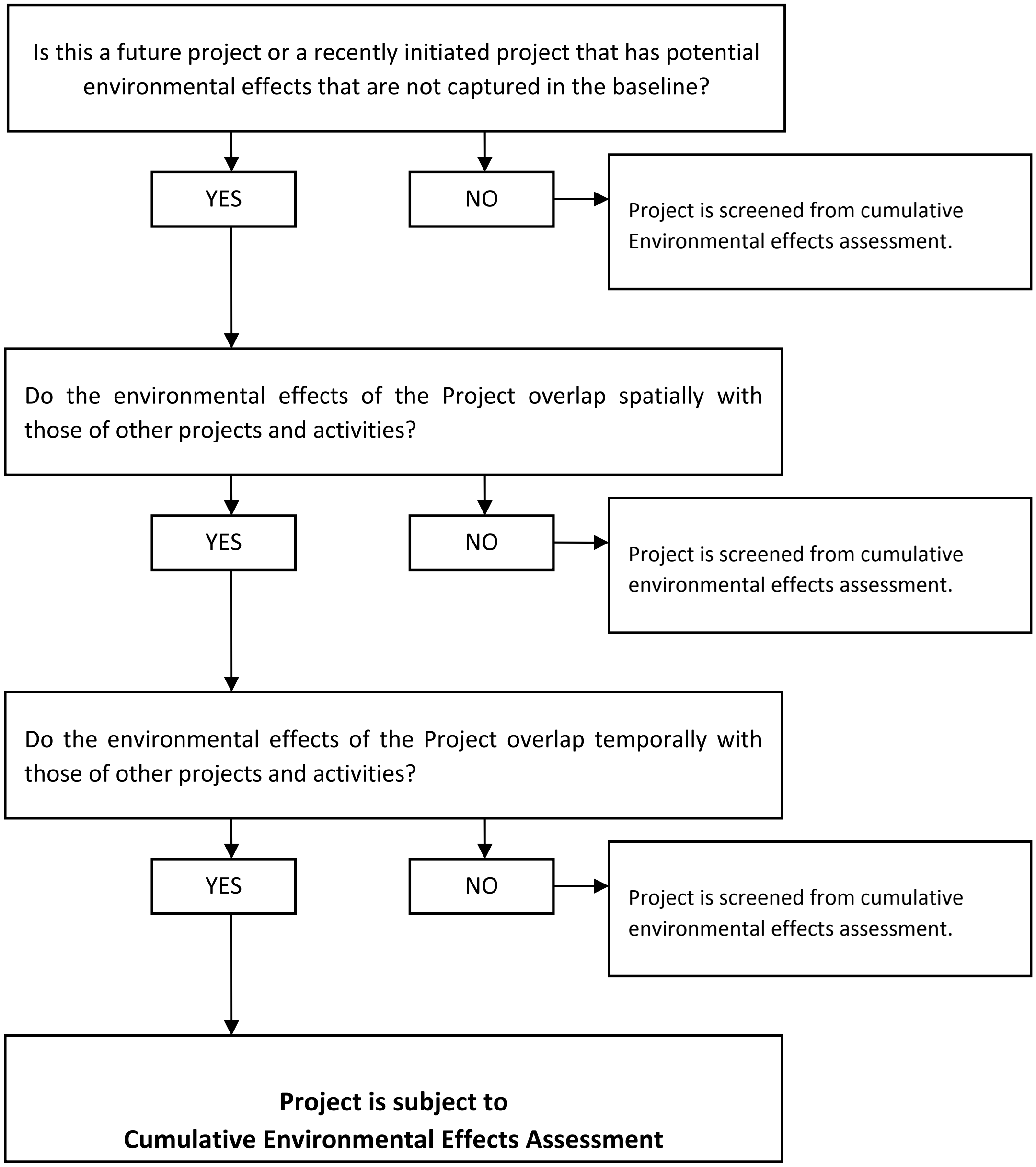


Table 9-6 (reproduced from the EIS) Criteria for Identification of Other Projects and Activities

Criteria	Rationale and Application of Criterion
Status of other project or activity: Reasonably foreseeable, past and present projects	• With some exceptions, the cumulative environmental effects assessment does not specifically consider past and present projects and activities because the environmental effects resulting from these projects and activities are captured in the description of the baseline conditions • Potential exceptions are recently initiated projects and activities where the environmental effects are also recent and may not be fully reflected in the existing baseline conditions (e.g., Black Rock Bridge and the TLH, or projects/activities that will probably change in nature and degree in the foreseeable future (e.g., Voisey's Bay Mine/Mill), or could be affected by the Project (e.g., Cultural and Recreational Land Use))
Status of other project or activity: Reasonably foreseeable, past and present projects (cont.)	• Reasonably foreseeable projects and activities are highly likely to be implemented and typically include those identified in approved development plans or those that are in other advanced stages of planning (e.g., forest management plans) • Hypothetical and speculative projects and activities are not considered as part of the cumulative environmental effects assessment
Potential for a temporal overlap of environmental effect: The environmental effects from other projects or activities should overlap temporally with the time frame that is relevant to the Project	• The Project timeframe includes the construction, and operation and maintenance phases • To be included within the cumulative environmental effects assessment, the effects from other projects and activities should have a measurable or meaningful overlap with some portion of the Project timeframe
Potential for a spatial overlap of environmental effect: The effects from other projects or activities should overlap with the Project Assessment Area as defined in the environmental effects analysis for the various VECs or KIs	• For the cumulative environmental effects assessment, projects should have an identified or expected zone of influence that may overlap with the geographic area likely affected by the Project area of interest. The potential for and nature of such spatial overlap will vary according to VEC or KI

As demonstrated above by Figure 9-2, the first action step in the screening process used for the EIS was to determine whether a reasonably foreseeable future project or a recently initiated project has likely environmental effects that are not already captured in the baseline.

The second question in the screening process was to consider whether the environmental effects of the Project are likely to overlap spatially with those from other reasonably foreseeable future projects. The application of this filter eliminates the need to consider certain environmental effects where this spatial overlap is not likely to occur. For example, the Project will not affect the biophysical environment upstream of the Project footprint. The Project has no biophysical environmental effect, for example, on the environment in and around the Smallwood Reservoir or the iron mines of western Labrador, or on the area around the Voisey's Bay Mine. Hence, changes in the watershed above Churchill Falls due to hydroelectric development only overlap with those of the Project downstream of Churchill Falls (e.g., changes in streamflow and water level in the lower Churchill River). While it is correct that the changes in the lower Churchill River due to existing hydroelectric facilities upstream (Churchill Falls and Twin Falls) do overlap with the effects of the Project and do require consideration, as stated above, the environmental effects of these past and present projects are considered and reflected in the current baseline conditions that were subsequently used to predict likely Project effects.

Activities such as economic and infrastructure development in the Upper Lake Melville area do not overlap spatially with the biophysical environmental effects of the Project. This activity involves civil and infrastructure upgrades such as re-grading or paving of roads, replacement of culverts, and construction of homes and businesses. These activities are expected to comply with standard construction practices and their limited associated footprint does not spatially overlap with the biophysical CEA Area for the Project.

A second example of an activity screened out due to lack of spatial overlap relates to forestry activities and the Aquatic Environment. Forestry practices near the river are licensed, regulated activities set out in the Operating Plan and reflect best management practices designed for environmental protection and sustainable development. These practices include buffers and erosion and sedimentation control measures, removing the potential for any spatial overlap of effects with the Aquatic Environment. In contrast, a likely overlap between Forestry and the Terrestrial Environment was identified and carried forward in the CEA. This interaction was fully assessed in the EIS.

A third example of how a project or activity was screened out of consideration in the CEA relates to mining and the biophysical environment. Mining activities in Voisey's Bay and in Western Labrador, and the resulting environmental effects, do not overlap spatially (i.e., are at least 100 km distant from the lower Churchill River watershed) with the Terrestrial or Aquatic CEA Area for this Project. Therefore biophysical effects from these projects are unlikely to influence the KIs within this Assessment Area and are therefore screened out. Depending on the nature of the effects being assessed, cumulative effects on Economy, Employment and Business were also assessed based on the Province as a whole, and Labrador. The CEA Area for some of the socio-economic VECs does overlap with these projects and activities, and thus were carried forward in the CEA and fully assessed in the EIS. CEA Areas were also established in consideration of the nature and type of populations, or in the case of the socio-economic environment, the spatial extent of socio-cultural systems and activities.

The final question in the screening process is whether the environmental effects of the Project overlap temporally with other Projects and activities. This step ensures that only effects from reasonably foreseeable future projects that are likely to have effects that overlap with predicted Project effects on both a spatial and temporal basis are carried forward in the CEA and fully assessed in the EIS.

Based on the above screening criteria and consistent with Table 9-7 of Volume IA of the EIS (reproduced below), the following projects and activities were assessed within the individual cumulative effects assessments for each VEC and/or KI, as applicable:

- Voisey's Bay Mine/Mill;
- Labrador West Mining Developments;
- NATO Special Forces Training (Military Training);
- General Economic and Infrastructural Development in the Upper Lake Melville Area;
- Cultural and Recreational Land Use;
- Commercial Forestry;
- TLH Upgrades; and
- Additional Transmission.

For example the cumulative effects of the Voisey's Bay Mine/Mill were assessed for Economy, Employment and Business because the effects overlapped with those of the Project. The cumulative effects of the Voisey's Bay Mine/Mill were not assessed for either the Aquatic or Terrestrial Environment VECs because there was no spatial overlap with the effects of the Project.

Table 9-7 (reproduced from the EIS) Projects and Activities Considered in Cumulative Environmental Effects Analysis

Project or Activity	Status	Potential for Cumulative Environmental Effects
Voisey's Bay Mine/Mill • Located in northern Labrador, south of Nain • Producing nickel mine and mill	Past and Present Project	Due to physical distance between Mine/Mill and the proposed Project, biophysical cumulative environmental effects are not anticipated. Potential for cumulative environmental effects with socio-economic VECs are considered in the assessment
Labrador West Mining Developments • Several proposed iron ore mines in western Labrador have been registered pursuant to *NLEPA*	Past and Present Activity	Due to physical distance between mining developments in western Labrador and the proposed Project, biophysical cumulative environmental effects are not anticipated. Potential for cumulative environmental effects with socio-economic VECs are considered in the assessment
NATO Special Forces Training (Military Training) • Base for low-level flying exercises • The base is not presently conducting regular low-level flying exercises	Past and Present Activity; Reasonably Foreseeable Activity	Could interact cumulatively with biophysical and socio-economic VECs
General Economic and Infrastructural Development in the Upper Lake Melville Area • Civil works • Sewage disposal • Sewage discharged into the Churchill River (Sewage is discharged into the Churchill River from the town of Happy Valley-Goose Bay. Average daily flow rate, as monitored for purpose of designing a sewage treatment facility, is 85 L/s) • Construction of new metal camera targets within the low-level flying area • Miscellaneous civil works on Base • General road improvements	Past and Present Project; Reasonably Foreseeable Activities	Due to limited physical nature of this activity, biophysical cumulative environmental effects are not anticipated. Potential for cumulative environmental effects with socio-economic VECs are considered in the assessment
Cultural and Recreational Land Use • Hunting and trapping • Boating and angling • Snowmobiling - 1,500 km of snowmobile trails running from Postville-Makkovik to North West River, and from North West River to Happy Valley-Goose Bay and through the Churchill River valley to Labrador West • Other uses such as camping, berry-picking	Past and Present Activity; Reasonably Foreseeable Activities	Could interact cumulatively with biophysical and socio-economic VECs, in area of spatial and temporal overlap
Commercial Forestry • Management District 19A 5 year Operating Plan was registered pursuant to *NLEPA* • Includes timber harvesting, road construction and maintenance and silviculture activities	Past and Present Activity; Reasonably Foreseeable Activity	Could interact cumulatively with biophysical and socio-economic VECs, in area of spatial and temporal overlap during the operation and maintenance phase

Table 9-7 (reproduced from the EIS) Projects and Activities Considered in Cumulative Environmental Effects Analysis

Project or Activity	Status	Potential for Cumulative Environmental Effects
TLH • Includes the road link between Cartwright and Happy Valley-Goose Bay (Phase III), ongoing upgrades to TLH Phase I, and Black Rock Bridge TLH Phase III • Scheduled for completion in 2009 • Approximate clearing of 750 ha (30 m along entire stretch of highway) Phase III of the TLH is a two-lane, gravel surface highway between Happy Valley-Goose Bay and Cartwright Junction (87 km south of Cartwright), where it connects with the Phase II route of the TLH. The approximately 250 km long highway is the final link in a highway system extending from the Labrador Straits region in south-eastern Labrador to western Labrador and onwards through Quebec. The highway crosses the Churchill River at Black Rock Bridge (see below) (NLDWST 2003). Construction is being carried out in phases over an eight-year period, beginning in 2003 and scheduled for completion in 2009 (D. Tee, pers. comm.) TLH Phase I • TLH Phase I from Wabush to Happy Valley-Goose Bay is and will continue to be upgraded Black Rock Bridge • Bridge spanning the Churchill River near Muskrat Falls. The bridge is part of the TLH (Phase III) • Construction completed 2007 Located approximately 8 km upstream from Happy Valley-Goose Bay. The bridge consists of two sections: a 500 m causeway and a 360 m bridge. As the bridge is a very recent addition to the road network and Churchill River, its environmental effects on the local environment, both terrestrial and aquatic, may not yet have been fully realized	Past and Present Reasonably Foreseeable Activity	Could interact cumulatively with biophysical and socio-economic VECs, in area of spatial and temporal overlap
Additional Transmission	Reasonably Foreseeable Project	Could interact cumulatively with biophysical and socio-economic VECs, in area of spatial and temporal overlap

References:

CEA Agency. November 1994. Responsible Authority's Guide. Addressing Cumulative Effects.

CEA Agency. February 1999. Cumulative Effects Practitioners' Guide. Prepared for the CEA Agency by the Cumulative Environmental Effects Working Group and AXYS Environmental Consulting Ltd.

CEA Agency. November 2007 (Revised). Operational Policy Statement. Addressing Cumulative Environmental Effects under the CEAA.

LCDC (Lower Churchill Development Corporation). 1980a. Environmental Impact Statement for the Proposed Gull Island and Muskrat Falls Hydroelectric Generation Projects. St. John's, NL.

LCDC (Lower Churchill Development Corporation). 1980b. Lower Churchill Hydroelectric Project, Report of the Environmental Assessment Panel. Minister of Supply and Services Canada.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

b. **present an updated list of actions and events likely to have had, to have at present or to have at a later date effects on components of the environment including, but not limited to, projects and activities associated with other hydroelectric facilities on the Churchill River, infrastructure including wastewater and sewage facilities, and mining and forestry operations;**

Response:

As described above in response to part (a) of this response, the CEA for the Project employed a screening process that considered all relevant past, present and reasonably foreseeable projects that are likely to have effects that overlap both temporally and spatially with predicted Project effects. This resulted in an appropriate list of Projects that were considered in the Project CEA, consistent with CEA Agency guidance and the EIS Guidelines. This list forms the basis for the table summarizing the CEA presented below in response to part (e) of this information request.

The "Rationale" section of this IR states that "*The Proponent's own Labrador-Island Transmission Link project, dated January 29, 2009, appears to fit the criteria of a project with spatial and temporal overlap however it has not been specifically addressed in the cumulative impacts assessment*." This potential future transmission line was included and fully assessed in the cumulative effects assessment for all appropriate VECs. In the EIS it is referred to as "Additional Transmission".

The "Rationale" section also cited an apparent oversight in the EIS with respect to Voisey's Bay Mine/Mill and Labrador Western mining projects, and the assessment of greenhouse gas (GHG) emissions for the Atmospheric Environment. Published data on GHG emissions of the Voisey's Bay Mine/Mill were not available. However, the 2005 GHG emissions for Newfoundland and Labrador were obtained from Environment Canada's website (total of 10.5 million tones CO_2e per year), which includes GHG emissions from the IOC and Wabush Mines in western Labrador, and these were therefore considered as part of the environmental effects assessment.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

c. **describe and justify, for each VEC or key indicator, the spatial and temporal boundaries, and indicators used specifically for the cumulative effects assessment, this may include aspects of the physical environment that were not previously included in the assessment;**

Response:

All aspects of the physical environment have been considered appropriately with the selected VECs in the EIS.

For each VEC and KI, the spatial and temporal boundaries for the CEA was based on the predicted extent of the Project effects, and considered the likelihood for spatial and temporal overlap of environmental effects from projects and activities included in the CEA with these predicted residual Project effects. These boundaries varied between VECs and KIs, and the description and rationale for these boundaries are included in the EIS and summarized below. The CEA boundaries for each VEC and KI are consolidated and illustrated on Figures 1, 2, and 3, at the end of this response, along with locations of other projects and activities that were included in the cumulative effects analyses.

Atmospheric Environment VEC:

The CEA is presented in Section 3.11, Volume IIA of the EIS.

Climate KI – Project-related emissions were compared with emissions from similar projects for the Province and Canada in accordance with the guidance of the CEA Agency (2003). The 2005 GHG emissions for Newfoundland and Labrador were obtained from Environment Canada's website (total of 10.5 million tonnes CO_2e per year), and as such, the entire province was considered in a spatial context, and for the reporting period regarding the temporal context for the CEA Area for this KI.

Air Quality KI - The CEA Area for the characterization of potential environmental effects on Air Quality resulting from Project activities is the Project footprint, plus an extended area out from the Project Area in each direction to approximately 5 km, as well as 500 m from the centreline of the TLH (from Churchill Falls to Happy Valley-Goose Bay), the transmission line and access roads. This area was selected as it provides sufficient dispersion of emissions from heavy equipment operation and vehicle traffic to a point where ambient concentrations are within the regulatory limits. As this is the anticipated geographic extent of Project environmental effects for Air Quality, it is also the extent of potential geographic overlap of Project effects with other projects and activities. Temporally, the CEA was limited to Project construction, as air emissions during construction are many times greater than those predicted for operation and maintenance. The CEA therefore focused on the construction phase.

Aquatic Environment VEC – Fish and Fish Habitat KI: The CEA is presented in Section 4.16, Volume IIA of the EIS. For the Aquatic VEC, the CEA Area encompasses the lower Churchill River from the upper reaches of the lower Churchill main stem just upriver (i.e., small portion near the tailrace) from the existing Churchill Falls Power Station to Muskrat Falls and Goose Bay. It also includes all accessible tributary and stream habitat (i.e., below any obstruction to fish passage) between the Churchill Falls Power Station and Muskrat Falls. Aquatic habitat within the main stem of the lower Churchill River that is above the existing Churchill Falls Power Station is not likely to be affected by construction or operation and maintenance of the facilities on the lower Churchill River, as the extent of inundation does not extend above to the elevation of the Churchill Falls Power Station tailrace. Any flooding beyond that point would reduce the head and hence the generation capacity of the Churchill Falls Power Station. Therefore, the Churchill Falls Power Station tailrace represents the upriver boundary for the CEA. Likewise, tributaries downstream of Muskrat Falls are not likely to be affected by inundation and hence are not included within the CEA Area. Lake Melville is not included within the CEA Area as there is no substantive change in flow or salinity, water temperature, ice or other physical disturbance beyond the mouth of the Churchill River from this Project (please refer to the response to IR# JRP.43). As this is the anticipated geographic extent of Project-related environmental effects for the Aquatic Environment, it also represents the extent of potential geographic overlap of Project-related environmental effects with effects from other projects and activities. Temporally, the CEA boundaries include Project construction, and operation and maintenance.

Terrestrial VEC and KIs: As the CEA Area for the Terrestrial KIs is beyond the anticipated geographic extent of Project-related environmental effects, it also represents the extent of potential geographic overlap with effects from other projects and activities, and is the CEA Area for the Terrestrial KIs. The CEA is presented in Section 5.15, Volume IIB of the EIS.

Temporally, the CEA boundaries for the Terrestrial Environment include Project construction, operation and maintenance. The CEA considers potential interactions on a year-round basis, including animals that make seasonal movements in and out of the lower Churchill River valley. For some of the migratory species, the CEA focuses on the time of year when they are present in the lower Churchill River watershed.

Spatially, the CEA Area for the Terrestrial Environment VEC is the geographic area within which Project effects would occur for each KI. For all KIs, except caribou, the CEA Area coincides with the lower Churchill River watershed. Due to the threatened status of caribou and its nature as a species that is likely to have a large portion of its population in one geographic area at one time, the Red Wine Mountains (RWM) Caribou Herd's recent range defines the CEA Area for caribou. The CEA examines the George River Herd in this CEA Area, given the similar habitat relationships when individuals from this herd overwinter there.

With the exception of the Red Wine Mountains Caribou Herd, the KIs species have widespread distribution patterns, a relatively limited proportion of their population within the CEA Area and, therefore, a high degree of resilience (Conover et al. 1985). While some avifauna populations, including Harlequin Duck, Common Nighthawk, Grey-cheeked Thrush, Olive-sided Flycatcher and Rusty Blackbird are species of concern, they still share the same population characteristics; in central Labrador these species have a widespread distribution, and most are not restricted to specific or localized habitats.

For most of the terrestrial KIs considered in this CEA, the ranges of the species under assessment extend well beyond the lower Churchill River watershed. For KIs such as Moose, Canada Goose, Osprey and Harlequin Duck, the individuals occurring within the CEA Area are part of a larger population (e.g., the Ungava Peninsula population for Canada Goose and Osprey). However, the CEA examines interactions in detail within the CEA Area. This approach represents a compromise between choosing a large area that would mask the environmental effects of the Project (an inherent conservatism), versus choosing a smaller area where the population under consideration may no longer be meaningful at a landscape scale.

Economy, Employment and Business VEC and KIs - The CEA Area for the Economy, Employment and Business VEC and KIs was based on the geographic extent of the interactions with the Project, and the socio-economic and administrative boundaries described in Section 2.3.1 of Volume III of the EIS. The CEA Area for this VEC focuses on the Upper Lake Melville area because this is where most Project activity interactions will likely occur. The Upper Lake Melville area encompasses the communities of Happy Valley-Goose Bay, North West River, Sheshatshiu and Mud Lake. Depending on the nature of the effects being assessed, cumulative effects on Economy, Employment and Business were also assessed based on the Province as a whole, and Labrador. The CEA is presented in Sections 3.5.6, 3.6.6, and 3.7.6, Volume III of the EIS.

Cumulative environmental effects will likely occur primarily during construction, but extend through operations, and are likely to occur in those communities nearest the Project. Churchill Falls and communities in western Labrador are expected to remain unaffected by the Project because they will not be used as staging areas or as an accommodation base and are also not expected to be the source of labour for this Project.

Communities VEC and KIs - The CEA Area for the Communities VEC and KIs focuses on the Upper Lake Melville area as this is the area within which the Project will primarily interact. The potential for cumulative environmental effects within Labrador as a whole were also considered. The temporal boundaries include construction, operations and decommissioning. The CEA is presented in Sections 4.5.6, 4.6.6, and 4.7.6, Volume III of the EIS, and shown in Figure 3, attached to this response.

Land and Resource Use VEC- The CEA Area is based on the geographic extent of the interactions with the Project, and the ecological/socio-economic and administrative boundaries described in Section 2.8.1 of Volume III. The CEA is presented in Section 5.5.6, Volume III of the EIS. It extends north from the southern limits of the proposed reservoirs to the transmission lines that approximately parallel Phase I of the TLH between Happy Valley-Goose Bay and Churchill Falls. It extends from below the Churchill Falls Power Station in the west to the mouth of the Churchill River. As this is the predicted geographic extent of Project environmental effects, it also represents the extent of likely geographic overlap of Project environmental effects with effects from other projects and activities (i.e., the CEA Area).

The temporal boundaries include construction and operation and maintenance.

Cultural Heritage Resources VEC- The CEA is presented in Section 6.5.6, Volume III of the EIS. Cultural Heritage Resources are essentially fixed which limits the CEA Area to the extent of its physical disturbance. For this VEC, the CEA Area includes all areas where ground disturbance or landscape alteration will occur. Reservoir preparation and impounding will be the Project activity most likely to result in environmental effects on Cultural Heritage Resources. As this is the predicted geographic extent of Project environmental effects, it also represents the extent of likely geographic overlap of Project environmental effects with effects from other projects and activities (i.e., CEA Area).

Temporal boundaries primarily include construction, but some aspects of operations (e.g., borrow pit expansion) are also considered.

References:

CEA Agency. November, 2003. Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners.

Conover, S.A.M., K.W. Strong, T.E. Hickey, and F. Sander 1985. An evolving framework for environmental impact analysis. I Methods. Journal of Environmental Management. 21: 343-358.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

d. **discuss any potential induced development in Labrador that may arise if the Lower Churchill hydroelectric generation Project proceeds as planned;**

Response:

The potential induced development in Labrador that may arise if the Project proceeds are likely to be related to opportunities for residential, commercial/business and industrial development. The likelihood of such induced development cannot be predicted with any certainty. If and when such development may occur is not known. However, any such development that occurs will be subject to applicable governmental approvals, including environmental assessment and an evaluation of their cumulative effects as applicable.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

e. **provide a summary table showing the expected interactions between past, present and future projects, actions and events, Project components, and Key Indicators; and**

Response:

A summary of the expected interactions between past, present and reasonably foreseeable future projects, actions and events, Project components, and key indicators is provided below in Table 1. The CEA, as summarized in Table 1, assumes that the various provincial and federal laws and regulations as they relate to all projects being considered (e.g., provincial hunting regulations; *Fisheries Act*) are being adhered to, and enforced.

The following are corrections to the EIS; these corrections do not affect the conclusions. Table 4-24, Volume IIA: The Magnitude for the Construction phase was listed as "low" and should read "high". Table 5-44, Volume IIB: The Duration for the Operation and Maintenance phase was listed as "long term" and should read "permanent"; there are some positive aspects for Osprey (in addition to Moose and Ruffed Grouse) during the Operation and Maintenance Phase; for Wetland Sparrows, the magnitude was listed as "moderate", and should read "high".

Table 1 Summary of Expected Interactions between Past, Present and Future Projects, Actions and Events, Project Components, and Key Indicators

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Atmospheric Environment: Air Quality			
Construction			
NATO Special Forces	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generation Components; Concrete Production; Transmission Line Construction; Vehicular Traffic on Site; Quarrying and Borrowing; Reservoir Preparation; Transportation and Road Maintenance	Change in Air Quality	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Short term/Occasional Occurrence Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generation Components; Concrete Production; Transmission Line Construction; Vehicular Traffic on Site; Quarrying and Borrowing; Reservoir Preparation; Transportation and Road Maintenance	Change in Air Quality	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Long term/Frequent Occurrence Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Aquatic Environment			
Construction			
TLH Upgrades	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generation Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Transportation and Road Maintenance	Change in Habitat Quantity and Quality	Nature: Neutral Magnitude: High Geographic Extent: Local Duration/Frequency: Permanent/Continuous Reversibility: Reversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
Operation and Maintenance			
Cultural and Recreational Land Use	Water Management and Operating Regime; Operation of Generation Facilities	Change in Fish Distribution and Abundance	Nature: Neutral Magnitude: Low Geographic Extent: Local Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
Terrestrial Environment: George River Caribou Herd			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Long-term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades	Transportation/ Presence and Maintenance of Access Roads	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Red Wine Mountains Caribou Herd			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: High Geographic Extent: Regional Duration/Frequency: Long-term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: High Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades	Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Moose			
Construction			
Commercial Forestry	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	
NATO Special Forces Training	Impounding	Change in Health	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse (habitat alteration) and Positive (forest regeneration) Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Black Bear			
Construction			
Commercial Forestry; Cultural and Recreational Land Use	Upgrading and Constructing Site Access Roads; Transmission Line Construction; Camp Operations; Vehicular Traffic On-site; Transportation and Road Maintenance	Mortality	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
Additional Transmission; TLH Upgrades; Cultural and Recreational Land Use	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	
NATO Special Forces Training	Impounding	Change in Health	
Operation and Maintenance			
Commercial Forestry	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Beaver			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/ Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; TLH Upgrades	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/ Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Marten			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Porcupine			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use; TLH Upgrades	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Canada Goose			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; TLH Upgrades	Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Water Management and Operating Regime; Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Surf Scoter			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; TLH Upgrades	Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Water Management and Operating Regime; Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Ruffed Grouse			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse (habitat alteration) and Positive (forest regeneration) Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; Cultural and Recreational Land Use	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Osprey			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/ Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; TLH Upgrades	Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Water Management and Operating Regime; Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse (loss of natural nest sites) and positive (provision of alternate nest sites) Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/ Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Commercial Forestry; TLH Upgrades	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Wetland Sparrows			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude::High Geographic Extent: Regional Duration/Frequency: Long Term/ Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
TLH Upgrades	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction	Mortality	
Operation and Maintenance			
TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Change in Habitat	Nature: Adverse Magnitude: High Geographic Extent: Regional Duration/Frequency: Permanent/ Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
TLH Upgrades	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Terrestrial Environment: Harlequin Duck			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/ Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry; TLH Upgrades	Vehicular Traffic On-site; Transmission Line Construction; Transportation and Road Maintenance	Mortality	
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Water Management and Operating Regime; Inspection, Maintenance and Repairs along Transmission Line	Change in Habitat	Nature: Adverse Magnitude: Low Geographic Extent: Regional Duration/Frequency: Permanent/ Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Cultural and Recreational Land Use	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Mortality	
Terrestrial Environment: Other Species of Concern			
Construction			
Commercial Forestry; TLH Upgrades; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Quarrying and Borrowing; Reservoir Preparation; Impounding	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Long Term/ Continuous Reversibility: Reversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Impounding	Change in Health	
Commercial Forestry	Upgrading and Constructing Site Access Roads; Vehicular Traffic On-site; Transmission Line Construction	Mortality	

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Change in Habitat	Nature: Adverse Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/ Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
NATO Special Forces Training	Inspection, Maintenance and Repairs along Transmission Line	Change in Health	
Economy, Employment and Business: Economy			
Construction			
Voisey's Bay Mine/Mill; Labrador West Mining Developments; NATO Special Forces Training; Additional Transmission; General Economic and Infrastructure Development	Expenditures; Employment	Change in Income and Government Revenue	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Construction Phase / Continuous Level and Degree of Certainty of Knowledge: High
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; NATO Special Forces Training; Additional Transmission; General Economic and Infrastructure Development	Expenditures; Employment	Change in Income and Government Revenue	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Operation and Maintenance Phase / Continuous Level and Degree of Certainty of Knowledge: High
Economy, Employment and Business: Employment			
Construction			
Voisey's Bay Mine/Mill; Labrador West Mining Developments; TLH Upgrades; NATO Special Forces Training; Additional Transmission; General Economic and Infrastructure Development	Expenditures; Employment	Change in Employment Levels and Rates	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Construction Phase / Continuous Level and Degree of Certainty of Knowledge: High

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
Commercial Forestry; TLH Upgrades; NATO Special Forces Training; Additional Transmission; General Economic and Infrastructure Development	Expenditures; Employment	Change in Employment Levels and Rates	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Operation and Maintenance Phase / Continuous Level and Degree of Certainty of Knowledge: High
Economy, Employment and Business: Business			
Construction			
Voisey's Bay Mine/Mill; Labrador West Mining Developments; TLH Upgrades; NATO Special Forces Training; Additional Transmission	Expenditures; Employment	Change in Business Activity Levels	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Construction Phase / Continuous Level and Degree of Certainty of Knowledge: High
Operation and Maintenance			
Voisey's Bay Mine/Mill; Labrador West Mining Developments; Commercial Forestry, TLH Upgrades; NATO Special Forces Training; Additional Transmission	Expenditures; Employment	Change in Business Activity Levels	Nature: Positive Magnitude: Increase Geographic Extent: Labrador/Province Duration/Frequency: Operation and Maintenance Phase / Continuous Level and Degree of Certainty of Knowledge: High
Communities: Physical Infrastructure and Services			
Construction, Operation and Maintenance Phases			
Commercial Forestry, TLH Upgrades; NATO Special Forces Training; Additional Transmission	Employment; Transportation and Road Maintenance; Transportation/ Presence and Maintenance of Access Roads	Change in Ability to Deliver Physical Infrastructure and Services	Nature: Adverse (exceeding capacity) and Positive (upgrades of physical infrastructure) Magnitude: Low Geographic Extent: Regional Duration/Frequency: Construction and Operation and Maintenance Phase / Continuous Level and Degree of Certainty of Knowledge: High

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Communities: Social Infrastructure and Services			
Construction			
Voisey's Bay Mine/Mill; NATO Special Forces Training; General Economic and Infrastructure Development in the Upper Lake Melville Area; Additional Transmission	Expenditures; Employment; Transportation and Road Maintenance	Change in Ability to Deliver Social Infrastructure and Services	Nature: Adverse (exceeding capacity) and Positive (upgrades of social infrastructure) Magnitude: Low Geographic Extent: CEA Area Duration/Frequency: Construction Phase / Continuous Level and Degree of Certainty of Knowledge: High
Communities: Community Health			
Construction, Operation and Maintenance Phases			
Voisey's Bay Mine/Mill; NATO Special Forces Training; General Economic and Infrastructure Development; Additional Transmission	Expenditures; Employment; Transportation and Road Maintenance; Water Management and Operating Regime; Transportation/ Presence and Maintenance of Access Roads	Change in Status of Community Health Determinants	Nature: Adverse (potential increased stress and increased demand for health services and potential increased level of mercury) and Positive (potential increase in self esteem, income and social status) Magnitude: Low to Moderate Geographic Extent: CEA Area Duration/Frequency: Long-Term to Permanent/Continuous Level and Degree of Certainty of Knowledge: Moderate
Land and Resource Use			
Construction			
NATO special forces training; general economic and infrastructural development in the Upper Lake Melville Area; TLH; Labrador West Mining Development; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of generating Components; Transmission Line Construction; Vehicular Traffic On-site; Quarrying and Borrowing; Reservoir Preparation; Impounding; Employment; Transportation and Road Maintenance	Change in Land and/or Resource Use	Nature: Adverse (shift in resource use patterns) and Positive (increased access with associated increase opportunity for resource use) Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Medium-term to Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed/Undisturbed Level and Degree of Certainty of Knowledge: High

Contributing Past, Present or Future Project, Action or Event	Contributing Project Components and Activities	Nature of Cumulative Environmental Effect	Summary of Cumulative Environmental Effect
Operation and Maintenance			
NATO special forces training; general economic and infrastructural development in the Upper Lake Melville Area; Commercial Forestry; TLH Phase III	Water Management and Operating Regime; Operation of Generation Facilities; Inspection, maintenance and Repairs along Transmission Line; Employment; Transportation/ Presence and Maintenance of Access Roads	Change in Land and/or Resource Use	Nature: Adverse (shift in resource use patterns) and Positive (increased access with associated increase opportunity for resource use) Magnitude: Moderate Geographic Extent: Regional Duration/Frequency: Permanent/Continuous Reversibility: Irreversible Ecological Context: Disturbed Level and Degree of Certainty of Knowledge: High
Cultural Heritage Resources			
Construction			
Cultural and Recreational Land Use; TLH; Additional Transmission	Upgrading and Constructing Site Access Roads; Site Preparation and Construction of Site Buildings; Excavation for and Installation of Generating Components; Transmission Line Construction; Camp Operations; Quarrying and Borrowing; Reservoir Preparation; Impounding	Loss/Disturbance of cultural heritage resources	Nature: Adverse Magnitude: 44 Historic and Archaeological sites and 1 cultural/spiritual site lost or disturbed as a result of Project Geographic Extent: Site-specific Duration/Frequency: Permanent / occurs once Reversibility: Irreversible Ecological Context: Undisturbed Level and Degree of Certainty of Knowledge: High
Operation and Maintenance			
Commercial Forestry; Cultural and Recreational Land Use; TLH; Additional Transmission	Inspection, Maintenance and Repairs along Transmission Line; Transportation/ Presence and Maintenance of Access Roads	Loss/Disturbance of cultural heritage resources	Nature: Adverse Magnitude: No known sites lost or disturbed Geographic Extent: Site-specific Duration/Frequency: Permanent / occurs sporadically at irregular intervals Reversibility: Irreversible Ecological Context: Developed Level and Degree of Certainty of Knowledge: High

Requesting Organization – Joint Review Panel **Information Request No.: JRP.97**

Information Requested:

The Proponent is asked to:

f. **provide a comprehensive summary of the cumulative effects assessment, revised on the basis of the preceding points, together with a map or maps in GIS format, indicating the relationship of the Project with the other projects or activities included in the cumulative effects analysis and the nature of the overlapping impacts.**

Response:

Based on the foregoing, no revisions to the CEA conducted for the Project are required. The table provided in response to part (e) provides a comprehensive summary of the CEA presented in the EIS and incorporates clarifications. Figure 1 shows the locations of the other projects and activities discussed in the CEA in relation to the Project. Figures 2 and 3 show the various CEA Areas, as they relate to the biophysical and socio-economic components, respectively. The nature of the overlapping impacts are provided in Table 1, and discussed, in part (e) of this response.

Figure 1 Existing and Proposed Activities in Central Labrador

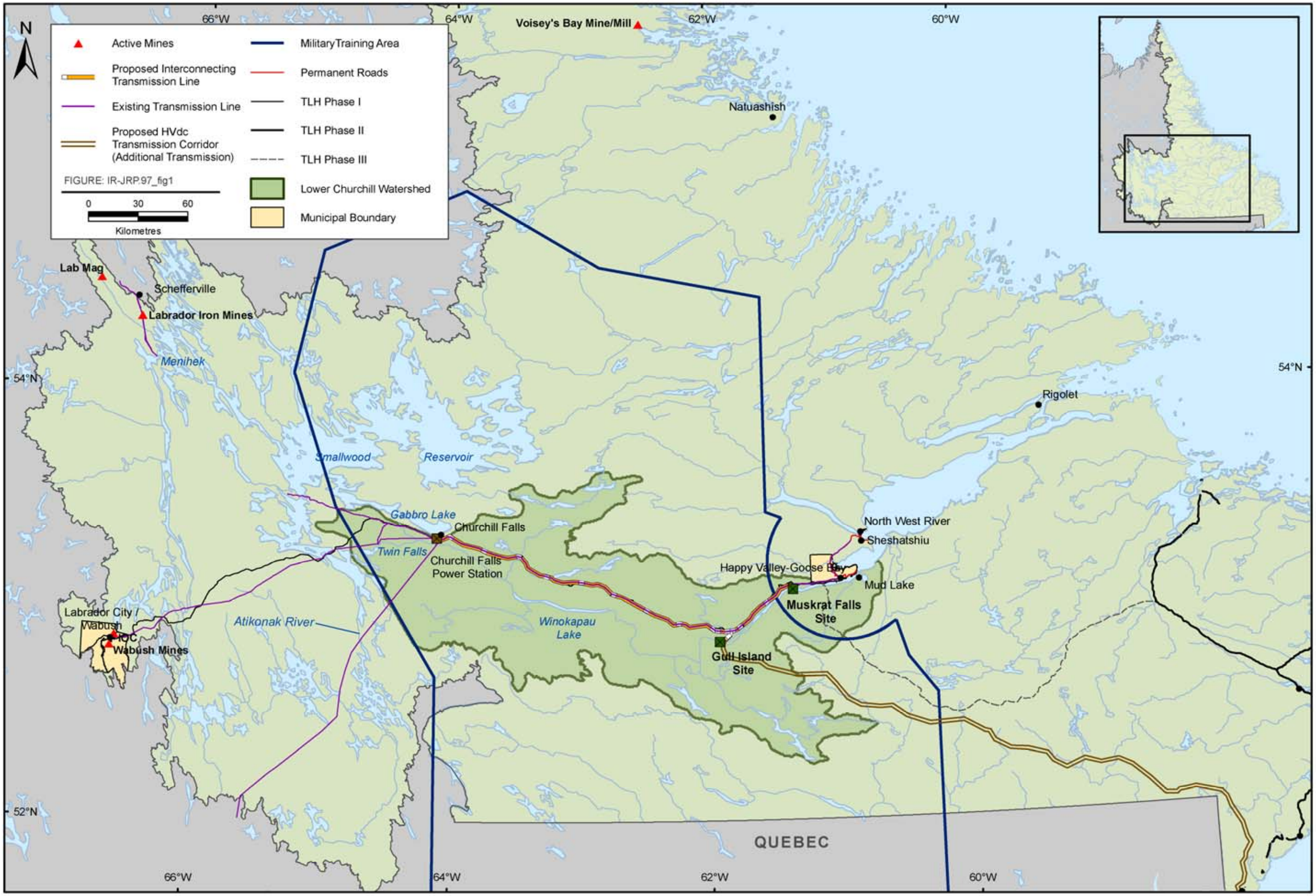


Figure 2 **Biophysical Cumulative Effects Assessment Areas and Other Projects and Activities**

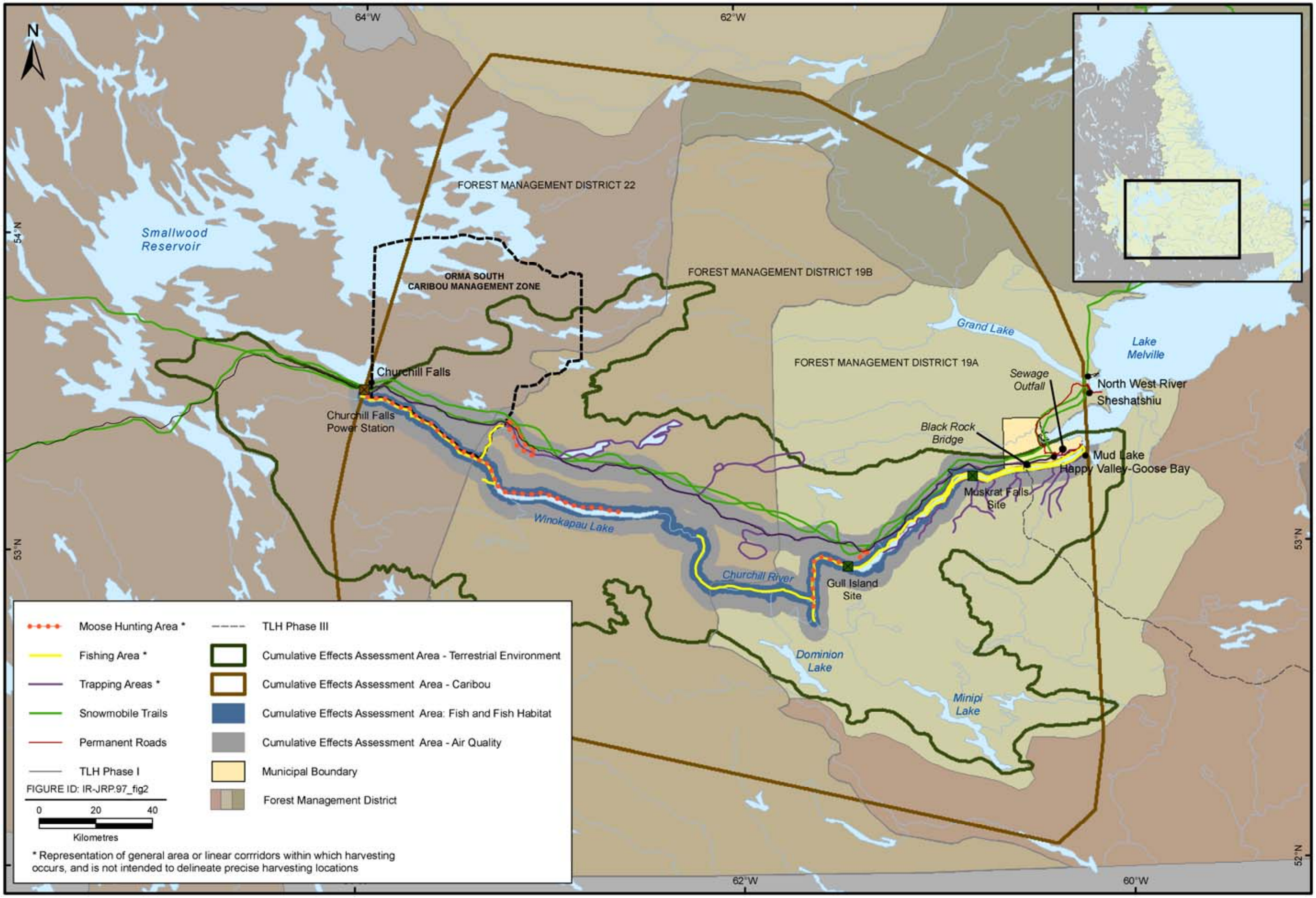
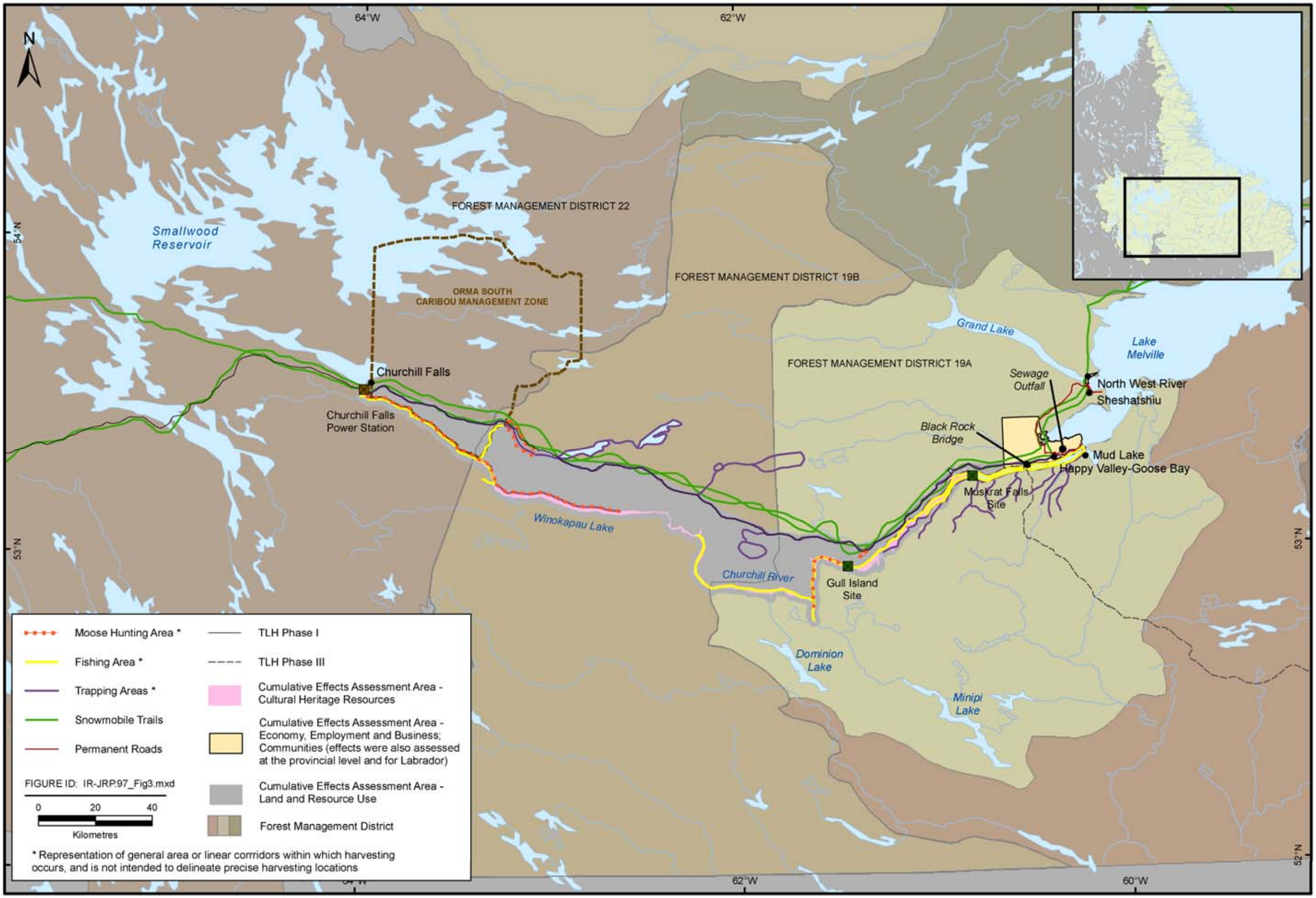


Figure 3 Socio-Economic Cumulative Effects Assessment Areas and Other Projects and Activities



IR# JRP.98

Capacity of Renewable Resources

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Subject - Capacity of Renewable Resources

References:

EIS Guidelines, Section 4.5.4 (Renewable Resources)

EIS Volume IB, Section 9.11 (Sustainability)

EIS Volume IIB, Section 7.4.2 (The Capacity of Renewable Resources that are Likely to be Significantly Affected)

Volume III, Section 8.4.2 (The Capacity of Renewable Resources that are Likely to be Significantly Affected)

Related Comments / Information Requests:

CEAR # 184 (Sierra Club Atlantic)
CEAR # 185 (S. Pottle -Memorial University of Newfoundland, Faculty Submission)

Rationale:

The EIS Guidelines define renewable resources as those that can be renewed on a regular basis, either naturally or by human action. While the emphasis is placed on living renewable resources such as fish, wildlife and forest, the analysis of effects should also consider non-living renewable resources. The analysis should consider consumptive (i.e. forestry) as well as non-consumptive (i.e. recreational and aesthetic) uses.

Although the EIS determines that the environmental effects on renewable resources will not be significant (Vol. IIB, p.7-10. Vol. III, p.8-10), at present, the EIS does not provide a thorough description of what has been considered as a renewable resource or provide the detailed analysis as to how significance was determined including thresholds applied.

In addition, Nalcor states that, despite the 'not significant' determination, it "is planning to apply effects management measures to reduce adverse environmental effects on animal and plant species that may be affected. Environmental effects to game species such as caribou, moose, black bear, waterfowl, furbearers and to non-game species will be mitigated to help achieve population sustainability" (emphasis added).(Vol. III, p.8-10). No description of the proposed mitigation is provided.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

The Proponent is asked to:

a. **provide a list, and where not previously described in the Environmental Impact Statement (EIS), a thorough description of those living and non-living components that have been considered as renewable resources, clearly identifying those that are considered Valued Environmental Components Key Indicators (VECs/KIs) in the EIS and any other renewable resources that were identified in either the analyses of environmental effects, or cumulative effects, as being affected by the Project. Renewable resources should include living renewable resources (fish, wildlife, vegetation, forest, etc.), as well as non-living renewable resources (water quality, water quantity, landscape features, etc.);**

   When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources;

Response:

Table 1 provides a listing of all of the living and non-living renewable resources located within the Assessment Area and considered within the EIS as having the potential to be affected by the Project. The table also provides references to where a description of the resource can be found in the EIS.

Note that some resources considered within the EIS including Red Wine Mountains Caribou Herd, Raptors (Osprey), Forest Songbirds (Wetland Sparrows), Harlequin Duck and Other Species of Concern are considered a non-consumptive renewable resource due to their nature or their populations status (e.g., hunting of Harlequin Duck is not permitted due to their conservation status).

It is also important to note that the Project itself represents a non-consumptive use of the Churchill River as a renewable resource. The Churchill River is recognized as a significant, long term, reliable source of renewable hydroelectric energy, which has yet to be fully developed. Development of the untapped hydroelectric potential on the Churchill River will contribute benefits to the Province as a long term renewable energy supply and a source of revenue. Renewable electricity from the lower Churchill River will potentially eliminate the need for the thermal generating station at Holyrood. As well, excess electricity from the Project has the potential to displace existing fossil-fuel generation in export markets.

The IR requests that the proponent consider that both the population in question and the ecosystem as a whole should play an important role in determining the capacity of renewable resources. While both the *Canadian Environmental Assessment Act* (Section 16(2)(d)) and the EIS Guidelines (Section 4.5.4) require that the capacity of renewable resources only be evaluated for those resources likely to be significantly affected by the Project, Nalcor Energy (Nalcor) has considered the importance of the ecosystem as a whole throughout the environmental assessment. The biophysical VECs selected for the assessment were purposefully broad (e.g., Aquatic Environment and Terrestrial Environment) to allow consideration of the ecosystem as a whole. The selected KIs allow the assessment to focus on specific issues and species as required and appropriate. The environmental effects analyses for the VECs include consideration of potential Project-related environmental effects on biodiversity and ecosystem health, as well as on specific populations.

Table 1 Summary of Consideration of Renewable Resources Within The EIS

Renewable Resource	How and Where Described in the EIS	Uses/Activities Considered and Whether Use if Consumptive (C) and/or Non-Consumptive (NC)			Statement of Significance of Project Effects and EIS Reference for Supporting Rationale*	Cumulative Effects Discussion and Supporting EIS Reference **
		Use/Activity	C	NC		
Air Quality (Non-living)	Atmospheric Environment KI – Volume IIA, Section 2.2.5	Public Health		✓	Not Significant – Volume IIA, Section 3.10.2	Volume IIA, Section 3.11
River Environment, including Water Quality and Quantity (Non-living)	Aquatic Environment VEC – Volume IIA, Section 2.3.3 and Land and Resource Use VEC - Volume III, Section 2.8	Navigation and Recreational Travel		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Outfitting		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Ecotourism		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Innu Land and Resource Use		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Other Water Uses	✓	✓	Not Significant – Project related environmental effects will not be of sufficient nature or magnitude to preclude other water uses.	Project related environmental effects in combination with other past, present and reasonably foreseeable projects and activities will not be of sufficient nature or magnitude to preclude other water uses.
Fish and Fish Habitat (including seals) (Living and non-living)	Aquatic Environment VEC - Volume IIA, Sections 2.3.4 to 2.3.7 and Land and Resource Use VEC - Volume III, Section 2.8	Angling for consumption and for outfitting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Hunting of seals	✓		Not Applicable– Volume IIA, Section 2.3.1 (Project effects will not extend into Lake Mellville)	Volume IIA, Section 2.3.1 (Project effects will not extend into Lake Mellville)
Forests, Other Vegetation and Landscapes (Living and Non-Living)	Terrestrial Environment VEC (Ecological Land Classification) – Volume IIA, Section 2.4.2 and Land and Resource Use VEC - Volume III, Section 2.8	Forestry	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Innu Land and Resource Use	✓	✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Recreational Use (camping, cottages, cross country skiing, snowmobiling)		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7

Renewable Resource	How and Where Described in the EIS	Uses/Activities Considered and Whether Use if Consumptive (C) and/or Non-Consumptive (NC)			Statement of Significance of Project Effects and EIS Reference for Supporting Rationale*	Cumulative Effects Discussion and Supporting EIS Reference **
		Use/Activity	C	NC		
Forests, Other Vegetation and Landscapes (Living and Non-Living) cont.	Terrestrial Environment VEC (Ecological Land Classification) – Volume IIA, Section 2.4.2 and Land and Resource Use VEC - Volume III, Section 2.8 cont.	Special Areas	✓	✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Berry Picking and Medicinal Plants	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Agriculture	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
		Municipal Land Use		✓	Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
George River Caribou Herd (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.3 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume IIB, Section 5.5.6 and 5.5.7
Red Wine Mountains Caribou Herd (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.4	Hunting of this species is currently illegal due to its conservation status and therefore is classified as non-consumptive		✓	Not Significant – Volume IIB, Section 5.14.2	The residual environmental effect associated with the Project is not significant. - Volume III, Section 5.15.4.2.
Moose (Living)	Terrestrial Environment KI - Volume IIA, Section 2.4.5 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Black Bear (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.6 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Furbearer - Beaver (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.7 and Land and Resource Use VEC - Volume III, Section 2.8	Trapping	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Furbearer - Marten (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.8 and Land and Resource Use VEC - Volume III, Section 2.8	Trapping	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7

Renewable Resource	How and Where Described in the EIS	Uses/Activities Considered and Whether Use if Consumptive (C) and/or Non-Consumptive (NC)			Statement of Significance of Project Effects and EIS Reference for Supporting Rationale*	Cumulative Effects Discussion and Supporting EIS Reference **
		Use/Activity	C	NC		
Porcupine (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.9 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Waterfowl – Canada Goose (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.10 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Waterfowl - Surf Scoter (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.11 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Upland Birds - Ruffed Grouse (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.12 and Land and Resource Use VEC - Volume III, Section 2.8	Hunting	✓		Not Significant – Volume III, Section 5.5 and 5.6	Volume III, Section 5.5.6 and 5.5.7
Raptors – Osprey (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.13			✓	Not Significant – Volume IIB, Section 5.14.11	Volume IIB, Section 5.15.4.11
Forest Songbirds – Wetland Sparrows (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.14			✓	Not Significant – Volume IIB, Section 5.14.12	Volume IIB, Section 5.15.4.12
Species of Concern – Harlequin Duck (Living)	Terrestrial Environment KI – Volume IIA, Section 2.4.15	Hunting of this species is currently illegal due to its conservation status and therefore is classified as non-consumptive		✓	Not Significant – Volume IIB, Section 5.14.13	Volume IIB, Section 5.15.4.13
Other Species of Concern	Terrestrial Environment KI – Volume IIA, Section 2.4.16			✓	Not Significant – Volume IIB, Section 5.14.14	Volume IIB, Section 5.15.4.14

* Effects prediction are supported by the residual environmental effects summary tables presented in Volume IIA, Appendix IIA-A, Volume IIB, Appendix IIB-A, and Volume III, Appendix III-B.

** Cumulative effects prediction are supported by the cumulative environmental effects summary tables presented in Volume IIA, Appendix IIA-A, Volume IIB, Appendix IIB-A, and Volume III, Appendix III-B.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

The Proponent is asked to:

b. **clearly identify which consumptive and non-consumptive renewable resource uses have been considered, and how existing and future needs have been determined; and**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

The consumptive and non-consumptive renewable resource uses that have been considered for each of the identified resources are included in Table 1. Consistent with Section 16(2)(d) of *CEAA* and the EIS Guidelines (Section 4.5.4), the EIS predictions are based on the conclusion that the Project will not cause any significant adverse environmental effects on any resources, after mitigation, and therefore, the capacity of renewable resources to meet existing and future needs will not be compromised.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

The Proponent is asked to:

c. **provide a clear statement as to whether each of the listed resources are likely to be significantly affected by the Project. The theory and rationale for the significance determination should be provided. Determinations should take into account location and access factors.**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

A statement as to whether each of the listed resources is likely to be significantly affected by the Project is included in Table 1. The theory and rationale for the significance determinations are provided in the relevant EIS sections as referenced in Table 1. Further information on the rationale for selection of significance definitions is provided in the response to IR# JRP.116.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource identified the Proponent is asked to:

d. **specify whether the renewable resource is consumptive and/or non-consumptive;**

   When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Table 1 indicates whether each of the resource uses considered are consumptive and/or non-consumptive. Please refer as well to the response provided for part (a).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource identified the Proponent is asked to:

e. **provide a clear statement as to whether each of the listed resources are likely to be significantly affected by the Project including the theory and rationale behind this determination and a brief description of the Project's environmental effects on the renewable resource; and**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

A statement as to whether each of the listed resources is likely to be significantly affected by the Project is included in Table 1. The theory and rationale for the significance determinations are provided in the relevant EIS sections as referenced in Table 1. Further information on the rationale for selection of significance definitions is provided in the response to IR# JRP.116.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

The Proponent is asked to:

For each renewable resource <u>identified</u> the Proponent is asked to:

f. **provide a discussion of the cumulative impacts on each of the renewable resources listed.**

   When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Table 1 refers the reviewer to the appropriate section of the EIS in which the cumulative effects on each of the listed renewable resources are discussed. Further information on the cumulative effects assessment is also found in the response to IR# JRP.97.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource, identified above, that the Proponent determines <u>is likely to be significantly affected by the Project</u>, the Proponent is asked to provide:

g. **a determination of the capacity of the resource to meet current needs;**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

The Project is not predicted to cause any adverse significant environmental effects because of one or more factors related to the resilience of the species assessed. For each KI within the Aquatic and Terrestrial Environment VECs, a relatively small proportion of primary habitat for a particular KI will change, and/or the size and specific home range needs of individuals can be accommodated in the areas that remain, during the implementation of the Project. Therefore, the sustainability of populations will not be compromised. In addition, significant adverse effects were also not predicted for any of the Land and Resource Uses evaluated in the EIS. Refer to Volume IIB, Section 7.4.2 and Volume III, Section 8.4.2 for further discussion.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource, identified above, that the Proponent determines <u>is likely to be significantly affected by the Project</u>, the Proponent is asked to provide:

h. a determination of the capacity of the resource to meet future needs;

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Please refer to the response provided for part (g) and to Table 1.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Request:

For each renewable resource, identified above, that the Proponent determines <u>is likely to be significantly affected by the Project</u>, the Proponent is asked to provide:

i. **a description of any other appropriate mitigation measures;**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Please refer to the response provided for part (g) and to Table 1.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource, identified above, that the Proponent determines <u>is likely to be significantly affected by the Project</u>, the Proponent is asked to provide:

j. **a determination of the significance of the residual effects on the renewable resource and its capacity to meet the needs of current and future generations; and**

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Please refer to the response provided for part (g) and to Table 1.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.98**

Information Requested:

For each renewable resource, identified above, that the Proponent determines <u>is likely to be significantly affected by the Project</u>, the Proponent is asked to provide:

k. an identification of the risks and uncertainties that remain and a description of the next steps, if any, that will be required to address this effect.

When assessing the above points, the Proponent should consider that both the population in question and the ecosystem as a whole play an important role in determining the capacity of renewable resources.

Response:

Please refer to the response provided for part (g) and to Table 1.

IR# JRP.99

Application of Climate Change to Project

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Subject - Application of Climate Change to Project

References:

EIS Volume IA, Section 10.5.1 (Consideration of Environmental Factors in Design – Generation Facilities

International Panel on Climate Change (IPCC) Fourth Assessment Report. Accessed: http://www.ipcc.ch/ipccreports/ar4-syr.htm

Related Comments / Information Requests:

CEAR # 173 (Environment Canada)
CEAR # 184 (Sierra Club Atlantic)

IRs # JRP.7, 27, 46, 85, 100

Rationale:

The guidelines require that the Proponent describe the predicted future condition of the environment within the expected life span of the Project, if the Project were not to proceed. This aids in distinguishing Project related effects from environmental change due to natural processes and is to include a discussion of climate change.

In the Environmental Impact Statement (EIS) (Section 10.5.1, Para 4 Page 10-15) the Proponent describes the projected changes to precipitation on a seasonal scale. Such values will provide insight into the “mean” changes in climate. However changes are also projected for extreme precipitation amounts but it is not clear whether these were factored into design considerations.

In the EIS Section 10.5.1.6 (Para 2 Page 10-19) the Proponent makes it clear that projections of climate change are well within the estimates of changes factored into the dam’s design, however given comments made above regarding extreme precipitation events, it is not clear how the Proponent has incorporated information on changing return periods for extreme events into its design criteria.

In Section 10.5.1(Para 5 Page 10-15) of the EIS the Proponent describes sea level rise as determined partially by “melting of polar ice caps”. The Arctic Ice Cap and portion of the

Antarctic Ice Caps are floating in the ocean and hence any melt of this ice would not significantly raise global sea levels (Environment Canada submission). Statements in the EIS do not accurately reflect current understanding of sea level rise drivers. In addition, the Proponent identifies sea level rise values that have been taken from International Panel on Climate Change (IPCC) 2007. While these values are correct they are generated by one emission scenario (A1B). Across all emission scenarios the projection for sea level rise is 0.18-0.59 m by 2100 (IPCC SPM 2007 page 13). The Proponent then uses a 0.5 m estimate of sea level rise to determine the impact at Muskrat Falls (Section 10.5.1.6, para 1) but does not explain how this value was reached.

Recent work done by Memorial University of Newfoundland points to current sea level decreases at Lake Mellville in a range of 1-2 mm per year, predominantly due to isostatic rebound. The EIS does not indicate whether sea level decrease was factored into the determination of sea level impacts at Goose Bay and Muskrat Falls.

The Proponent indicates (Section 10.5.1.6, Para 4 Page 10-19) that it has initiated research into climate change impacts for the Project; however no further details are given.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

a. **explain how climate change will impact on water temperature and precipitation;**

Response:

Observed changes in the water temperature of lakes in North America indicate an increase of 0.1 – 1.5°C (Bates et al. 2008) over the past century. While the resolution of existing IPCC models does not allow for a reasonable projection of water temperature in the Churchill River region, it is expected to increase globally.

Mean annual precipitation in the region is expected to increase 10 to 15 present from 1980 to 1999 levels by 2080 to 2099. Precipitation variance (i.e., extreme events) is also expected to increase over this time (Bates et al. 2008).

Reference:

Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof (eds). 2008. Climate Change and Water. Intergovernmental Panel on Climate Change Technical Paper VI. IPCC Secretariat, Geneva, 210pp.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

b. **explain how changes in extreme precipitation amounts were factored into design considerations;**

Response:

Severe weather is predicted to become more frequent and more severe across the world; however, there has been little study to date on the potential for increased severe weather in Labrador. The current design is robust and any increase in the frequency of extreme events is within the accuracy of the probable maximum flood (PMF) estimate.

The critical PMF scenario for the upper and lower Churchill River basin based on the 2007 engineering studies is a combination of a 100-year snow pack, a severe temperature sequence, and the spring probable maximum precipitation (PMP) event. This was done as per the Canadian Dam Association Dam Safety Guidelines (Canadian Dam Association 2007). Warmer air has the potential to hold more moisture which could lead to an increase in the PMP; however, the critical scenario for the Churchill River basin is in the spring when there is expected to be little change in air temperatures. Further, warmer winter temperatures would lead to a reduction in the 100-year snow pack. These reasons suggest that climate change should have little effect on the magnitude of the PMF estimate. An increased summer PMP is not expected to result in a PMF more severe than the spring PMF currently being used for design.

The proponent will continue to conduct and monitor the findings of ongoing climate change research, and revisit the PMF estimate if warranted. Adaptation strategies that may be employed include increasing the spillway capacity of the dams and modifying flood-handling procedures.

Reference:

Canadian Dam Association. 2007. Dam Safety Guidelines 2007.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

c. **explain how information on changing return periods for extreme events will be incorporated into design criteria;**

Response:

See response to part (b).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

d. clarify statements with respect to sea-level rise based on current understanding of sea level rise drivers;

Response:

While it is true that the melting of floating ice shelves would not significantly raise sea levels, there is growing evidence to show that Antarctic and Greenland glaciers (partially fed from the ice sheets) are losing mass at an increasing rate (Rignot 2008, Velicogna and Wahr 2006). This means that more ice is flowing into the sea than can be accumulated from snowfall, resulting in a net rise in sea level.

References:

Rignot, E. 2008. Changes in West Antarctic ice stream dynamics observed with ALOS PALSAR data. Geophysical Research Letters. 35: LI2505, doi:10.1029/2008GL033365, USA.

Velicogna, I.and J. Wahr. 2006. Acceleration of Greenland ice mass loss in spring 2004. Nature. 443: 329–331. 21 September 2006, USA.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

e. **explain how the proponent decided on a particular sea-level value, given the range of IPCC projections on sea-level rise under the other emissions scenarios. Did it evolve from the IPCC values quoted earlier? Does it include crustal subsidence or isostatic rebound;**

Response:

The 0.5 m estimate of sea-level rise was chosen as a value near the high end of the 0.18 to 0.59 m scale (encompasses all emissions scenarios). The value does not include crustal subsidence or isostatic rebound, which are discussed IR# JRP.99(f).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

f. **provide an explanation as to how isostatic rebound was factored into the determination of sea lever impacts at Goose Bay and Muskrat Falls;**

Response:

At present, sea level continues to fall in the Lake Mellville region, in response to glacioisostatic rebound, at the estimated rate of 1 to 2 mm/yr (Catto 2007). According to the most recent IPCC report (Bindoff et al. 2007) the average global sea-level rise will likely be between 0.18 to 0.59 m at a rate of increase of 1.5 to 9.7 mm/yr by the end of the 21st century.

The global mean rate of sea level increase at the time of the original study approximating the isostatic rebound in the Lake Mellville area (Catto and Jacques Whitford 1998) was 1.7 mm/yr (Meehl et al. 2007). Taking into account that sea level is falling at a rate of 1 to 2 mm/yr in the region, one can deduce that isostatic rebound is causing the land under and around Lake Mellville to rise by 2.7 to 3.7 mm/yr (e.g., if global mean sea level rise is 1.7 mm/yr and sea level is falling in Lake Mellville at 1 mm/yr then isostatic rebound occurs at a rate of 2.7 mm/yr).

Assuming a linear trend in the global mean sea level increase rate (from the approximated value of 1.7 mm/yr to the extremes of 1.5 and 9.7 mm/yr) between now and 2100, the average rate of increase in sea level rise in the Lake Mellville area could be between -2.1 and 3 mm/yr. Therefore, a rough approximation of net sea level rises for the area is from -0.19 to 0.27 m. However, given that there is a regional variation of +/- 0.15 m (Catto 2007), one can conclude that the approximate range of sea level rise for Lake Mellville by 2100 is from -0.34 to 0.42 m. Of course, within these rough calculations are several assumptions and a great deal of uncertainty.

Any decrease in sea level would produce a net benefit for the Muskrat Falls installation and would not be of a magnitude to warrant design modification. Also, as mentioned in Volume IA, Section 10.5.1.6 of the EIS, sea-level rise of this magnitude is well within the current project design and the economic feasibility of the project will not be affected.

References:

Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan. 2007. Observations: Oceanic Climate Change and Sea Level. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller – eds.). Cambridge University Press, United Kingdom and USA.

Catto, N. 2007. Impacts of Climate Change and Variation on the Natural Areas of Newfoundland and Labrador. Canadian Climate Impacts and Adaptation Research Network, Canada.

Catto, N.R. and Jacques Whitford Ltd. 1998. Geomorphology and Sea Level History, Lower Churchill River- Lake Mellville region, Labrador. Commissioned report to Newfoundland Power, Labrador Hydro Project, Canada.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao. 2007. Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller – eds.). Cambridge University Press, United Kingdom and USA.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

g. discuss the scope and timelines of the proposed climate change research; and

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Response:

The research scope of the proposed climate change research encompasses modeling the effects of climate change on the hydrological cycle in the Churchill River basin. This includes output variables such as the mean timing, amount and variability (i.e. extremes) of precipitation, river runoff and air temperature. This requires the use and coupling of customized regional climate models and hydrological models.

The expected timeline is as follows:

2009 Conduct background climate change work including: compilation of relevant studies (e.g., IPCC reports); investigation into regional climate models (both numerical modeling and physical processes) and hydrological models; development and application of hydrologic modeling using existing data from previous studies;

2010 Refine and customize regional climate and hydrological models for the Churchill River basin. Attempt to reduce uncertainty in models (e.g., improve a regional climate model's ability to synthetically generate stream flow) while conducting runs that apply various scenarios;

2011 Continue with uncertainty reduction and conclude initial modeling runs. Explore additional research opportunities (e.g., reservoir evaporation rates and effects of ice-cover); and

2012 Continued exploration of additional research opportunities and incorporation into climate and hydrological modeling work.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.99**

Information Requested:

The Proponent is asked to:

h. outline how the proponent will respond to the various possible outcomes of further climate change studies in terms of mitigation, adaptive management, and changes to project design.

Response:

Under current climate change projections it is not anticipated that climate change will substantially affect the development of the Project. The current design is robust and can accommodate changes in extreme weather events and will allow the hydraulic structures to operate in a safe manner. Current projections regarding effects on the hydrological cycle also indicate that these changes will not affect the operability and economic viability of the Project. As the climate change research progresses there will be an improved understanding of the local changes to the hydrological cycle as a result of climate change. This understanding will then be used to develop an adaptive management strategy for water management and flood handling procedures.

IR# JRP.100

Mitigation Measures (Air Quality)

Requesting Organization – Joint Review Panel **Information Request No.: JRP.100**

Subject - Mitigation Measures (Air Quality)

References:

EIS Guidelines, Section 4.6.1 (Mitigation Measures)

EIS Volume IIA, Section 3.8 (Environmental Effects Management)

Related Comments / Information Requests:

CEAR # 184 (Sierra Club Atlantic)

IR#s JRP.7, JRP.27, JRP.46, JRP.85, JRP.88, JRP.99

Rationale:

The EIS Volume IIA states that an Environmental Protection Plan (EPP) will be implemented. The EPP "[w]ill describe, for site personnel, the appropriate procedures consistent with legislation and best practices to reduce environmental effects." However, there are no details provided on mitigation measures that would be implemented should the air emissions (air quality standards and GHG emissions) turn out to be higher than anticipated. The document doesn't specify the measures the Proponent intends to put in place to minimize fuel consumption and there are no commitments to use fuel and/or energy efficient equipment during construction, operation and maintenance.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.100**

Information Requested:

The Proponent is asked to provide further information on mitigation measures that would be implemented to ensure air quality standards are met throughout construction, operation, and maintenance, and to keep GHG emissions at a minimum level throughout construction, operation, and maintenance.

Response:

Since the majority of emissions during construction of the proposed Project will result from diesel fuel combustion in vehicles and heavy equipment, compliance with applicable regulations associated with the operation of such vehicles is the primary compliance measure.

The Newfoundland and Labrador *Air Pollution Control Regulations*, 2004 specify emissions limits for light and heavy duty vehicles, and equipment will be maintained to ensure compliance with these standards. In the unlikely event that air quality objectives set forth in the regulations cannot be achieved, the regulations require that an air quality management plan be developed by the Minister of Environment and Conservation. Nalcor Energy (Nalcor) will cooperate with the Department of Environment and Conservation in the development and implementation of such a plan if it is found to be required.

Other opportunities to reduce emissions and improve air quality are related to efforts to reduce fuel consumption, which also leads to reduced costs for equipment operators. Nalcor will communicate the opportunities to improve fuel economy, and the savings that can accrue to operators during the course of construction.

The following highlights some potential opportunities:

- **Reduction in Fuel Usage:**
    - The following actions represent areas for potential reduction in fuel usage:
        - reduce the amount of time vehicles idle by implementing a “no idle or minimum” policy;
        - reduce unnecessary weight being carried in vehicles by removing extra/unwanted equipment and tools; and
        - travel at recommended speeds for optimal fuel efficiency while respecting speed limits.
- **Increase Fuel Efficiency:**
    - The following actions represent areas for potential increased fuel efficiency in construction equipment:
        - uphold maintenance schedules on all vehicles and equipment;
        - maintain optimal tire pressure, clean air filters, proper wheel alignment, as well as regular oil changes and engine tune-ups;
        - replace gas caps tightly after re-fuelling to prevent evaporation of fuel; and
        - maintain logs of mileage and fuel purchases to allow for fuel consumption tracking.

- **Fleet Management:**
  - evaluate the life cycle cost of equipment used during construction, and consider both vehicle cost and the cost of fuel to minimize total costs; and
  - select the appropriate vehicles for the task at hand, and encourage the purchase of smaller vehicles where possible.
- **Reduce Vehicle Trips:**
  - establish mass transport from Happy Valley-Goose Bay to the site to reduce the number of vehicles travelling to and from the work site; and

Efforts to reduce fuel use and improve fuel economy will result in commensurate reductions in GHGs, but no independent GHG reduction initiatives are contemplated during construction.

Mitigation of Operational GHG Emissions

The primary source of GHG emissions from the Project during operation is from the reservoir, but mitigation of GHG emissions resulting from reservoir inundation has received little attention in the literature. As a result, many of the operational GHG emissions, such as biomass inundation present limited viable options for mitigation. As outlined in IPCC (2006) emissions resulting from land-use change are relative to the land area converted from forest to non-forested land.

Reduce Biomass Removal and Decomposition

Opportunities to reduce biomass removal and decomposition associated with reservoir clearing do exist, and while some information is available regarding the rate of organic matter decomposition in aquatic systems and the preservation of organic matter in cold, anoxic conditions (Bilby et al. 1999; Harmon et al. 2000; Jordan 2001; Scherer 2004), very little information regarding the burial of biomass from the perspective of preventing decomposition in reservoirs is available.

Wood burial has been recently studied for its potential in GHG reduction and CO_2 storage (Cook et al. 2008; Zeng 2008). In most cases, this approach is considered for old and/or dead trees and compared to other carbon capture methods (e.g., storing captured CO_2 in geological formations). Considering wood burial as an alternative to wood removal in a hydroelectric development is a more complicated issue, especially when considering competing alternate uses of the wood, such as making it available for the marketplace.

There are, however, some known benefits and drawbacks to wood burial in terms of GHG emissions and carbon sequestration. Some of the known benefits are as follows:

- anaerobic conditions under a sufficiently thick layer of soil will substantially slow and possibly prevent the decomposition of the buried wood, thus forming an effective carbon sink; and
- when compared to other carbon sequestration options, wood burial is lower than the typical cost for power plant CO_2 capture with geological storage. The low cost for carbon sequestration with wood burial is possible because the technique uses the natural process of photosynthesis to remove carbon from the atmosphere (Cook et al. 2008; Zeng 2008) and the cost to excavate and cover the wood is relatively inexpensive.

Some potential drawbacks include:

- emissions from and cost of operating the heavy equipment necessary for burial;
- transportation of wood to a suitable site where soil is deep enough to dig burial trenches.
- where site selection is limited to an area with risk for some aerobic conditions to persist, additional means may need to be taken to further reduce soil oxygen concentrations (e.g., sealing the ground with an impenetrable substance);
- habitat loss, forest floor disturbance and the potential for subsequent environmental effects at the burial site, especially if site selection requires biomass to be buried outside the current Project area;
    - For example, digging trenches may harm forest regeneration capability, biodiversity and cause significant loss of soil carbon.
    - Nutrient lockup can be a concern as nutrients are already a limitation for plant growth in some forest ecosystems (Zeng 2008).
- potential for methane emissions if decomposition of carbon is not stopped by anoxic conditions. This is a concern given that CH_4 has a 100 year global warming potential 21 times that of CO_2 (Intergovernmental Panel on Climate Change [IPCC] 2006).

References:

Bilby, R., J. Heffner, B. Fransen, J. Ward and P. Bisson. 1999. Effects of immersion in water on deterioration of wood from five species of trees used for habitat enhancement projects. North American Journal of Fisheries Management, Vol. 19: 687-695.

Cook, B, N. Zeng, B. Zaitchik and J. Gregg. 2008. How burying biomass can contribute to CO2 stabilization. American Geophysical Union, Fall Meeting 2008, abstract #B22C-04.

Harmon, M. E., O.N. Krankina and J. Sexton. 2000. Decomposition vectors: a new approach to estimating woody detritus decomposition dynamics. Canadian Journal of Forest Research, Vol. 30, pp. 76-84.

IPCC (Intergovernmental Panel on Climate Change). 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe (eds.). Published: IGES, Japan.

Jordan, B.A. 2001. Site characteristics impacting the survival of historic waterlogged wood: A review. Int. Biodeterior. Biodegrad., Vol. 47: 47-54.

Scherer, R. 2004. Decomposition and longevity of in-stream woody debris: a review of literature from North America, pp. 127-133 In G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest Land–Fish Conference – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Zeng, N. 2008. Carbon sequestration via wood burial. Carbon Balance Manag. 3:1, Doi: 10.1186/1750-0680-3-1.

IR# JRP.101

Mitigation Measures (Riparian Habitat)

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Subject - Mitigation Measures (Riparian Habitat)

References:

EIS Executive Summary

EIS Guidelines, Section 4.6.1 (Mitigation)

EIS Volume IIB, Section 5.0 (Environmental Effects Assessment - Terrestrial Environment)

EIS Volume III, Section 5.6 (Summary of Residual Environmental Effects and Evaluation of Significance)

Related Comments / Information Requests:

CEAR #169 (A. Lutterman)
CEAR # 184 (Sierra Club Atlantic)
CEAR # 200 (Grand Riverkeeper Labrador Inc.)

Rationale:

Throughout the EIS the Proponent has stated an intention to mitigate damage to the riparian environment caused by reservoir impoundment through restitution; specifically through offset of riparian zone habitat losses by encouragement and/or creation of new riparian zone(s) along the Churchill River above the reservoir flood level.

The EIS Guidelines on mitigation require the Proponent to discuss and evaluate the rationale for and effectiveness of proposed mitigation and enhancement measures and where possible make reference to similar situations where the proposed mitigation has proven to be successful. In addition, the Proponent is to provide specific mitigation methods to control and manage sediment action and shoreline stability.

In the EIS Nalcor provides information that suggests it may both encourage and/or create new riparian habitat:

The encouragement of riparian zone formation:

- "The new reservoirs' riparian zone (generally up to 3 m elevation above high water level) will be cleared of existing vegetation to encourage the growth of shoreline vegetation reflecting a natural (pre-Project) riparian zone" (Vol. IIB p.5-36);
- "Nalcor Energy will encourage formation of riparian marsh (wetland) at selected locations adjacent to the reservoirs. Riparian vegetation approximately 30 m in width will be left in place during the Muskrat Falls Reservoir preparation, allowing time for replacement areas to become established" (p.5-36);
- "At the inflow areas for major tributaries, special measures (e.g., scarification) will be taken to encourage development and re-establishment of delta areas and wetlands." (p.5-36);
- "The riparian zone in each reservoir will be prepared to encourage rapid development of shrubs and vegetation reflecting a natural near-shore zone, where hunting and trapping can occur." (Vol. III p.5-32);

The creation of alternative riparian zones:

- "Nalcor Energy proposes to offset this loss of habitat by developing alternative areas within the lower Churchill River watershed that contain similar vegetation and structure" (p.5-57); and
- "Nalcor Energy proposes to establish/create habitat approximating the preferred riparian meadow and marsh that serves as primary habitat in the Assessment Area. (p.5-119).

The EIS Guidelines also require the Proponent to discuss mitigation failure with respect to risk and severity of consequence. Although there is some doubt presented in the EIS concerning the success of the proposed riparian zone mitigation when it says that "this initiative will be investigated and pursued, although it is not certain the mitigation (habitat development) will be successful" (p.5-105), no analysis of risk and impacts to VECs (terrestrial, aquatic, land and resource use) is presented.

With respect to riparian marsh in particular, the EIS states that outside the Churchill River valley riparian marsh is uncommon and that "[a]lthough alder-dominated thickets may recolonize along the new high water level, the hydrology, soil and microclimatic conditions do not favour the natural reestablishment of marshes" (p.5-57). The EIS also states that "[t]he program of habitat creation will be effective in enhancing wetland habitat for Wetland Sparrows, as rehabilitation of other sites has been observed by the study team to attract these species. The extent and success of this initiative will, however, require follow-up monitoring" (p.5-119).

No details on the proposed habitat creation program, impacts of higher elevation micro-climate, the likelihood of success, a discussion of observations from other rehabilitation sites, or the proposed follow-up monitoring program is provided in the EIS. This information is required to verify Nalcor's assertions that the creation of riparian marsh habitat would be sufficient to offset riparian habitat losses to such an extent that the impact on species (i.e. Wetland Sparrows) would not be significant.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to:

a. **provide a comprehensive description of the proposed mitigation of impacts to riparian habitat (including riparian marsh, meadow, and thicket);**

Response:

The approach to mitigation of effects to riparian habitat will include physical works to allow for vegetation establishment at selected areas along the reservoir. The riparian habitat mitigation will also consider efforts undertaken as fish habitat mitigation (e.g., delta creation), and where possible, will be developed collaboratively. These efforts will include quantitative and qualitative analysis and follow-up and are expected to augment/enhance post-Construction habitat.

The riparian habitat mitigation strategy will include:

1. **Rationale and Approach -** This will describe the challenges associated with the scale of the Project, the habitats being addressed and existing methods of habitat quantification. It will lead the way for a description of the quantification method used for the Project.
2. **Pre-Construction Riparian Habitat Quantification -** This will describe how the habitat quantification was undertaken for the Project. It will describe the key tasks associated with the method, including relevant data collection and description of existing habitat to be lost to inundation;
3. **Post-Construction (i.e., Operation and Maintenance Phase) Riparian Habitat Quantification –** This will describe riparian areas that are expected to be established by the inundation**;**
4. **Riparian Habitat Creation Opportunities –** This will identify areas along the future reservoirs that exhibit appropriate terrain, soil conditions and proximity to the reservoirs to support riparian habitat establishment efforts in addition to the clearing proposed by the reservoir preparation;
5. **Physical Works –** This will outline the techniques to be used to prepare the selected sites to optimize the potential for establishment of riparian habitat. This could include use of boulders or concrete structures to hold back water at shallow depths to promote wetland vegetation establishment. This may include initial test plots prior to full implementation.
6. **Follow-up –** This will describe the program, and timelines, to be undertaken related to the riparian habitat establishment areas to assess success and provide recommendations for additional efforts, if required.
7. **Reporting –** This will provide the framework for a reporting structure, including timelines and distribution.

Elements 6 and 7 above will conform to the program outlined in IR# JRP.112.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to:

b. discuss and evaluate the rationale for and effectiveness of proposed riparian mitigation and enhancement measures;

Response:

The rationale for this mitigation is to create comparable habitat elsewhere in the lower Churchill River watershed, preferably adjacent to the area where riparian habitat will be altered or lost. Developed habitat would then be available for the species currently using those habitats. Refer to part (c) for examples of where this approach has successfully occurred in Labrador.

The effectiveness of the mitigation will be based on natural processes in this environment and the ability to duplicate or simulate same. There are two important ecological considerations for maximizing marsh (meadow) and riparian enhancement. By managing the degree and frequency of flooding, the vegetation succession can be manipulated to favour certain species (Roberts and Robertson 1986, Roberts and van Nostrand 1995, Roberts and van Kesteren 2003) as indicated in Figure 1.

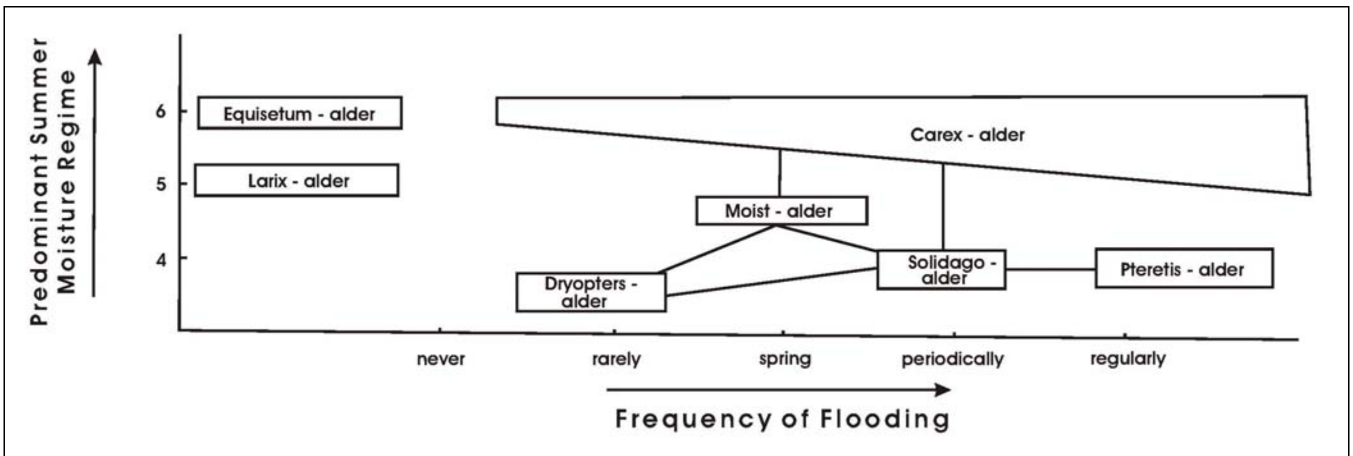

Figure 1 Frequency of flooding and vegetation type (Roberts and van Kesteren 2003 modified from Damman 1964)

The second consideration involves the need to implement measures to retain coarse and fine alluvial material above the normal stream or river shoreline during spring runoff periods. This may be achieved through the scarification of land and forest cutting adjacent to steams (Roberts and van Nostrand 1995) or with the placement of natural boulders or engineered structures.

Examples of deliberate or coincidental creation of riparian wetland habitat are described in part (c).

References:

Roberts, B.A. and A.W. Robertson. 1986. Salt marshes of Atlantic Canada: their ecology and distribution. Can. J. Bot. 64: 455-467

Roberts, B. A. & R.S. van Nostrand 1995. p-349-357. In : Ecology and Management of Larix Forests: A look head. USDA, Forest Service Intermountain Research Station, General Technical Report GTR-INT-319, May 1995.521- Compilers W. C. Schmidt and K. J. McDonaldRoberts, B. A. and A. Rein van Kesteren. 2003. Buffer Zone Management- Forest Structure, Soils and Water. Paper Presented at Buffer Zone Management Workshop Sponsored by the Buffer Zone Working Group & The Western Newfoundland Model Forest, Corner Brook, Newfoundland, February 19-21, 2003. Paper published as a CD by 7 Partners

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to:

c. **provide examples of similar situations where the proposed mitigation has proven to be successful;**

Response:

There are examples in Labrador where artificially created riparian wetland resulted in habitat that attracted avifauna and other species of wildlife. Examples are provided in the following subsections.

Lobstick Lake

In the upper Churchill River watershed (near Lobstick Lake) there has been enough seepage (lateral water movement) and flooding over the past 35 years that a new shoreline exists behind the system of dykes that provides ideal habitat for staging waterfowl (Bajzak and Roberts 1999a and 1999b). One example is a small unnamed pond 1 km east of the Lobstick control structure. The creation of wetland habitat along the road to the structure has had a resident population of waterfowl since 1977. In August 2006 water levels rose above the existing high water mark but have since receded. This shoreline contains all seven vegetation types represented in part (b), Figure 1 (unpublished data Roberts 1977-2007). See Photos 1 and 2 below.

Photo 1 Man-made Pond Shoreline at the North End - 1 km east of Lobstick Control Structure at High Water level, August 2006

Photo 2 Man-made Pond Shoreline Features with Boulders, Flooded Equisetum (Horsetail) Vegetation and Larch Alder in the Backshore as per Frequency of Flooding Diagram (Figure 1 in part (b))

Forest Management District 19

New forest access roads and new forest management practices have been implemented in Forest Management District 19 (i.e., the greater Goose Bay area, Grand Lake Road and Cape Caribou areas) where stream crossings are being managed to increase riparian habitat and minimize washout and siltation of fish habitat using rip rap boulders and proper culverts. Lateral seepage has resulted in conditions conducive for the establishment of an adjacent wetland habitat (Photo 3).

Photo 3 Flooding from Lateral Seepage Water Creating the Conditions needed for New Marsh

Wabush Lake

The Iron Ore Company of Canada began operating in Labrador West in 1962 (IOCC N.D.). For years, the tailings stored in Wabush Lake coloured the water red and produced fine sediment that covered the bottom of the lake. The reclaimed tailings cover approximately 540 hectares and are non-toxic and chemically inert. As such, the area has been sculpted into ponds, hills, valleys, and wetlands that are suitable to support plants and wildlife. Over the past decade, tailings management has involved re-vegetation programs on the exposed tailings to not only suppress dust, but also to provide a diverse natural environment. The implementation of this project and its contribution to sustainable development was recognized in 2005 when the North American Waterfowl Management Plan awarded IOC with the Great Blue Heron National Award for long-term contributions for the benefit of waterfowl and other migratory bird populations. Several species of avifauna now use the site, including species of Wetland Sparrows (Jacques Whitford unpublished data).

References:

Bajzak, D. and B. A. Roberts 1999a. The effect of flooding on the vegetation in the main reservoir of the Churchill Falls Power Plant . Poster & Summary Paper Presented at Labrador Collaborative Research Workshop, Memorial University of Newfoundland, April 7-9, 1999.

Bajzak, D. and B. A. Roberts 1999b. Snow Studies at Churchill Falls , Labrador. Poster & Summary Paper Presented at Labrador Collaborative Research Workshop, Memorial University of Newfoundland, April 7-9, 1999.

Iron Ore Company of Canada (IOCC). N.D. Internet site accessed 6 September 2009 at: http://www.ironore.ca/main/index.php?&sec=2&loc=9&page=pressdet.php&pageurl=press.php&title=&id=114&lng=EN

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to provide:

d. **discuss micro-climate conditions that would contribute/detract from the successful establishment of similar composition riparian zones at a higher elevation;**

Response:

Microclimate conditions created along the edge of the reservoir, and at areas selected for riparian mitigation, are expected to provide suitable growing conditions (similar to those altered or lost) for the vegetation species expected to invade and colonize following inundation. The elevation difference (in the order of 100 m) is not likely to negatively influence microclimate available, nor prevent plant species present at the lower elevation from establishing. As indicated in IR# JRP.46, the microclimate in select areas of the future riparian zone is likely comparable to the micro-climate at select current locations. At some time in the past, these higher areas were the riparian zone.

Nalcor Energy (Nalcor) will consider microclimate conditions as they relate to soil types and other factors such as exposure, aspect, adjacent vegetation (e.g., shading), to select candidate riparian habitat mitigation areas. Areas with conditions that are not conducive to wetland establishment (e.g., fast water flow, deep water, inappropriate substrate) will be avoided during the selection process. The goal will be to identify and complete riparian mitigation in areas with the highest potential for success.

In some areas, higher elevation streams that have swift drainage possess little flood plain and few shoreline features. Although there may not be much difference in microclimate and rainfall intensity, the water has greater potential energy because of the higher elevation. Careful placing of large rip rap bounders and small side ditching may be used to create habitat in these situations. Natural materials can be used to reduce water flow and increase frequency of stream and bank side flooding to create comparable riparian habitat.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to provide:

e. **discuss if and/or how riparian zone creation would be used as a mitigation method to control and manage sediment action and shoreline stability;**

Response:

The riparian mitigation would likely assist in sediment deposition and shoreline stability. Typically, riparian vegetation (i.e., along the shores of rivers and lakes) provide stability (i.e., the root system helps hold the soil in place), traps sediment from water that flows over or around the plants, and limits the potential for sediment transfer from adjacent upland areas. The efficiency of these processes depends on the vegetation types growing in the riparian area. Given that alder (*Alnus sp.)*, willow (*Salix sp.)*, and grass (*Calamagrostis sp.)* establish naturally in areas of disturbance in the lower Churchill River valley (Section 2.4.2.1 in Volume IIA of the EIS), there is a high level of confidence that a riparian thicket zone can be created. As indicated in part (a), additional efforts will be implemented to enhance the establishment of areas subject to flooding which discourages the growth of woody vegetation and deposits sediment.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The Proponent is asked to provide:

f. **identify who would be responsible for the implementation of these mitigation measures and the system of accountability;**

Response:

Nalcor Energy (Nalcor) will be responsible for the implementation of these mitigation measures, and accountable for the outcomes (see response to IR# JRP.112). Through the Monitoring and Follow-up Plan (Section 7.3 of Volume IIB and IR# JRP.112), Nalcor will provide updates, as per a reporting schedule and distribution list identified in the final follow-up program. Nalcor will use Adaptive Management to identify issues and determine if additional actions are required. Appropriate additional action would be undertaken in a timely manner.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The proponent is asked to provide:

g. **discuss mitigation failure with respect to risk and severity of consequence including an outline of potential short-term and long-term impacts of mitigation failure on Key Indicators and/or VECs within aquatic, terrestrial, land and resource use as appropriate; and**

Response:

Riparian habitat creation is likely to occur naturally following inundation. Riparian habitat will also be enhanced/encouraged through the reservoir preparation and in combination with the efforts being undertaken for fish habitat compensation (e.g., delta habitat). As a result, riparian habitat mitigation is considered precautionary as it would provide augmentation of this particular habitat. Considering this, in the unlikely event that the riparian mitigation failed, the risk and severity of consequence to the Key Indicators/VECs would be limited. The potential short-term and long-term environmental effects (e.g., habitat loss) to Key Indicators are predicted to be not significant regardless of the mitigation, considering the natural riparian habitat establishment expected and other mitigation being undertaken (e.g., delta habitat creation).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.101**

Information Requested:

The proponent is asked to provide:

h. **explain if and how the precautionary principle was applied in the determination of significance for species that would rely on successful riparian zone creation to offset habitat losses caused by impoundment.**

Response:

As explained in response to IR# JRP 19 and at Section 9.12 of Volume IA of the EIS, a precautionary approach has been applied to the Project and its EIS in order to be conservative in the assessment of environmental effects and design mitigative measures that will result in residual effects that are likely not significant. The Precautionary principle is a specific application of the precautionary approach used for the Project planning and EIS. The precautionary principle did not factor into the significance determination for Project effects to riparian zones. An example of a precautionary approach in Project design and implementation is Nalcor Energy's (Nalcor's) proposed mitigation for Project-related environmental effects on Wetland Sparrow. Of the Key Indicators included within the environmental assessment, Wetland Sparrows are the KI most closely associated with riparian vegetation and therefore would benefit from riparian zone enhancement. Even though such effects are predicted to not likely be significant and adverse (Volume IIB, Sections 5.7.11, 5.8, 5.9, 5.10, 5.11.1.14, 5.11.2.15, 5.12, 5.13, 5.14.12, 5.15.4.12 and 5.16, Nalcor is proposing to create comparable wetland habitat adjacent to the riparian fringe of the newly created reservoirs or creation of suitable wetland habitat along tributary streams and watercourses adjacent to the reservoir. While this proposed mitigation poses hydrological and ecological challenges, there are examples in Labrador where Wetland Sparrow have colonized artificially created habitat (e.g., the remediation program implemented by the Iron Ore Company of Canada for their tailings management area at Wabush Lake).

IR# JRP.102

Mitigation Measures (Deciduous/Hardwood Forest Habitat)

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Subject - Mitigation Measures (Deciduous/Hardwood forest habitat)

References:

EIS Guidelines, Section 4.6.1 (Mitigation)

EIS Volume IIB, Section 5.0 (Environmental Effects Assessment - Terrestrial Environment),

7.2.3 (Conclusions and Sustainability – Terrestrial Environment)

Related Comments / Information Requests:

CEAR # 184 (Sierra Club Atlantic)

Rationale:

In several places in the EIS the Proponent has stated an intention to mitigate damage to the deciduous/hardwood forest habitat caused by reservoir impoundment through restitution; specifically encouraging or creating new alternative habitat area(s) along the Churchill River above the reservoir flood level. Species that commonly use deciduous/hardwood habitat include: beaver, ruffed grouse, and moose. The EIS proposed both creating additional hardwood habitat and encouraging and perpetuating the deciduous ecotype in existing hardwood stands, with the goal of supporting increased density of species such as Ruffed Grouse (p.5-55). These activities are proposed primarily in the Muskrat Falls Reservoir.

The EIS Guidelines on mitigation require the Proponent to discuss and evaluate the rationale for and effectiveness of proposed mitigation and enhancement measures and where possible make reference to similar situations where the proposed mitigation has proven to be successful. Given that the deciduous habitat in question is relatively uncommon immediately upstream of Muskrat Falls, Nalcor Energy has proposed developing adjacent areas that will encourage the vegetation type.

In the EIS Nalcor provides information that suggests it will create deciduous/hardwood forest habitat in the following manner:

- "The encouragement of alternative deciduous habitat, specifically for Ruffed Grouse, will benefit Beaver. This is particularly true in terms of enhancing areas for aspen near Muskrat Falls" (Vol. IIB, p.5-50);
- "Clearing will allow more deciduous species to establish. As a mitigation measure directed specifically at Ruffed Grouse, Nalcor Energy will encourage this type of succession in new riparian areas adjacent to where primary habitat would be lost (e.g., Lower Brook)" (p. 5-55);
- However, during reservoir preparation, forest vegetation above the proposed future shoreline will be removed to assist development of new riparian zones and to provide primary succession vegetation for displaced wildlife such as Ruffed Grouse. (p.5-55); and
- Nalcor Energy will undertake to create replacement deciduous hardwood and riparian marsh habitats for Wetland Sparrows, as well as species such as Ruffed Grouse (p.7-4).

The EIS Guidelines also require the Proponent to discuss mitigation failure with respect to risk and severity of consequence. No analysis of risk and impacts to VECs (terrestrial, aquatic, land and resource use) is presented.

No details on the proposed habitat creation program, impacts of higher elevation micro-climate, the likelihood of success, impacts of altering currently existing hardwood to accommodate aspen areas, a discussion of observations from other rehabilitation sites, or the proposed follow-up monitoring program is provided in the EIS. This information is required to verify Nalcor's assertions that the creation of deciduous/hardwood forest habitat would be sufficient to offset habitat losses to such an extent that the impact on species (i.e. ruffed grouse) would not be significant.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

a. **provide a comprehensive description of the proposed mitigation of the impacts on deciduous/hardwood forests;**

Response:

Nalcor Energy (Nalcor) will create, or facilitate, the establishment of hardwood forest types (predominantly white birch and trembling aspen, and in some areas, balsam poplar), at areas where surface disturbance will occur and in areas targeted specifically for this mitigation. The mitigation is based on standard silvicultural techniques, knowledge of local ecological processes and relevant experience in central Labrador.

White birch and trembling aspen (Richardson 1974) can form pure stands following both cutting and burning. There are many examples of this succession pattern in the Lake Melville Ecoregion, but this can only happen naturally if there is a seed source present. Both species have light seed capable of long dispersal and trembling aspen also grows well from root stock after both cutting and fire (Page 1972) but mid to good quality sites with adequate moisture (drainage class 2-4, CSSC 1978) are needed. Physical disturbance from forest cutting (Meades and Roberts 1992, Roberts et al. 1998), wildfire (Foster and King 1986) or controlled burning (moderate to high temperature (Mallik and Roberts 1994)], will assist in the succession of hardwood species in the lower Churchill River watershed. The key consideration for this mitigation will be to alter the site substrate to enhance conditions for the establishment of hardwood (versus coniferous) species.

During reservoir preparation, suitable locations (i.e., accessible, conducive moisture and soil conditions, proximity to areas of previous deciduous hardwood forest that will be affected by the Project), will be identified. The role of forest site quality (Forest Capability Class) (Roberts and Titus 1994, Roberts et al. 1998, Titus et al. 1997 and 1998) and soil seepage (lateral water movement (Roberts 1986)), at mid and bottom slopes are two other important factors influencing coniferous softwood to hardwood succession. At the time of writing, the preferred locations for this mitigation would be adjacent to the Muskrat Falls reservoir, where the majority of the existing hardwood habitat would be lost as a result of the inundation. Note that other areas of disturbance throughout the footprint of the Project will naturally regenerate in hardwood vegetation also offsetting losses during construction.

The potential conversion sites for this mitigation will be of mid to high site quality, and clear cut or large patch cut. Coniferous softwood cover will be removed and the remaining slash piled in rows to later facilitate a controlled burn. Forest cuts will follow natural slope contours and be irregular in shape thereby avoiding block and straight line configurations so as to blend in with natural contours especially in the viewscape of the Trans Labrador Highway. If a wheel skidder with a blade is employed the ground can be also further disturbed to the upper mineral soil and this will favor all hardwood species.

The high temperature burn would be designed to remove duff layers, increase pH levels thus reducing acidity levels (Roberts et al. 1998) and therefore making the site more acceptable for hardwood root growth immediately following the ashing process. The availability of nutrients increases with increased pH (Roberts 1983) through the consolidation of tops and branches which contain the majority of nutrients (Roberts et al.

1998, Titus et al. 1997 and 1998). A high temperature fall patch (5 to 10 ha) controlled burn would best occur after the wildfire summer season to promote the best conditions for success.

In terms of mechanical site preparation, the Provincial government (Dept. of Environment N.D.) and others (Peterson et al. 1997) advocate the use of scarification techniques when encouraging hardwood succession. The preference for exposed mineral soil seedbeds necessitates soil disturbance particularly where there is a thick duff layer. Logging will be sufficient in some cases, but greater benefit could be achieved through the use of 'shark fin barrels' towed by heavy equipment over the site.

In summary, the role of site moisture and fertility are the main controlling variables but when the mid to high quality coniferous sites are scarified to expose mineral soil or soil humus is removed with road building, forest cutting, wildfire or controlled burning, the potential for the stand conversion from softwood to hardwood is greatly enhanced (Roberts et al. 2006). Examples of succession in Labrador forest types after wildfire and logging are shown in photographs in Attachment A, (modified from Bajzak 1973, Bajzak and Roberts 1984) for the Lake Melville Ecoregion.

References:

Bajzak, D. 1973. Biophysical Land Classification of the Lake Melville Area, Labrador. Environment Canada, Canadian Forest Service. Information Report N-X-88. 115 p.

Bajzak, D and B. A. Roberts. 1984. Mapping Land Types for forest evaluation in Lake Melville area, Labrador, Canada.Paper presented at the joint meeting of the Working Parties No. 1.02-06 and No. 1.02-10 of IUFRO on Qualitative and Quantitative Assessment of Forest Sites with Special Reference to Soil. Sept. 10-15, 1984. Birmensdorf, Switzerland. 12 p.

Canadian System of Soil Classification (CSSC). 1978. The Canadian system of soil classification. Canadian Department of Agriculture, Research Branch Publication No. 1646. 164 p.

Department of Environment. N.D. Internet site accessed on 31 August 2009. http://www.env.gov.nl.ca/env/env/EA%202001/pdf%20files%201221-1309/1296%20-%20Crown%20Dist%202%20Five%20Year%20Plan/Section%207.5-7.pdf

Foster, D. R. and G. A. King 1986. Vegetation pattern and diversity in south eastern Labrador, Canada. Betula papyrifera (birch) forest development in relation to fire history and physiography. Journal of Ecology 74: 465-483.

Mallik, A.U. and B.A. Roberts. 1994. Natural regeneration of Pinus resinosa on burned and unburned sites in Newfoundland. Journal of Vegetation Science 5: 179-186.

Meades, W.J. and B. A. Roberts. 1992. A review of forest site classification activities in Newfoundland and Labrador. Forestry Chronicle 68: 25-33.

Page, G. 1972. The occurrence and growth of trembling aspen in Newfoundland. Environment Canada, Canadian Forestry Service, Ottawa. Publication No. 1314, 15 pp.

Peterson, E.B., N.M. Peterson, S.W. Simard and J.R. Wang. 1997. Paper birch managers handbook for British Columbia. Prepared for the British Columbia Ministry of Forests, Research Branch, Victoria, B.C.

Richardson, J. 1974. Natural regeneration after disturbance in the forests of Labrador. Environment Canada, Forest Service, Newfoundland Forest Research Centre, St. John's, Newfoundland. Information Report N-X-113. 34p.

Roberts, B.A. 1983. Soils of Newfoundland, an introduction. Monographiae Biologicae 48:107-161.

Roberts, B.A. 1986. The importance of soil drainage and soil seepage factors in assessing forest site capacity in central Newfoundland. P. 89-100. In van Groenewoud ed. Proceedings of IUFRO working party S.02.06, Forest Site Classification Methods, October 7-10, 1985, Fredericton, New Brunswick, Canada. 182 pp.

Roberts, B.A. and B.D.Titus. 1994. The impact of whole-tree and conventional harvesting on white birch sites in central Newfoundland: an ENFOR establishment report. Canadian Forest Service, Newfoundland and Labrador Region, Inf.Rep. N-X-293. 23pp.

Roberts, B. A., K.W. Deering and B. D. Titus. 1998. Effects of intensive harvesting on forest floor properties in Betula papyrifera stands in Newfoundland. Journal of Vegetation Science 9: 521-528.

Roberts, B. A., N.P. Simon and K.W. Deering. 2006. The forests and woodlands of Labrador, Canada: ecology, distribution and future management. Ecological Research 21: 868-880.

Titus, B. D., B. A. Roberts and K. W. Deering. 1997. Soil solution concentrations on three white birch sites in central, Newfoundland following different harvesting intensities. Biomass and Bioenergy 13: 313-330.

Titus , B. D. , B. A. Roberts and K. W. Deering. 1998. Nutrient removals with harvesting and by deep percolation from white birch (*Betula papyrifera* (Marsh)) sites in central Newfoundland. Canadian Journal of Soil Science 78: 127-137.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

b. discuss and evaluate the rationale for and effectiveness of proposed deciduous/hardwood habitat mitigation and enhancement measures;

Response:

Aspects of the rationale and effectiveness of proposed deciduous/hardwood habitat mitigation are presented in part (a) above, in terms of this approach being successful in Labrador. A review of hardwood types that exist in Labrador, (Wilton 1965) and their silvicultural characteristics are provided in Attachment A.

Road construction since 1965 and forest harvesting by Labrador Linerboard Company, with extensive cuts in the 1970s and by Eastern Wood Harvesters during the 1990s, has resulted in an increase in white birch and trembling aspen stand succession in the Lake Melville Ecoregion. The influence of wildfire in the ecoregion also has increased coniferous forest succession to white birch dominated forest types, especially on good sites where hot wildfires burned upslope. The Labrador Linerboard cuts, especially in mid-slope areas where the soil surface was scarified by the wheel skidders are now visually prominent, especially in the fall (see photographs in Attachment A). There are many examples of disturbance leading to hardwood succession in central Labrador (Attachment A, and also see part (c) below).

Reference:

Wilton, W. C. 1961. Forests of the Ashuanipi Lake area, western Labrador. Canada Dept. of Forestry, Forest Research Branch, Ottawa. Mimeo 61-2, 27p.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

c. **provide examples of similar situations where the proposed mitigation has proven to be successful;**

Response:

The Labrador Linerboard cuts on the Grand Lake Road and Churchill Falls Road from Muskrat Falls to Gull Island are good examples of both cutting and wildfire hardwood stand conversion (see photographs in Attachment A).

Experimental burning and different types of forest harvesting at white birch sites in Newfoundland (e.g., near Badger and North Pond Gambo), from a nutrient cycling and regeneration point of view, have been documented in peer-reviewed published studies (Roberts et al. 1998, Titus et al. 1997 and 1998). Innu Forest Guardians already have some patch cutting experience in the last ten years in spruce and balsam fir stands that are regenerating with a high percentage of hardwood adjacent to the Grand Lake Forest Access Road.

References:

Roberts, B. A., K.W. Deering and B. D. Titus. 1998. Effects of intensive harvesting on forest floor properties in Betula papyrifera stands in Newfoundland. Journal of Vegetation Science 9: 521-528.

Titus, B. D., B. A. Roberts and K. W. Deering. 1997. Soil solution concentrations on three white birch sites in central, Newfoundland following different harvesting intensities. Biomass and Bioenergy 13: 313-330.

Titus , B. D. , B. A. Roberts and K. W. Deering. 1998. Nutrient removals with harvesting and by deep percolation from white birch (*Betula papyrifera* (Marsh)) sites in central Newfoundland. Canadian Journal of Soil Science 78: 127-137.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

d. Discuss micro-climate conditions that would contribute/detract from the successful establishment of similar composition deciduous/hardwood habitat at a higher elevation;

Response:

Important criteria regarding micro-climate and the establishment of hardwood habitat include site quality and available moisture to promote regeneration success (Table 1). Sites should have some soil seepage (lateral water flow) potential to provide optimum regeneration success and growth potential (Roberts et al. 2006).

Table 1 Moisture Regime and Site Class Characteristics of Forest Type in Labrador (Roberts et al. 2006)

Forest Type	Moisture Regime	Site Class
Black spruce / Lichen, fire type	Very dry	III
Black spruce / feathermoss, fire type	Dry	II
Black spruce / feathermoss, fire type	Dry	II
Fir-spruce-birch/rich herb type, undisturbed type	Moist	I
Black spruce-white birch/ bunchberry, fire type	Moist	I
White birch/ bunchberry, fire type	Moist	I
Black spruce-balsam fir/Sphagnum, undisturbed type	Wet	II
Black spruce/ Ledum, undisturbed type	Very Wet	III

Selected locations for the proposed mitigation should occur at mid slope. Mature balsam fir and black spruce would be removed but any white birch and aspen would remain standing as seed sources. Roughing up the ground adjacent to cuts in pure fir and spruce stands will also enhance hardwood regeneration potential. A small percentage of white birch (Roberts et al. 1998) is known to greatly improve site quality due to the nitrogen content of hardwood leaves (more than twice that of conifer needles) and stands develop quicker and productivity and nutrient reserves improve. To ensure success, locations will be selected that meet these micro-climate conditions adjacent to the Muskrat Falls reservoir.

References:

Roberts, B. A., K.W. Deering and B. D. Titus. 1998. Effects of intensive harvesting on forest floor properties in Betula papyrifera stands in Newfoundland. Journal of Vegetation Science 9: 521-528.

Roberts, B. A., N.P. Simon and K.W. Deering. 2006. The forests and woodlands of Labrador, Canada: ecology, distribution and future management. Ecological Research 21: 868-880.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

e. **identify who would be responsible for the implementation of these mitigation measures and the system of accountability;**

Response:

Nalcor, as the proponent, will ultimately be responsible for the implementation of these mitigation measures and their evaluation through the Environmental Effects Monitoring Program (refer to Chapter 7 in Volume IIB and IR# JRP.112 and IR# JRP.112S). Nalcor anticipates that these measures will be implemented and evaluated in collaboration with other stakeholders through the EEM as the system of accountability.

Both Provincial Government foresters and Innu Forest Guardians could facilitate this type of cutting and patch burning through their normal planning and stakeholder consultation process. A qualified forest ecologist would assist by evaluating site quality, moisture and seepage status and potential for regenerating to hardwood. As noted in part (c) Innu Forest Guardians already have some patch cutting experience in the last ten years in spruce and fir stands that are regenerating with a high percentage of hardwood adjacent to the Grand Lake Forest Access Road.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

f. **discuss mitigation failure with respect to risk and severity of consequence including an outline of potential short-term and long-term impacts of mitigation failure on Key Indicators and/or VECs within aquatic, terrestrial, land and resource use as appropriate; and**

Response:

Mitigation failure in the context of this initiative would suggest that either Nalcor would not implement these procedures, that they would be implemented incorrectly and/or that no passive succession would occur in any of the selected areas. Given the understanding of ecological requirements for these hardwood species and the proven effectiveness of silvicultural techniques to promote hardwood succession in Labrador as presented within this response, Nalcor is confident in the effectiveness of this mitigation. Nevertheless, additional silvicultural strategies such as the planting of trembling aspen and white birch, direct seeding and planting of aspen root stock on recently roughed-up ground will be implemented if such regeneration is not evident after 5 to 10 years, to encourage hardwood regeneration. Hardwood succession may occur with only a few parent trees remain in the stand prior to cutting or patch burning or from wind-carried seed associated with adjacent stands within the reservoir. By combining cutting, scarification and patch control burning and leaving seedlings a high degree of success is expected.

If mitigation failure were to occur, less hardwood habitat would be available following construction. The short- and long-term effects would be a decrease in abundance for species closely associated with this habitat, including Ruffed Grouse, however such species would continue to persist in other locations of existing hardwood habitat in the Assessment Area. Implications for aquatic species would be localized (subjected to increased run-off and perhaps sedimentation, if no revegation occurred) or not measurable (if coniferous cover re-established) due to the lack of interaction. There is a possibility of some shift in land-use pattern such as hunting of Ruffed Grouse although other coniferous affiliated (alternate cover to hardwood) wildlife would be available. Over the longer-term, vegetation cover will establish and eventually climax in coniferous forest depending on the occurrence of other perturbations.

This unrealistic scenario of mitigation failure is again based on Nalcor not fulfilling its commitments and the inability of natural regeneration to succeed in areas of disturbance or designed for this mitigation – all of which are considered as not plausible.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.102**

Information Requested:

The Proponent is asked to:

g. **explain if and how the precautionary principle was applied in the determination of significance for species that would rely on successful deciduous/hardwood habitat creation to offset habitat losses caused by impoundment.**

Response:

The Precautionary Approach, as described in Section 9.12 (Volume IA) of the EIS (and refer to IR# JRP.19), included application of the "Precautionary Principle" (i.e., "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."). The use of a precautionary approach means that:

- environmental effects predictions are based on conservative values or modeling inputs and assumptions (at the high end of the scale when predictions result in a range of possibilities) and are used to address uncertainty and propose mitigation that will prevent and reduce adverse effects;
- the lack of scientific certainty regarding the probability of an environmental effect occurring has not been used as a reason to postpone mitigation (i.e., the Precautionary Principle);
- mitigation has been proposed for Project effects, including those that are not likely to be significant and adverse; and,
- follow-up and monitoring have been proposed.

The precautionary approach was applied in all aspects of the environmental assessment, including for Ruffed Grouse, which was selected as a KI, in part due to its close association with hardwood habitat. Despite the loss of approximately 9.9 percent of primary habitat in the lower Churchill River valley (or 2.5 percent of the Assessment Area) the Ruffed Grouse population is expected to remain in this watershed. Even if this hardwood habitat was not offset by the commitments of Nalcor identified in part (a) or there was no natural succession in disturbed areas, the reduced amount of habitat caused by the Project would not be expected to lead to a decline that would affect the sustainability of the population. This precautionary mitigation is being applied to create additional habitat for Ruffed Grouse (and other hardwood habitat related species) in the vicinity of the Project despite the fact that it was not required to assure a likely not significant environmental effect.

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

JOINT REVIEW PANEL

Attachment A

Silvicultural Characteristics of Commercial Hardwood species in Labrador, including succession, nutrient cycling after forest cutting and fire influences

IR# JRP.102

October 5, 2009

nalcor energy
LOWER CHURCHILL PROJECT

Silvicultural Characteristics of Commercial Hardwood species in Labrador, including succession, nutrient cycling after forest cutting and fire influences.

(Text and references below after Wilton 1965 and Roberts et al. 2006)

White Birch

White birch (*Betula papyrifera*) is the most prevalent hardwood species in Newfoundland and Labrador but it does not constitute more than one percent of the total forest cover. It ranges all over the Labrador peninsula from the southern boundary north almost up to the tree line, but inland from the coast at latitude 55° N, it rarely exists except in a dwarfed form.

White birch is rated as a pioneer species and is one of the first trees to invade an area after a fire. In such situations it can form pure stands but more frequently grows in association with other hardwoods and with black spruce (*Picea mariana*). It is a shade intolerant tree that in natural succession usually lasts only one generation, before being replaced by more tolerant species. Its occurrence in the undisturbed forest varies with locality and with site: in the two most productive forest zones it is a common component of the rich balsam fir (*Abies balsamea*)-white spruce-white birch forest type and it occurs as a widely scattered tree in all other forest types. In the less productive forest zones its occurrence varies from a scattered tree in the better types to a rare invader of the poorer types. Seed crop observations over a four year period showed three crops and one complete failure.

White birch is normally a small tree and the average diametre at maturity is from 20 to 25 cm. However, when growing under optimum conditions much larger trees may be produced; the largest tree recorded in Labrador measured 46 cm in diametre at breast height. No insect enemies were noted but the condition termed "birch dieback" is prevalent throughout the Peninsula. About ten percent of all trees are affected but up to 1960 mortality was light and developing stands today are in good condition.

White birch cannot be considered an important commercial species although some good stands are in existence and individual specimens may be of excellent quality. Normally the trees are many branched with little clear bole and unsuitable for most commercial purposes.

Trembling Aspen

Trembling aspen (*Populus tremuloides*) is not a prevalent tree and constitutes a small proportion of the total tree cover. Its range is more restricted than that of any other species and it is rarely found north of latitude 54° or west of longitude 64°. At this northern limit of its range it occurs in association with warmer soils and grows with the greatest abundance on sandy terraces and till slopes with favorable aspects.

Aspen is a pioneer species. It is one of the first trees to colonize burns and quickly invades landslides, sand dunes and other areas with drastically disturbed soils. It rarely forms pure stands but usually grows in association with white birch or as a scattered tree in fire-type spruce stands. Aspen is rated as very intolerant and cannot reproduce under any appreciable degree of shade. Aspen holds a temporary place in forest succession and is eventually replaced by more tolerant species; it was not observed in the undisturbed forest. This is a short lived species and in Labrador the growth rate is slower than normal with trees comparatively small. The largest tree recorded was 35 cm in diametre at breast height.

Trembling aspen is not a commercial tree in this region but its presence adds immeasurably to the intrinsic value of the forest. This species is a favored food of many northern mammals and birds and it gives color and aesthetic value to the park-like lichen stands.

Balsam Poplar

Balsam poplar (*Populus balsamifera*) is numerically the least important tree and its total proportion of forest tree cover is insignificant. The range of the species is not known but is believed to coincide approximately with that of the balsam fir and white birch. It is irregularly distributed and is entirely absent from many areas. Poplar is not a true forest tree here, but is one of the first to invade recently deposited soils. It is frequently found growing with alders and willows on low inundated alluvial river flats, sand bars, stream banks and lake borders; it sometimes grows in association with black spruce on the drier lichen sites. Usually balsam poplar occurs as scattered individuals but occasionally it forms small pure stands. Vegetative reproduction by root suckers and stump sprouts is common and is the usual method whereby small stands are formed from scattered trees.

Balsam poplar is neither a large tree nor a well-formed one. The largest tree recorded measured 40 cm in diametre at breast height but most mature trees are considerably smaller. They are many branched and with little clear bole. The species is not of commercial importance and like trembling aspen its value to the region is mainly aesthetic.

Hardwood and Forest Disturbance

Regarding soil texture and its relationships to forest type, moisture status and growth, see van Kesteren (2000) for drumlinoid moraine, Cape Caribou area. For slope influences and nutrients, see Roberts, Deering and Titus (1998) remembering that although in the white birch stage these sites represent the moderate to rich balsam fir sites, Roberts (1986). For forest harvesting and nutrient cycling for white birch, see Titus et al. (1997 and 1998). The black spruce/kalmia forest type (Mallik and Roberts 1994) is related to burning temperature and pH. This is really the controlling mechanism. White birch marsh, trembling aspen, balsam poplar and showy mountain ash (*Sorbus decora*) are the main hardwoods along with some 23 species of willow (Salix spp.) of which three species are known only from the Labrador sector of the Province (Ryan 1978)

Until the Labrador Linerboard operations started in 1969, Forest Management District 19 had a conservative annual allowable cut of 200,000 m^3 (Hillyard 2004). Labrador Linerboard opened in Stephenville in 1973, and was to use Labrador wood, but costs and market conditions led to its closure in 1977. Abitibi-Price bought the mill in 1979 and converted it to a pulp and paper mill and opened it in 1981. The early operation in the areas between the Churchill and Goose Rivers saw some 15,500 ha cut during 1970 to 1974. These cuts were not burned or mechanically treated and regenerated with vigorous young fir and spruce forests, some having slightly more white birch, which increases site quality, growth and biodiversity (Titus et al. 1997 and 1998, Roberts et al. 1998). Wildfire on drier black spruce forests usually assures black spruce regeneration depending on the fire interval and intensity as a high burning temperature is required to open cones both current and residual. The removal of the thick duff and understory results in the initial and dramatic improvement of root growth and more favorable pH conditions with the ashing of acidic humus to more basic conditions with burning temperature (Mallik and Roberts 1994). In lichen forests dominated by Cladonia and Cladina lichens five phases of fire intervals can be identified (Roberts and Mallik 1994).

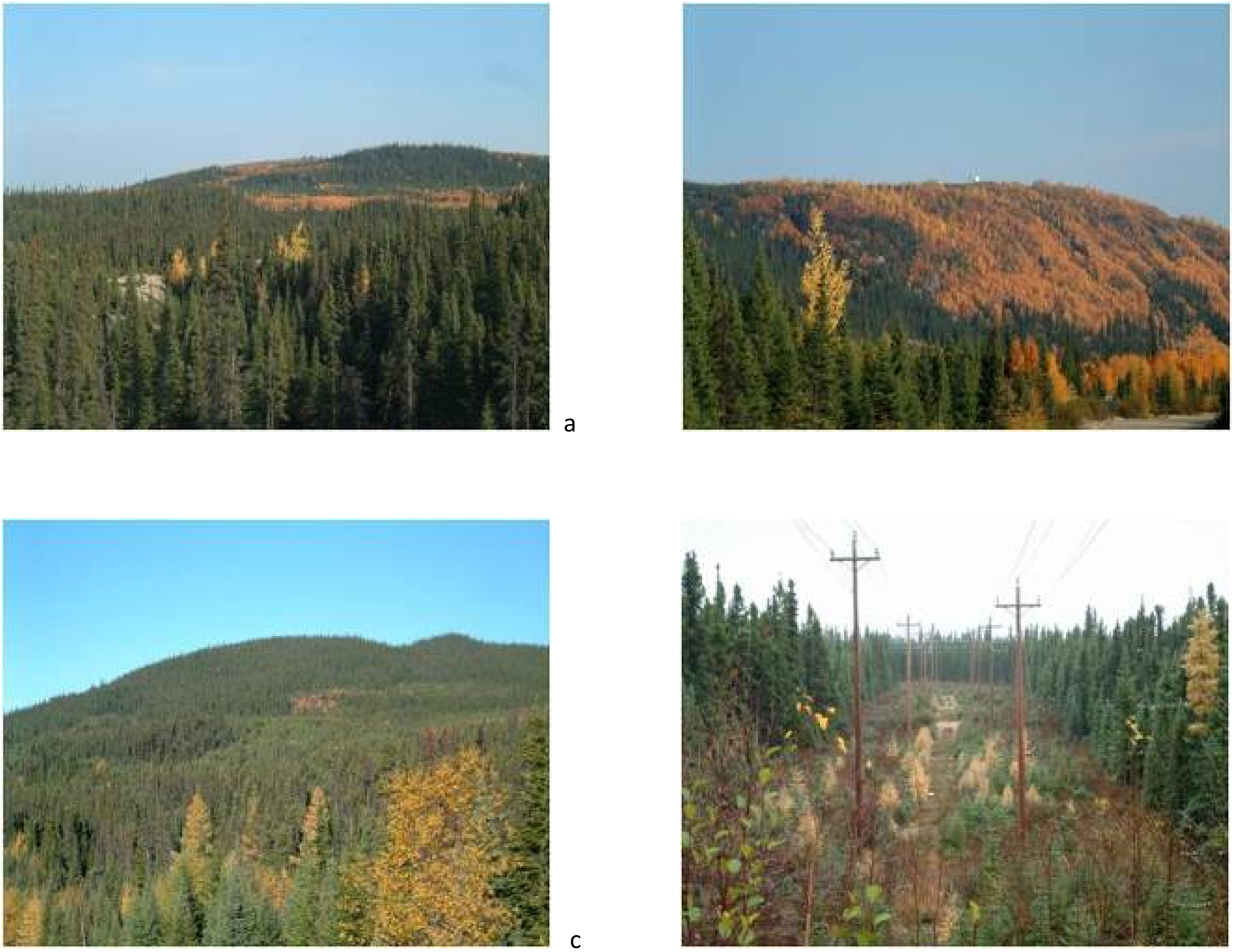
a b c d

Figure 1 Clearcuts from the 1970's show increased white birch (a and b) white birch increase after wildfire (c) balsam fir regeneration after clearcutting (d) black spruce, balsam fir and eastern larch regeneration on hydro line after cutting.

The probable succession after fire on the main forest types in the Lake Melville area is presented in Figure 2 below. Practically all the balsam fir forests appear to revert to black spruce forests following fire while the black spruce and white birch forests are usually stable types and perpetuate themselves after fire.

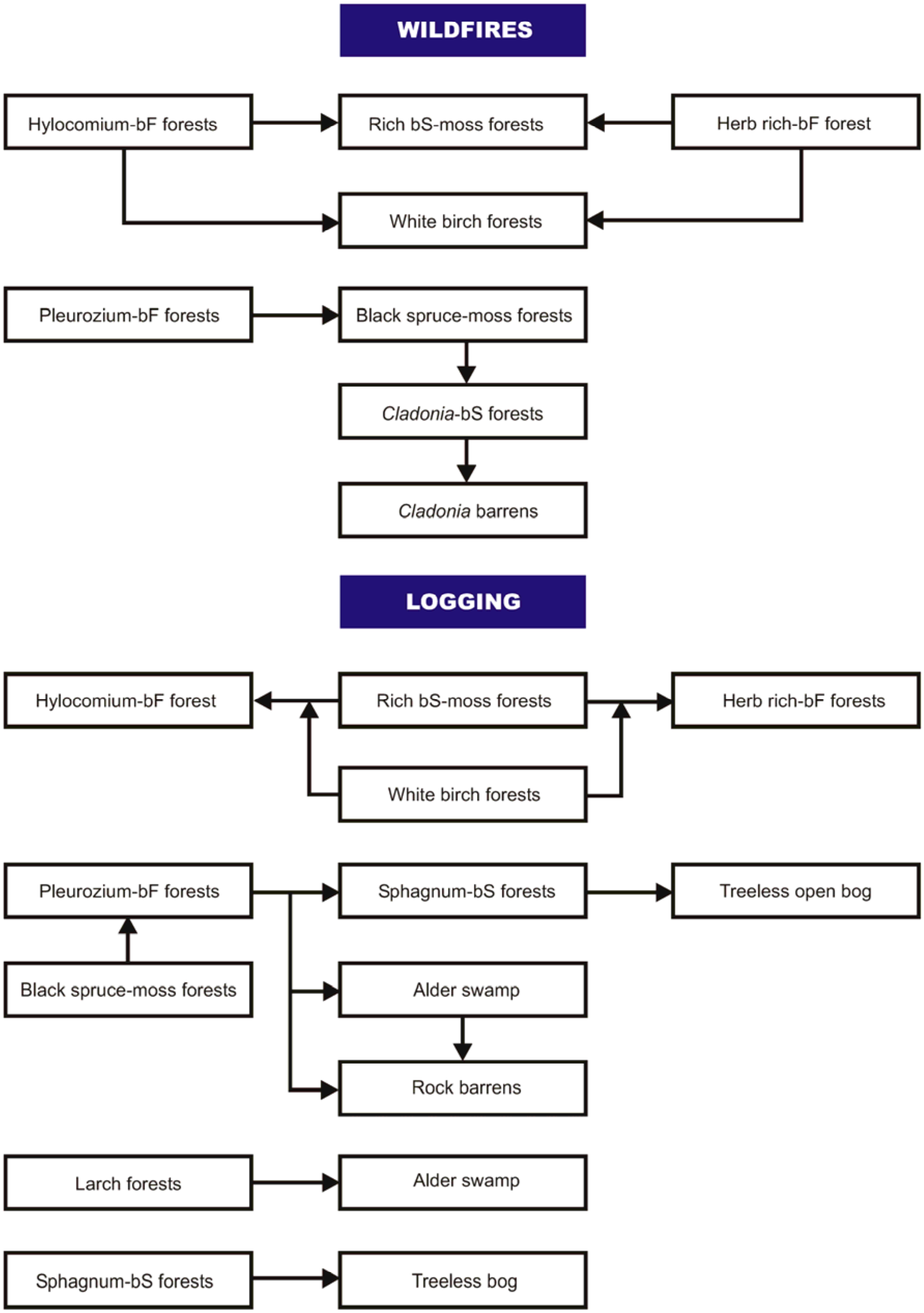

Figure 2 Succession after Natural Disturbance of WildFire or Forest Cutting and Logging (Bajzak & Roberts 1984), High Boreal Forest – Lake Melville. Succession after fire (those types in blocks are normally stable)

Disturbance and Forest Succession

The importance of fire in the forests of Labrador should not be underestimated. Most of the forests in this ecosystem owe their origin to fire. This probably accounts for the importance of black spruce in balsam fir stands on the richer sites in the Lake Melville forests. Each balsam fir forest type in different areas on similar site conditions shows considerable variation in percentage of black spruce in tree layer. This is undoubtedly due to the different ages of the stands following fire (Bajzak and Roberts 1984).

Where cutting causes drastic soil moisture changes, the forests will revert to different forest types. This is especially true of sphagnum black spruce forests and Cladonia black spruce forests.

The Assessment Area encompasses the following: a) Lake Melville Ecoregion characterized by the southern part of the Boreal Forest zone (Rowe 1972) and supporting excellent forests. Three main and four less significant tree species occur in the Lake Melville region: black spruce, balsam fir, larch (*Larix laricina*), white birch, trembling aspen and balsam poplar. The richer sites are dominated by balsam fir forests while black spruce stands usually occupy the nutrient poor sites. White spruce, trembling aspen and white birch are most common on the nutrient rich soils. Aspen stands were observed sparsely. Larch usually occurs on the very wet and very dry sites on the total range of nutrient levels. Balsam poplar can be found on periodically flooded shores along rivers and lakes.


(a)


(b)

Figure 3 a) Richest litter sites of hardwood, herbs and ferns are associated with the best site class. b) Mixed hardwood and softwood, Site Class II on fine to medium sand with well drained conditions disturbed by decade old road right of way

Using field collected data, a vegetation classification was developed and the Lake Melville area forests were divided into six major groups (code designation indicated in parentheses) (Bajzak and Roberts 1984):

1. balsam fir white birch forests (BF)
2. black spruce forests (BS)
3. larch forests (LAF)
4. bogs and fens (B)
5. heath barrens (SHB)
6. alder thickets (ALT)

On the basis of typical ground vegetation, soil and stand characteristics the following types of balsam fir-white birch forests were recognized (Bajzak and Roberts 1984):

1. balsam fir-herb rich forests(HBF)
2. balsam fir-moss forests: (MBF)
   - hylocomium subtype (MBF-h)
   - pleurozium subtype (MBF-p)
3. alder-balsam fir forests (ABF)
4. myrica-sphagnum-balsam fir forests (MYBF)
5. white birch forests (BBF)

The most productive forests in Labrador occur in this region and there is a good relationship between soil subgroup and forest types. As an example of this, the excessively drained Orthic Regosols grade into Rego or juvenile Humic Podzols on the lichen forest covered beach ridges while Orthic Humic Podzols can be found on the ridge bluffs dominated by black spruce moss forests.

The podzolic soils on the beach ridge slopes are often Ortstein Humo-Ferric Podzols and Placic Humic podzols supporting Cladonia black spruce forests. Further downslope moderately well drained gleyed members of the Ferro Humic and Humo Ferric Podzols (as a result of the fragipans) produce the richer hylocomium balsam fir forest types. The Brunisolic soils are confined to the middle and bottom slopes with a mixture of hylocomium balsam fir and white birch forests. They also tend to be gleyed as a result of the compact Cx horizon.

References:

Bajzak, D and B. A. Roberts. 1984. Mapping Land Types for forest evaluation in Lake Melville area, Labrador, Canada.Paper presented at the joint meeting of the Working Parties No. 1.02-06 and No. 1.02-10 of IUFRO on Qualitative and Quantitative Assessment of Forest Sites with Special Reference to Soil. Sept. 10-15, 1984. Birmensdorf, Switzerland. 12 p.

Hillyard, R. 2004. Forestry in Labrador: An Update. Paper Presented at the Canadian Institute of Forestry (CIF) Newfoundland & Labrador Section, 47th AGM, St. John's , Newfoundland. October 23-24, 2003. P.133-149 In Sustaining Communities and the Resource. Proceedings from the Technical Session of The C.I.F/I.F.C. and The Registered Professional Foresters Association (R.P.F) of NL.

Mallik, A.U. and B.A. Roberts. 1994. Natural regeneration of *Pinus resinosa* on burned and unburned sites in Newfoundland. Journal of Vegetation Science 5: 179-186.

Roberts, B.A. 1986. The importance of soil drainage and soil seepage factors in assessing forest site capacity in central Newfoundland. P. 89-100. In van Groenewoud ed. Proceedings of IUFRO working party S.02.06, Forest Site Classification Methods, October 7-10, 1985, Fredericton, New Brunswick, Canada. 182 pp.

Roberts, B. A., K.W. Deering and B. D. Titus. 1998. Effects of intensive harvesting on forest floor properties in Betula papyrifera stands in Newfoundland. Journal of Vegetation Science 9: 521-528.

Rowe, J.S. 1972. Forest regions of Canada. Env.Can.Can.For.Serv. Publication No. 1300, Ottawa, Ont. 172 pp.

Ryan, A. G. 1978. Native trees & shrubs of Newfoundland 7 Labrador. Parks division, Dept. of Environment & Lands, Province of Newfoundland. 120p.

Titus, B. D., B. A. Roberts and K. W. Deering. 1997. Soil solution concentrations on three white birch sites in central, Newfoundland following different harvesting intensities. Biomass and Bioenergy 13: 313-330.

Titus , B. D. , B. A. Roberts and K. W. Deering. 1998. Nutrient removals with harvesting and by deep percolation from white birch (*Betula papyrifera* (Marsh)) sites in central Newfoundland. Canadian Journal of Soil Science 78: 127-137.

van Kesteren, A. R. 2000. Soil erodibility relationships on drumlin deposits in the Cape Caribou River area, Labrador. Canadian Journal of Soil Sciences 80: 577-580.

IR# JRP.103

Mitigation Measures (Rare Plants - Canada Yew)

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Subject - Mitigation Measures (Rare plants -Canada Yew)

References:

EIS, Volume III, Section 5.5.5.1 (Environmental Effects Analysis and Effects Management – Construction)

Rationale:

The EIS states that "Reservoir impoundment will result in the inundation of three sites where Canada yew has been recorded. Canada yew is a medicinal plant used by the Labrador Innu with limited distribution in the Assessment Area. In **consultation with Innu Nation**, Nalcor Energy will **relocate these plants to suitable sites for re-establishment**." (Volume III, p. 5-34) (emphasis added).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Information Requested:

The Proponent is asked to:

a. **discuss the current status of Canada Yew as a medicinal plant in Labrador, including frequency of harvesting and use;**

Response:

Canada yew has been used as the main ingredient in, or as a component of, medicines by several First Nations (Arnason et al. 1981). Canada yew is known by the Innu of Labrador as "Assiuashik", and has been used as a traditional medicine (Volume IB, Appendix IIB-H, pp. 64-67). Some elders of the Innu community gather these plants and prepare them as medicines, some of which are used daily for preventing sickness. Innu may collect Canada yew in late August or early September, whereupon the plant is boiled and applied to sores (E. Piwas, pers. comm., July 2009). With the exception of the elders, most Innu are unaware of healing properties of this plant (M. Penashue, pers. comm.).

Canada yew foliage contains a family of chemicals called taxanes that are used in making a number of anti-cancer drugs. There is no known commercial harvest of Canada yew in Labrador. However, some commercial harvesting has occurred in Newfoundland and in Quebec (Gaspé and areas on the north shore of the Saint Lawrence River) (see proceedings of the meetings of the Canada Yew Association: www.canyew.org). Given its scarcity in Labrador (Minaskuat 2008), commercial scale harvesting for medicinal use is unlikely.

References:

Personal Communications:

Piwas, E. Innu Elder, Resident of Natuashish

Penashue, M. Innu Shaman in Training, Resident of Sheshatshiu

Literature Cited:

Arnason, T., R.J. Hebda, and T. Johns, 1981. Use of plants for food and medicine by Native Peoples of eastern Canada. Can. J. Bot. 59:2189-2325.

Minaskuat Inc. 2008. Rare Plant Survey in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Information Requested:

The Proponent is asked to:

b. describe how suitable spots for re-establishment will be identified;

Response:

Yew typically grows in the understorey on well-drained and relatively nutrient rich sites. This is consistent with the ecotypes on which it was found in the lower Churchill River valley where it was usually beneath a conifer or mixedwood cover. It grew under red-osier dogwood (*Cornus stolonifera)*, alder (*Alnus sp.*), and amongst raspberry (*Rubus sp.*) (Minaskuat 2008). The subsurface seepage characteristic combined with the associated species found on the Riparian Thicket (RT), Fir-White Spruce Forest (FW) and some of the Mixed Wood Forest (MW) sites are consistent with well-drained and nutrient rich sites observed elsewhere. The Gravel Bar (GB) sites would be more highly variable with respect to drainage but would not preclude subsurface water flow.

Steps required:

1. Focusing on the ecotypes discussed above, and in consultation with the Innu, potential candidate relocation sites outside of the proposed flood area will be identified from habitat maps generated for this Project (e.g., vegetation surveys), aerial photograph interpretation, Light Detection and Ranging (LiDAR) maps and applying local and traditional knowledge.

2. Field visits will be completed to confirm the suitability of candidate sites.

Reference:

Minaskuat Inc. 2008. Rare Plant Survey in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Information Requested:

The Proponent is asked to:

c. **describe how the Proponent will ensure that re-establishment is successful, both in the short and long terms, including a discussion of whether the Innu Nation will be involved in monitoring and follow-up;**

Response:

A Follow-up and Monitoring Program (see the response to IR# JRP.112) will be designed to assess the success of the relocated yew plants. This Follow-up and Monitoring Program, once finalized, would include assessing the plants at appropriate time intervals following re-establishment, and during the appropriate season, until such time that the plants are deemed to be established (short-term) and expanding in the relocation areas. Nalcor Energy's (Nalcor's) adaptive management procedures will be followed, as appropriate, so that re-establishment of Canada yew occurs over the long-term at the relocation sites.

In addition to the involvement outlined in the response to parts (a) and (b), the Innu will be consulted to determine their involvement with the Follow-up and Monitoring Program, including the design and field assessment. Traditional knowledge of this plant and the area is an important component of the Follow-up and Monitoring Program.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Information Requested:

The Proponent is asked to:

d. **provide information on any successful relocations of Canada Yew elsewhere, including the experts involved and the attributes that made these re-establishment operations successful; and**

Response:

Although relocating plants is a common practice, and has been applied to the genus *Taxus* (Cullina 2002), no specific information on relocation of Canada yew plants could be located. To date, much of the effort related to Canada yew has been towards domestic propagation of this species (cfs.nrcan.gc.ca/subsite/nontimber/interest).

Attributes that are likely important to successful re-establishment include: appropriate site selection (e.g., Canada yew is not drought tolerant); appropriate site preparation (e.g., Canada yew grows slowly and cannot compete effectively with fast growing weeds); care during collection, transporting, and re-planting; and protection from moose browsing (see Minaskuat 2008).

References:

Cullina, W. 2002. Native Trees, Shrubs & Vines: A guide to using, growing, and propagating. The New England Wild Flower Society.

Minaskuat Inc. 2008. Rare Plant Survey in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.103**

Information Requested:

The Proponent is asked to:

e. **provide plans for cooperation with other departments and/or experts during the reestablishment, follow-up, and monitoring phases.**

Response:

During the design and implementation of the Follow-up and Monitoring Program, Nalcor will consult with recognized experts to help refine the parameters for the collection, transportation, transplanting and assessment of the relocated Canada yew plants. Nalcor will consult with, and include the Innu in the Follow-up and Monitoring Program, as outlined in the response to parts (b) and (c) above.

IR# JRP.104

Mitigation Measures (Cultural Heritage Resources)

Requesting Organization – Joint Review Panel **Information Request No.: JRP.104**

Subject - Mitigation Measures (Cultural Heritage Resources)

References:

EIS, Volume III, Section 6.5.5 (Environmental Effects Analysis and Effects Management – Cultural Heritage Resources)

Rationale:

According to the EIS, "Nalcor Energy will undertake other mitigation measures for all archaeological sites, subject to regulatory approval. Nalcor Energy will also **consult with local stakeholders, such as heritage and historical societies and/or cultural groups**, to determine the level of mitigation appropriate for a number of sites, notably the remains of historic tilts." (p. 6-14) (emphasis added).

Also, "[i]n the event that undiscovered Historic and Archaeological Resources are identified as a result of Project construction activities, Nalcor Energy will **implement a Stage 1 HROA in accordance with provincial guidelines**. No further activity at that site would proceed until an appropriate approach is approved by the PAO." (Volume III, p. 6-14) (emphasis added).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.104**

Information Requested:

The Proponent is asked to:

a. **clarify when mitigation measures would be implemented for the 44 archaeological sites that will be permanently lost as a result of the Project; and**

Response:

The mitigation measures for the 44 archaeological sites identified within the Assessment Area will be completed prior to any Project-related ground disturbance activities, including brush and tree clearing, and impoundment of reservoirs. For further details on mitigation measures for the archeological sites, please see Attachment A (Historic and Archaeological Resources Mitigation Plan).

Requesting Organization – Joint Review Panel **Information Request No.: JRP.104**

Information Requested:

The Proponent is asked to:

b. **describe whether and how Aboriginal groups would be engaged in implementation of mitigation for the archaeological sites and the preservation and documentation of undiscovered Historic and Archaeological Resources identified as a result of Project construction activities.**

Response:

Aboriginal groups will be engaged in the implementation of mitigation for the archaeological sites and the preservation and documentation of any undiscovered Historic and Archaeological Resources that might be identified once Project activities commence. This would involve the hiring of Aboriginal people to carry out the research under the direction of qualified Archaeologists. A training program in archaeological field techniques will be delivered to Aboriginal field research participants prior to fieldwork. The training will serve to provide background in:

- Labrador pre-history and history;
- basic methods and techniques required for the archaeological field program;
- identification and classification of archaeological materials and preparation of records;
- basic methods and principals of artifact conservation; and
- the value of understanding and preserving the area's archaeological heritage.

INFORMATION RESPONSES
LOWER CHURCHILL PROJECT
CEAA REFERENCE NO.07-05-26178

JOINT REVIEW PANEL

Attachment A
Historic and Archaeological Resources Mitigation Plan

IR# JRP.104

October 2009

nalcor energy
LOWER CHURCHILL PROJECT

HISTORIC AND ARCHAEOLOGICAL RESOURCES MITIGATION PLAN

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1.0 BACKGROUND

1.1 The Project

Nalcor Energy (Nalcor) is proposing to develop hydroelectric generation facilities at Gull Island and Muskrat Falls on the lower Churchill River in central Labrador (the "Project") (Figure 1-1). The Project will involve creation of two reservoirs and associated infrastructure, as well as transmission lines between Muskrat Falls and Gull Island, and from Gull Island to the existing facility at Churchill Falls. Temporary access roads will be required, construction camps will be built, and partial clearing will take place in reservoir areas. The reservoir flooding required for the Project is estimated to be 126 km^2.

1.2 Historic and Archaeological Resources

In preparation for an environmental assessment of the Project, Jacques Whitford Environment Limited (Jacques Whitford), Innu Economic Development Enterprises Inc. (IEDE), Innu Environment Limited Partnership (IELP), and Minaskuat Limited Partnership (Minaskuat) were contracted by Nalcor and its predecessor (Newfoundland and Labrador Hydro) to undertake a study of the area's Historic and Archaeological Resources. The Historic and Archaeological Resources study (discussed in Chapter 6.0, Volume III of the Environmental Impact Statement (EIS) under Cultural Heritage Resources) involved an extensive review of background and documentary information, several phases of fieldwork within the Assessment Area (1998, 1999, 2000, and 2006), research and analysis of data, report preparation, and archaeological potential mapping (IEDE/Jacques Whitford 2000; Jacques Whitford/IELP 2001a, 2001b, 2001c, 2001d; Minaskuat Inc. 2008).

The primary objectives of the study were to systematically survey the Assessment Area for Historic and Archaeological Resources in order to reduce the likelihood of Project interactions with any sites or materials that might be present.

Historic and Archaeological Resources include sites, objects (such as stone tools), and structural remains pre-dating 1960 that show evidence of manufacture, alteration or use by humans. Also included are burial and other heritage sites and materials dating to the Pre-contact and Historic Periods as well as cultural and/or spiritual sites or places.

Historic and Archaeological Resources are valued by Aboriginal people and the public at large for their intrinsic value and for the information they provide on the pre-contact and historic human activity in the province. They are non-renewable and, in many cases, the resources themselves and the information and cultural meaning they hold cannot be replaced if damaged or destroyed. Historic and Archaeological Resources are physical representations of Aboriginal life prior to the arrival of Europeans in North America and can help shed light on the relationships that existed among different cultures and between people and the environment.

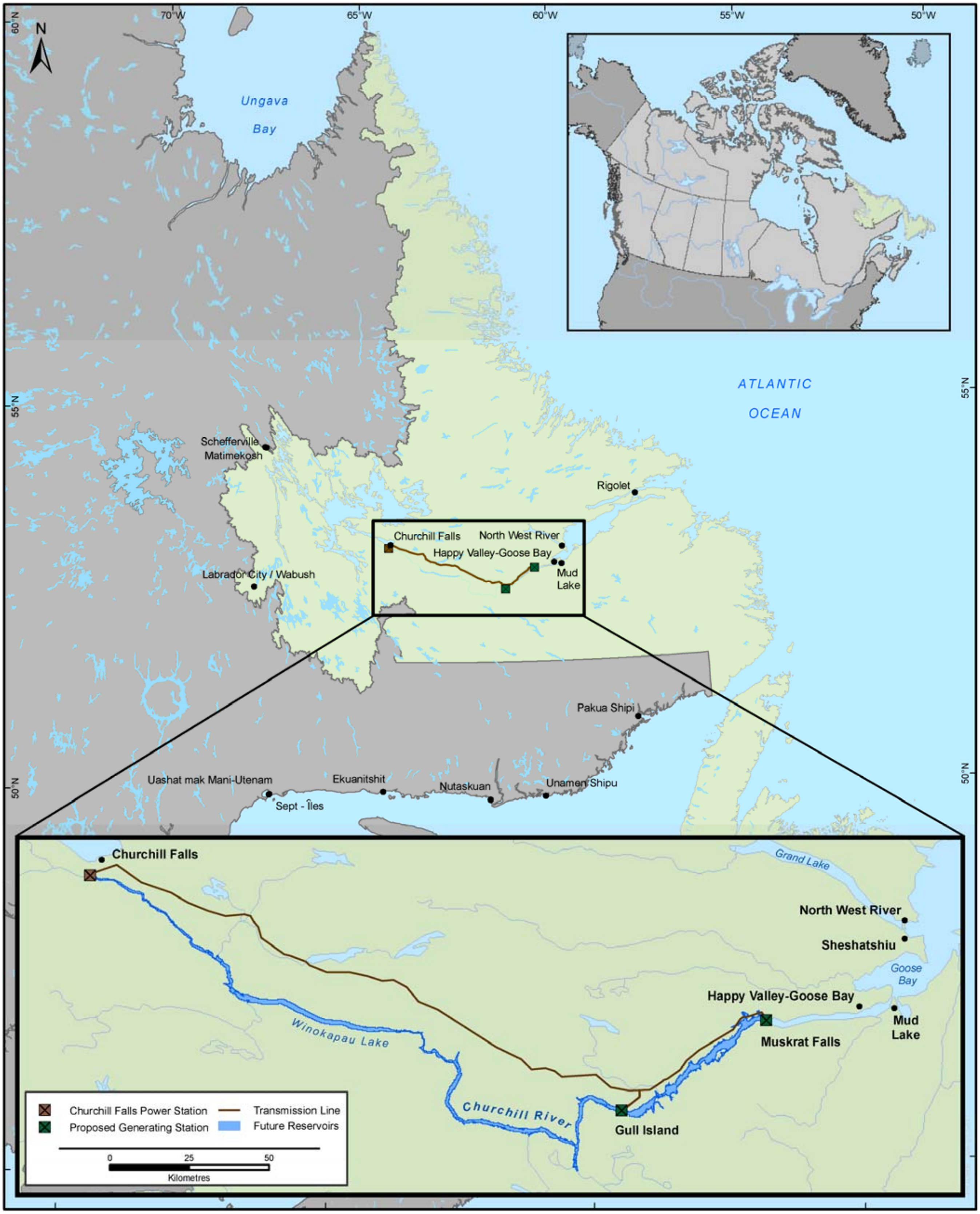

Figure 1-1 Project Location

1.2.1 Project Assessment Area and Potential Interactions

The Assessment Area for Historic and Archaeological Resources is limited to locations where ground disturbance or landscape alteration will occur as a result of construction and operation of Project infrastructure. This includes:

- the facilities at Gull Island and Muskrat Falls;
- the associated reservoirs; and
- the transmission line right-of-ways (Figure 1-2).

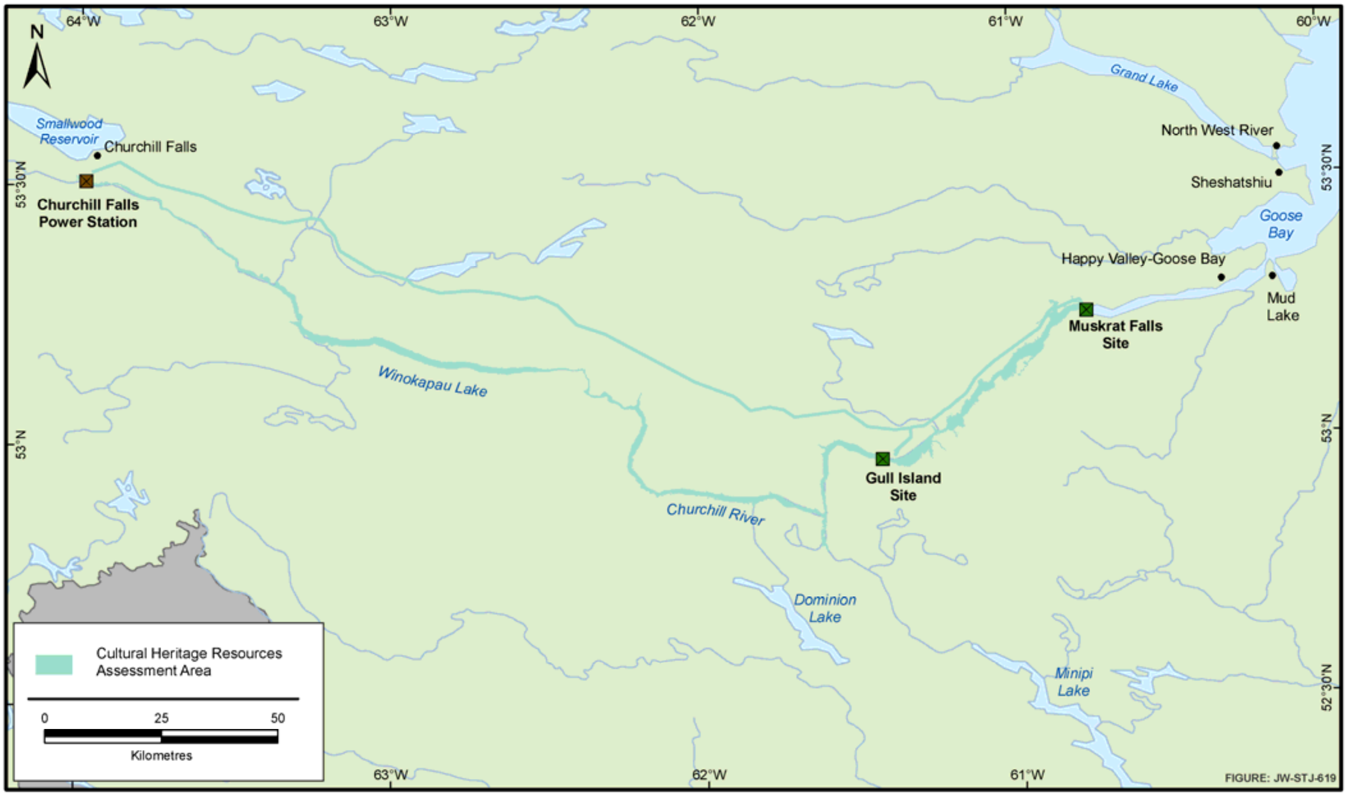

Figure 1-2 Historic and Archaeological Resources Assessment Area

Once identified, construction and operation of temporary and permanent access roads, rock quarries, borrow pits and other Project infrastructure could also result in interactions with Historic and Archaeological Resources. These areas will be surveyed prior to disturbance and in accordance with the *Historic Resources Act*.

In the case of cultural or spiritual sites, disturbance can occur if a site (or the adjacent landscape of which it is considered a part) is altered to the degree that the importance of the location as a whole has been diminished. For example, this can occur if the topography or vegetation surrounding a cultural site, feature or structure is radically changed (as could occur through clear-cutting of trees, rock quarrying, earth removal, or diversion of water), even though the site itself has not been affected physically or altered in any way.

Nalcor will mitigate Project-related effects to Historic and Archaeological Resources within the Assessment Area through the implementation of measures described in this Historic and Archaeological Resources Mitigation Plan. As circumstances change and as more specific information is acquired, the plan will be modified to reflect the most up-to-date knowledge. Appropriate mitigation measures will ensure that all sites and materials are protected from disturbance or are otherwise accorded respectful treatment during all Project phases.

1.2.2 Regulatory Policy

The management and protection of Historic and Archaeological Resources falls under the mandate of the Provincial Archaeology Office (PAO) of the Newfoundland and Labrador Department of Tourism, Culture and Recreation. The PAO administers its mandate through the Newfoundland and Labrador *Historic Resources Act* (1985), which has its own distinct regulatory requirements, in addition to those of the broader environmental assessment process.

2.0 HISTORIC AND ARCHAEOLOGICAL RESOURCES MITIGATION PLAN

The primary objective of this Historic and Archaeological Resources Mitigation Plan is to provide a detailed description of the mitigation measures proposed for the Historic and Archaeological Resources registered for the Assessment Area that will be affected as a result of Project activities. The mitigation measures follow current regulatory policy and guidelines outlined in the Historic Resources Assessment and Impact Management Summary (Government of Newfoundland and Labrador 1992), which is an appendix to the Newfoundland and Labrador *Historic Resource Act* (1985) administered by the PAO.

In addition, this report outlines a Contingency and Response Plan for Historic and Archaeological Resources in the unlikely event that any unknown sites or materials of archaeological or cultural/spiritual significance are discovered during Project construction, operation or maintenance. The Historic and Archaeological Resources Mitigation Plan can be integrated into the larger context of environmental management and orientation for site workers.

3.0 BACKGROUND

3.1 Project-related Research

Archaeological research on the Churchill River began in 1974, when James Tuck completed a survey between Churchill Falls and Gull Island by canoe (Tuck 1981). Subsurface testing was conducted in areas thought to hold potential for Aboriginal camps, such as islands, points of land, stream mouths, and portages. Eroding banks on Winokapau Lake toward the western end of the Assessment Area were also inspected, but no trace of Aboriginal occupation was identified. However, the remains of a trapper's cabin or tilt (abandoned in 1968) and the ruins of an older structure dating to the nineteenth century were located along a portage at Gull Island. The site has been disturbed by construction. Further east, at a portage on the north side of Muskrat Falls, a concentration of quartzite stone chipping debris and two bifacially-flaked stone tools were located, indicating a pre-contact Aboriginal campsite (Thurlow and Associates1974).

The 1998 Historic Resources Overview Assessment (HROA) carried out in relation to the Churchill River Hydroelectric Generation Project involved an extensive program of background research covering a broad study area encompassing most of Labrador south of the Fraser River and extending south to the north shore of the St. Lawrence River. The 1998 field research program that followed was principally focused on the Churchill River valley, but included assessment of additional Project features as far away as southwest Labrador, the Strait of Belle Isle, and insular Newfoundland. Archaeological assessment in 1998 was further supported by a separate Geomorphology component study (IEDE/Jacques Whitford 2000; Jacques Whitford/IELP 2001a, 2001b, 2001c, 2001d; Minaskuat Inc. 2008).

The 1999 HROA continued this research, further investigating data and apparent data gaps arising from the 1998 results, including an Innu land-use data verification component. In 2000, a mapping project developed a systematic characterization of survey effort and archaeological potential in order to plan the work required to complete the HROA. This included mapping archaeological potential along the proposed transmission line route from Gull Island to Muskrat Falls to assist in route selection. The results, reported in detail in the 1998, 1999, and 2000 mapping project reports (IEDE/JWEL 2000; JWEL/IELP 2001a; 2001b, 2001c, 2001d), constitute by far the largest archaeological research project undertaken to date in central Labrador.

Overall, archaeological assessment from 1998 to 2000 led to the investigation of over 984 locations. Approximately 32,500 test pits were excavated at over 809 of these. Within the Assessment Area, which represented the focus of work through most of the assessment, the testing effort stood at 820 locations, with 23,601 test pits excavated at 674 of these. The testing strategy used throughout the HROA involved testing pre-selected locations, based on air photo analysis and land use data, and intensive subsurface testing is targeted at those locations. This approach has been significantly more successful at recovering interior archaeological remains than any other approach attempted in Labrador to date.

While the Gull Island Generating Facility and reservoir had been assessed in detail in previous studies, additional work was undertaken in 2006 to complete further archaeological assessment of the Muskrat Falls generating facility and reservoir, and to address data gaps in the archaeological potential mapping of the transmission line corridor from Muskrat Falls to Gull Island and Churchill. As a result of the 2006 field program, the level of assessment is now equivalent to that already achieved in the Gull Island reservoir area. With respect to the transmission line corridor, previous mapping was extended in selected areas to cover sections of the line that diverged from the corridor originally mapped (IEDE/Jacques Whitford 2000; Jacques Whitford/IELP 2001a, 2001b, 2001c, 2001d; Minaskuat Inc. 2008).

3.2 Overview of Baseline Conditions for Historic and Archaeological Resources

In total, forty-six (46) archaeological sites with assigned Borden numbers (the Canadian registry for historic and archaeological sites) were identified within the Assessment Area during Project-related field studies (IEDE/Jacques Whitford 2000; Jacques Whitford/IELP 2001a, 2001b, 2001c, 2001d; Minaskuat Inc. 2008). It is important to note that because some of the sites contain evidence of more than one period of occupation and/or cultural group, the numbers summarized below for site types and components exceed the total number of sites recorded. The total inventory includes:

- 26 sites with pre-contact components:
- 6 historic tilts (i.e., makeshift trapper's cabins);
- 14 historic campsites and other indeterminate historic occupations; and
- 2 nineteenth century Hudson's Bay Company trading posts.

Two sites (FhCe-01 and FgCn-01) have been excavated archaeologically and no further mitigation is necessary, and two sites (FfCi-05 and FfCi-06) will be lost due to construction of Project infrastructure. Two other sites (FiCt-01 and FhCe-02) could be disturbed (and eventually lost) because of transmission line construction, increased access or shoreline erosion. Because 40 archaeological sites are situated close to the shoreline of the Churchill River within the area to be inundated, reservoir preparation and impounding is the principal Project activity that will result in loss. If unmitigated, the cultural information, artifacts, and other remains associated with all these sites would also be lost.

As well, there are two known sites of cultural and spiritual importance to the Innu within the Assessment Area. One is a rock knoll situated on the north side of Muskrat Falls (Manitu-utshu) believed to be the dwelling place of the giant otter or seal-like being known as Uenitshikumishiteu in Innu mythology. The second site (Ushkanshipiss), situated on the south side of the Churchill River near Upper Brook, is where the last shaking tent ceremony in Labrador and Quebec is reported to have taken place in the fall of 1969 (Figure 3-1).

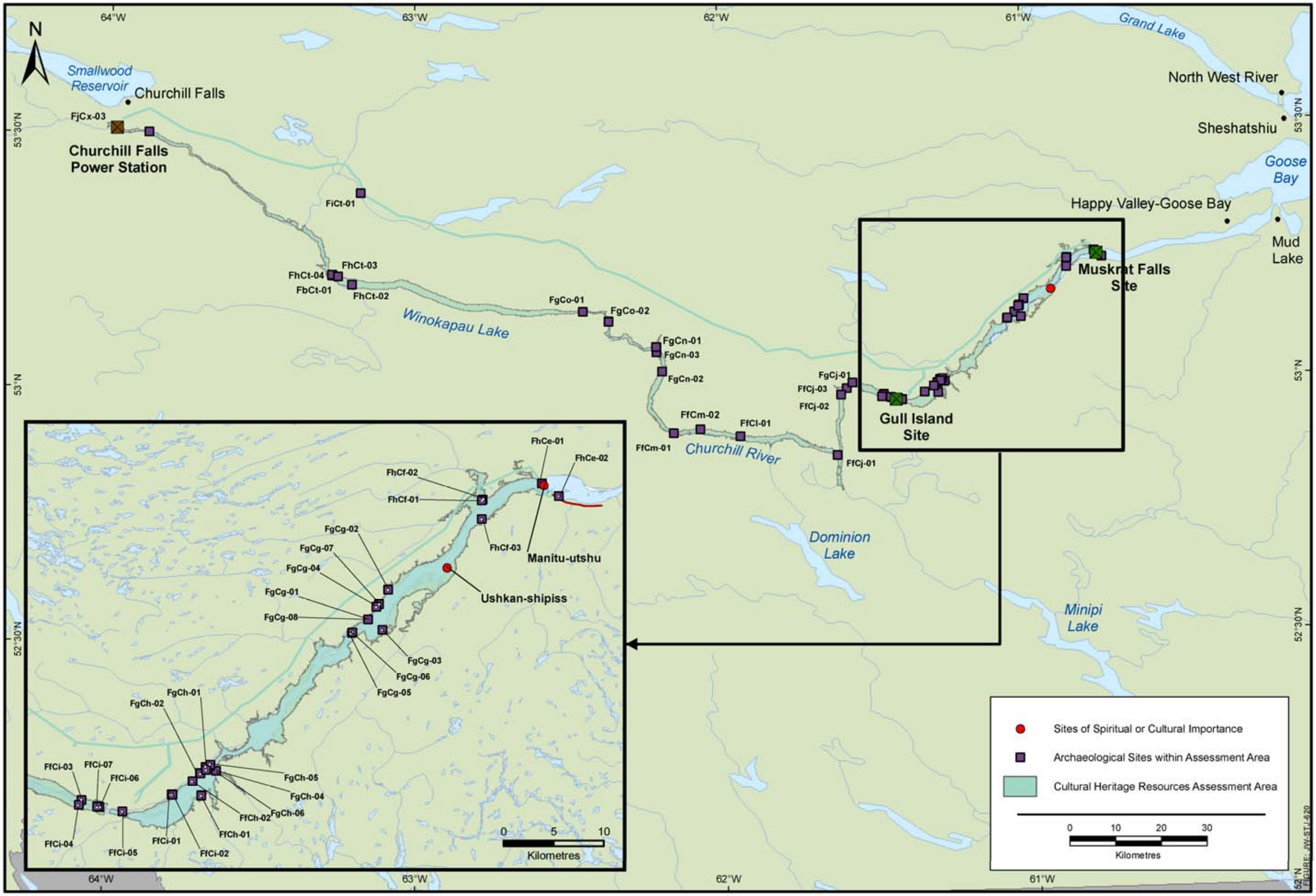

Figure 3-1 Historic and Archaeological Resources Within the Assessment Area

A complete listing of the Historic and Archaeological Resources known to exist in the Assessment Area, as well as an indication of their age, type, and baseline condition is provided in Table 3.1 below.

Table 3-1 Historic and Archaeological Resources Identified Within the Assessment Area

Archaeological Registration Number	Site Period or Type	Baseline Condition
FhCe-02	Intermediate Period Amerindian	Disturbed
FhCe-01	Intermediate Period Amerindian	Excavated 1979
FhCf-01	Historic Tilt	Unstable
FhCf-02	Historic Tilt	Unstable
FhCf-03	Historic Campsite	Stable
FgCg-02	Intermediate Period Amerindian	Stable
FgCg-03	Intermediate Period Amerindian	Stable
FgCg-08	Historic Tilt	Unstable
FgCg-01	Hudson's Bay Company Trading Post and Intermediate Period Amerindian	Stable
FgCg-04	Indeterminate Historic Occupation	Stable
FgCg-07	Indeterminate Historic Occupation	Stable
FgCg-05	Intermediate Period Amerindian	Stable
FgCg-06	Intermediate Period Amerindian	Stable
FgCh-01	Intermediate Period Amerindian	Stable
FfCi-01	Intermediate Period Amerindian	Stable
FfCi-02	Intermediate Period Amerindian	Stable
FfCi-05	Intermediate Period Amerindian	Stable
FgCh-05	Intermediate Period Amerindian	Stable
FgCh-06	Historic Campsite	Stable
FfCh-02	Intermediate Period Amerindian	Stable
FgCh-04	Intermediate Period Amerindian	Unstable
FgCh-02	Intermediate Period Amerindian	Stable
FgCh-03	Late Pre-contact Period Amerindian	Stable
FfCh-01	Historic Tilt	Unstable or Disturbed
FfCi-06	Intermediate Period Amerindian	Stable
FfCi-07	Intermediate Period Amerindian	Stable
FfCi-04	Intermediate Period Amerindian	Stable
FfCi-03	Intermediate Period Amerindian	Stable
FfCj-02	Intermediate Period Amerindian	Stable
FgCj-01	Intermediate Period Amerindian and Historic Tilt	Disturbed
FfCj-03	Historic Campsite	Stable
FfCj-01	Historic Campsite or Portage	Stable
FfCl-01	Historic Tilt	Unstable
FfCm-01	Intermediate Period Amerindian	Stable
FfCm-02	Intermediate Period Amerindian	Stable
FgCn-02	Historic Campsite	Stable
FgCn-01	Intermediate Period Amerindian	Excavated 1999
FgCn-03	Historic Campsite	Stable
FgCo-02	Historic Campsite	Stable
FgCo-01	Historic Tilt	Unstable
FhCt-02	Intermediate Period Amerindian and Historic Campsite	Stable
FbCt-01	Hudson's Bay Company Trading Post	Disturbed
FhCt-04	Historic Campsite	Stable
FhCt-03	Historic Campsite	Stable
FjCx-03	Historic Campsite	Stable
FiCt-01	Historic Campsite	Stable
Manitu-utshu	Cultural/Spiritual	Disturbed
Ushkan-shipiss	Cultural/Spiritual	Undisturbed

4.0 MITIGATION

A key goal of Historic and Archaeological Resources Mitigation Plan is to protect the resources and mitigate potentially adverse effects to reduce loss or disturbance of sites, objects or materials, and places of cultural and spiritual importance. Accordingly, measures will be (and have been), taken to mitigate potential environmental effects of the Project on known Historic and Archaeological Resources and to minimize adverse environmental effects on those that may be present within the Assessment Area but have not yet been discovered.

Mitigation measures for known Historic and Archaeological Resources typically follow guidelines outlined in the Historic Resources Assessment and Impact Management Summary (Government of Newfoundland and Labrador 1992), which is an appendix to the Newfoundland and Labrador *Historic Resource Act* (1985) administered by the PAO. Mitigation refers to measures or actions undertaken prior to ground disturbing activities to reduce any adverse environmental effects on Historic and Archaeological Resource values. Systematic Data Recovery (SDR; excavation) has typically been considered the only solution to alleviating adverse environmental effects on Historic and Archaeological Resources where disturbance is unavoidable. However, mitigation implies consideration of a wide range of options, including various forms of Project redesign (such as that implemented for Muskrat Falls) and types of active site protection or preservation, as well as different intensities of and approaches to documentation and SDR.

Decisions on which mitigation measures should be implemented in any specific case depend on a variety of factors, including:

- the nature and significance of the resource;
- the nature of the effect;
- the relative cost-effectiveness of various options under site-specific conditions;
- research and resource management priorities and needs; and
- relevant development objectives, conditions and constraints.

In the case of reservoir preparation and impounding, Project redesign, site avoidance and active site protection and preservation is not possible. Therefore, Nalcor will undertake other mitigation measures for all archaeological sites, subject to regulatory approval. Nalcor will also consult with local stakeholders, such as heritage and historical societies and/or cultural groups, to determine the level of mitigation appropriate for a number of sites, notably the remains of historic tilts. For example, this could include Additional Field Recording (AFR) and Systematic Field Recording (SFR) and, if warranted, Subsurface Sampling (SS). Nalcor will consult the PAO to obtain the approval of proposed mitigation measures before proceeding with construction at or near any of the known sites.

SDR involves the scientific and systematic investigation of unavoidable Historic and Archaeological Resource losses using accepted data recovery techniques. All data is fully analyzed and interpreted, and can lead to publication and dissemination of the research results. SDR also includes provisions for proper curation and conservation of all recovered materials and for their final deposit with the collections of the Provincial Museum of Newfoundland and Labrador. In particular, all the recovered materials, as well as all relevant records of the investigation, are required to be made available and accessible to future investigators (Government of Newfoundland and Labrador 1992). SDR differs importantly from salvage operations, which are normally undertaken only when the resource is discovered during construction and could not reasonably have been predicted.

Nalcor will undertake a systematic recovery of historic and archaeological resources, which will be designed to achieve the fullest possible understanding of the resources. In any specific case, the general scope and level of intensity of the recovery operation will vary depending on the number of sites involved, their importance, size and depositional character, the level of adverse effect and research and management priorities.

SDR of Historic and Archaeological Resources will include:

- a complete or partial systematic surface collection, controlled excavation, or both;
- a comparative analysis and interpretation of content and contextual information;
- documentation and conservation of materials; and
- an investigative report (Government of Newfoundland and Labrador 1992).

In accordance with provincial guidelines, excavation and comprehensive recording through SDR is the most feasible option for the 24 pre-contact sites and the two (2) nineteenth century Hudson's Bay Company trading posts recorded for the Assessment Area. For the six (6) historic tilt locations, AFR of all surface-visible features and artifacts will apply. This will include photographic, video and illustrative coverage, as well as collection, documentation, and conservation of all relevant site artifacts. For the 14 historic campsites and other indeterminate historic occupations, a program of SFR and SS will be implemented to identify nineteenth century or earlier components. Where indicated, SDR through excavation and recording will follow. All archaeological sites except those already excavated will be subject to this mitigation. For the cultural and spiritual site near Upper Brook (Ushkan-shipiss), a program of SFR and SS will apply in addition to the site visit recording obtained by Innu, and sponsored by Nalcor.

Moreover, interactions with the cultural and spiritual site at Muskrat Falls (Manitu-utshu) have been minimized through the Project design.

The mitigation measures proposed for each site is presented in Table 4-1.

Table 4-1 Historic and Archaeological Resources Mitigation

Archaeological Registration Number	Project Feature	Environmental Effect	Contributing Project Activity	Mitigation
FhCe-02	Muskrat Falls Generation Facility	Disturbance or Loss	Construction of Generation Components or Increased Access	SFR and SS
FhCe-01	Muskrat Falls Generation Facility	Previously excavated; no environmental effect from Project	Previously excavated; no environmental effect from Project	Previously excavated; no environmental effect from Project
FhCf-01	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FhCf-02	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FhCf-03	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-02	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-03	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-08	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FgCg-01	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-04	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SRF and SS

Archaeological Registration Number	Project Feature	Environmental Effect	Contributing Project Activity	Mitigation
FgCg-07	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-05	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCg-06	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCh-01	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCi-01	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCi-02	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCi-05	Muskrat Falls Reservoir and Gull Island Generation Facility	Disturbance or Loss	Construction of Access Road or Bridge	SDR
FgCh-05	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCh-06	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FfCh-02	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCh-04	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCh-02	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCh-03	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCh-01	Muskrat Falls Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FfCi-06	Gull Island Generation Facility and Reservoir	Loss	Construction or Reservoir Preparation and Impounding	SFR and SS
FfCi-07	Gull Island Generation Facility and Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCi-04	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCi-03	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCj-02	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCj-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FfCj-03	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FfCj-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FfCl-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FfCm-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FfCm-02	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FgCn-02	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FgCn-01	Gull Island Reservoir	Previously excavated; no environmental effect from Project	Previously excavated; no environmental effect from Project	Previously excavated; no environmental effect from Project
FgCn-03	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FgCo-02	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FgCo-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	AFR
FhCt-02	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FbCt-01	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SDR
FhCt-04	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FhCt-03	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FjCx-03	Gull Island Reservoir	Loss	Reservoir Preparation, Impounding	SFR and SS
FiCt-01	Proposed Transmission line	Disturbance or Loss	Construction and/or Increased Access	SFR and SS

Archaeological Registration Number	Project Feature	Environmental Effect	Contributing Project Activity	Mitigation
Manitu-utshu	Muskrat Falls Generation Facility	With selection of preferred layout, environmental effects are minimized	With selection of preferred layout, environmental effects are minimized	With selection of preferred layout, environmental effects are minimized
Ushkan-shipiss	Muskrat Falls Reservoir	Loss	Reservoir Preparation and Impounding	2006 Sponsored Site Visit by Innu Elders SFR and SS
Key:	SDR systematic data recovery (excavation) SFR systematic field recording		AFR additional field recording SS subsurface sampling	

5.0 CONTINGENCY AND RESPONSE PLAN

Even though the potential for inadvertent discoveries of Historic and Archaeological Resources within the Assessment Area is low given the extensive field research that has been completed to date, a Contingency and Response Plan will be implemented in the event of an inadvertent discovery of a historic or prehistoric artifact or archaeological site, which could include:

- scatters or concentrations of quartz, quartzsite or chert flakes resulting from stone tool manufacture;
- remains of earth-walled or stone tent rings from either the pre-contact or historic periods;
- stone, earth or wooden features related to hunting, fishing or trapping, such as stone hearths or caches, traps, caribou and bird blinds, and fish weirs;
- remains of wooden structures such as dilapidated tilts or outbuildings;
- remains of stone, antler, bone or metal tools, utensils and other artifacts related to land use in the area; and
- symbols of relationships between people and animals, such as caches of animal skulls and antlers and bird bones suspended in trees.

Representative photographs are provided in Appendix A.

All personnel working on the Project will be informed of the potential for the presence of archaeological and other cultural resources and of their responsibility to report and not disturb any suspected historic resources. Nalcor commits that:

a. Key personnel involved in various phases of the Project, including land surveying and tree and brush clearing, geotechnical drilling, road and accommodations construction, will be informed through an education and orientation program of the Historic and Archaeological Resources potential of the area, of the legalities regarding Historic and Archaeological Resources, and of responsibilities for reporting suspected finds.

b. Site supervisors will ensure that all site workers are informed about the Contingency and Response Plan and that a copy is available for review as an aid in site and artifact recognition.

c. Unless authorized by the PAO, archaeological sites will be avoided and protected from construction and related activities.

d. Under the *Historic Resources Act* (1985), all archaeological sites and artifacts are considered to be the property of the Crown, and must not be disturbed. Nalcor and its contractors will take all reasonable precautions to prevent employees or other persons from removing or damaging any such artifacts or sites and may be held liable for prosecution under Section 35.1 and 35.2 of the *Historic Resources Act* (1985) for all contraventions. Personnel working in the vicinity will be advised of the find. The site area will be flagged for protection and avoidance, if required by the proximity of Project activities.

In the event of unanticipated discovery of a historic or prehistoric artifact, archaeological site or ethnographic site, the following procedures will be implemented:

a. STOP ALL WORK in the immediate area (<25 m) of the discovery until authorized personnel from Nalcor, having consulted with the Newfoundland and Labrador Provincial Archaeologist, permits a resumption of the work.

b. Report the find immediately to the Site Supervisor.

c. Mark the site's visible boundaries; restrict activities to other parts of the Project area until clearance is obtained. Personnel will not move or remove any artifacts or associated material unless the integrity of the material is threatened.

d. A qualified Archaeologist will assess the significance and extent of the find and will provide the following information to the PAO; site workers will comply with any instructions provided:

    i. nature of the find;
    ii. precise descriptive and GPS location and the time of the find;
    iii. nature of the activity resulting in the find;
    iv. identity of the person(s) making the find;
    v. present location of the material, if moved, and any protective measures initiated for the material and the site; and
    vi. extenuating circumstances.

e. Following an assessment of the nature, significance and mitigation needs, a report will be made by the Archaeologist to Nalcor and the PAO. Any proposed mitigation will first be approved by the PAO.

f. Regular monitoring of the find will be conducted by a qualified Archaeologist to ensure that site protection measures are adequate.

In the event that undiscovered Historic and Archaeological Resources are identified as a result of Project construction activities, Nalcor will implement a Stage 1 HROA in accordance with provincial guidelines. No further activity at that site would proceed until an appropriate approach is approved by the PAO.

6.0 CONTACTS

Regulatory Agency:

Martha Drake
Provincial Archaeologist
Provincial Archaeology Office
Department of Tourism, Culture and Recreation
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Project Personnel:

To be completed when positions are filled

7.0 REFERENCES

Denton, D. 1989. La période préhistorique récente dans la région de Caniapiscau. Recherches Amérindiennes au Québec 19(2-3): 59–75.

Fitzhugh, W.W. 1972. Environmental archaeology and cultural systems in Hamilton Inlet, Labrador. Smithsonian Contributions to Anthropology 16. Washington, DC.

Fitzhugh, W.W. 1977. Indian and Eskimo/Inuit settlement history in Labrador: An archaeological view. Pp. 141. In: C. Brice Bennett (ed.). Our Footprints are Everywhere. Labrador Inuit Association, Nain, Labrador, NL.

Fitzhugh, W.W. 1978a. Maritime Archaic cultures of the central and northern Labrador coast. Arctic Anthropology 15(2): 61-95.

Fitzhugh, W.W. 1978b. Winter Cove 4 and the Point Revenge occupation of the central Labrador coast. Arctic Anthropology 15(2): 146-174.

Fitzhugh, W.W. 1986. Maritime Archaic field studies in central Labrador and notes on northwest corners. Pp. 54–65. In: J. Sproull Thomson and C. Thomson (eds.). Archaeology in Newfoundland and Labrador 1985, Annual Report 6. Historic Resources Division, Newfoundland and Labrador Department of Culture, Recreation and Youth, Government of Newfoundland and Labrador, St. John's, NL.

Fitzhugh, W.W. 1994. Staffe Island 1 and the Northern Labrador Dorset-Thulefont is different succession. Pp. 239–268. In: D. Morrison and J.L. Pilon (eds.). Threads of Arctic Prehistory: Papers in Honour of William E. Taylor Jr., Archaeological Survey of Canada Mercury Series, Paper 149.

Government of Newfoundland and Labrador, 1992. Historic Resources Assessment and Impact Management Summary. Copy on file at the Provincial Archaeology Office, St. John's.

IEDE/Jacques Whitford (IED Enterprises in partnership with Jacques Whitford Environment Limited). 2000. Churchill River Power Project 1998 Environmental Studies-Historic Resources Overview Assessment, Labrador Component. (LHP 98-17). Final Report submitted to Labrador Hydro Project, St. John's, NL. Copy on file at the Provincial Archaeology Office, Confederation Building, St. John's, NL

Jacques Whitford/IELP (Jacques Whitford Environment Limited and Innu Environmental Limited Partnership). 2001a. Labrador Hydro Project 1999 Environmental Studies-Historic Resources (Labrador Study) (LHP 99-17). Report submitted to Newfoundland and Labrador Hydro, St. John's, NL. Copy on file at the Provincial Archaeology Office, Confederation Building, St. John's, NL

Jacques Whitford/IELP (Jacques Whitford Environment Limited and Innu Environmental Limited Partnership). 2001b. Labrador Hydro Project 2000 Studies-Historic Resources Field Program (LHP 00-17). Report submitted to Newfoundland and Labrador Hydro, St. John's, NL. Copy on file at the Provincial Archaeology Office, Confederation Building, St. John's, NL.

Jacques Whitford/IELP (Jacques Whitford Environment Limited and Innu Environmental Limited Partnership). 2001c. Labrador Hydro Project 2000 Studies-Historic Resources Potential Mapping (LHP 00-17). Report submitted to Newfoundland and Labrador Hydro, St. John's, NL. Copy on file at the Provincial Archaeology Office, Confederation Building, St. John's, NL

Jacques Whitford/IELP (Jacques Whitford Environment Limited and Innu Environmental Limited Partnership). 2001d. Labrador Hydro Project Churchill River Power Project Historic Resources Overview Assessment 1998-2000, Volume 1: Interpretive Summary and Recommendations (LHP 00-17C). Report submitted to Newfoundland and Labrador Hydro, St. John's, NL. Copy on file at the Provincial Archaeology Office, Confederation Building, St. John's, NL.

Kaplan, S. 1983. Economic and Social Change in Labrador Neo-Eskimo Culture. Unpublished PhD Dissertation, Department of Anthropology, Bryn Mawr College, Bryn Mawr, PA.

Kennedy, J.C. 1995. People of the Bays and Headlands: Anthropological History and the Fate of Communities in the Unknown Labrador. University of Toronto Press. Toronto, ON.

Loring, S. 1992. Princes and Princesses of Ragged Fame: Innu Archaeology and Ethnohistory in Labrador. Unpublished PhD dissertation, Department of Anthropology, University of Massachusetts, MA.

Loring, S. 2001. Archaeology with the Innu at Kamistastin. National Museum of Natural History, Smithsonian Institution, Washington, DC. Arctic Studies Center Newsletter 9: 10–11.

Loring, S., M.T. McCaffrey, P. Armitage and D. Ashini. 2003. The archaeology and ethnohistory of a drowned land: Innu Nation research along the former Michikamats Lake shore in Nitassinan (interior Labrador). Archaeology of Eastern North America 31: 45–72.

McCaffrey, M.T. 2006. Archaic Period occupation in subarctic Quebec: A review of the evidence. Pp. 161-190. In: D. Sanger and M.A.P. Renouf (eds.). The Archaic of the Far Northeast, The University of Maine Press, Orono, ME.

MacLeod, D. 1967. 1967 Field Trip Report. Report on file, Provincial Archaeology Office, St. John's, NL.

MacLeod, D. 1968. 1968 Field Trip Report. Report on file, Provincial Archaeology Office, St. John's, NL.

Mailhot, J. 1997. The people of Sheshatshit: In the land of the Innu. Memorial University: St. John's, NL. Social and Economic Studies 58.

McAleese, K. 1991. The Archaeology of a Late 18th Century Sealing Post in Southern Labrador: George

Cartwright's Stage Cove. Unpublished MA Thesis, Department of Anthropology, Memorial University, St. John's, NL.

McAleese, K. 1992. Labrador Interior Waterways (Kanairiktok River Basis). Report on file, Provincial Archaeology Office, St. John's, NL.

McAleese, K. 1993. Labrador Interior Waterways Preliminary Report: Kanairiktok River Archaeological Survey. Report on file, Provincial Archaeology Office, St. John's, NL.

McGhee, R. and J.A. Tuck. 1975. An Archaic Sequence from the Strait of Belle Isle, Labrador. National Museum of Man Mercury Series 34, Ottawa, ON.

Minaskuat Inc. 2008a. 2006 Historic Resources Overview and Impact Assessment of Muskrat Falls Generating Facility and Reservoir and Muskrat Falls to Gull Island Transmission Line Corridor (LCP 535865/866). Lower Churchill Hydroelectric Generation Project Environmental Baseline Report. Report prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Nagle, C. 1978. Indian Occupations of the Intermediate Period on the central Labrador coast. Arctic Anthropology 15(2): 119–145.

Samson, G. 1978. Preliminary cultural sequence and palaeo-environmental reconstruction of the Indian House Lake region, Nouveau-Quebec. Arctic Anthropology 15(2): 186–205.

Tanner, V. 1947. Outlines of the Geography, Life and Customs of Newfoundland Labrador Volume II. Cambridge University Press, Cambridge.

Thurlow and Associates. 1974. Environmental Overview of the Lower Churchill Power Development. Final Report. Thurlow and Associates Environmental Control Consultants.

Tuck, J.A. and R. Grenier. 1989. Red Bay, Labrador, World Whaling Capital AD 1550-1600. Atlantic Archaeology Ltd., St. John's, NL

Tuck, J.A. 1981. Final Report: Lower Churchill Development Corporation Muskrat Falls Generating Project

Archaeological Report. Report on file, Provincial Archaeology Office, St. John's, NL.

APPENDIX A
Photos

PHOTO 1

Top Row (left to right)

Black, Banded Basalt, Stone Tool Chipping Flake from Pre-contact Site FfCi-07
Purple Quartzsite, Stone Tool Chipping Flake from Pre-contact Site FgCh-01
Cream-coloured Ceramic from HBC Trading Post FgCg-01

Bottom Row (left to right)

Dark Grey, Stone Tool Chipping Flake from Pre-contact Site FfCi-07
Purple Chert, Stone Tool Chipping Flake from Pre-contact Site FfCi-07
Purple Quartzsite, Stone Tool Chipping Flake from Pre-contact Site FgCh-01
Green Bottle Glass from HBC Trading Post FgCg-01

PHOTO 2

Concentration of Quartzsite Flakes from Pre-contact Site FhCe-01

PHOTO 3

Left to right

Metal Key from Historic Site FgCh-05
Metal Nail from Historic Site FgCh-05
Clay Smoking-Pipe Bowl and Stem from Historic Site FgCh-05