IR# JRP.165

Alternative Means of Carrying Out the Project

Requesting Organization – Joint Review Panel **Information Request No.: JRP.165**

Subject – Alternative Means of Carrying Out the Project

References:

EIS Guidelines, Section 4.3.2.2 (Alternative Means of Carrying Out the Project)

Related Comments / Information Requests:

IR # JRP.147

Comments from Premier Williams reported in various media on October 25, 2010

Rationale:

The Joint Review Panel (the Panel) for the Lower Churchill Hydroelectric Generation project (the Project) has reviewed the information submitted by Nalcor in response to Round 4 Information Requests (IR) and the comments received from participants.

The Panel is also aware of comments from Premier Williams reported in various media on October 25, 2010 regarding a possible change in the sequencing of Project phases where Muskrat Falls would be constructed first, followed by Gull Island at some indeterminate time in the future. If the preferred Project phasing i.e. the construction of Gull Island followed by Muskrat Falls at a fixed interval after, with an overlap in the construction of the 2 generating facilities, has changed, Nalcor is requested to inform the Panel as soon as possible.

In light of these comments from Premier Williams and of your response to the Panel's IR JRP.147, the Panel has determined that Nalcor must assess the implications of each possible alternative means of carrying out the Project as per the Environmental Impact Statement Guidelines (section 4.3.2.2) in order for the Panel to determine sufficiency.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.165**

Information Requested:

Provide an assessment of the bio-physical and socio-economic effects of changes in the sequencing of Project phases and other alternatives and alternative means of carrying out the project involving generating facilities at Muskrat Falls and Gull Island identified by Nalcor, including (a) the development of Muskrat Falls followed by Gull Island at a fixed time interval (overlap of construction of the 2 generating facilities), and (b) the development of Muskrat Falls followed by Gull Island at an indeterminate time later (no overlap in the construction of the 2 generating facilities). For preferred sequencing and the potential alternative means, issues to be addressed should include, but not be limited to:

a. Changes to the project description, construction (including schedule) and operation;

b. Transmission interconnection lines;

c. Changes to accommodation facilities;

d. New cost estimates;

e. New socio-economic data and timing, particularly employment, work scheduling approach, labour requirements, goods and services;

f. Changes to reservoir clearing and impoundment and validity of model results (mercury, flow, ice modeling, etc.);

g. Harmful alteration, disruption and destruction of fish habitat and implications for the proposed Fish Habitat Compensation Plan;

h. Potential aquatic and terrestrial impacts;

i. Traditional land use and Aboriginal issues;

j. Any other relevant information.

Response:

In accordance with Environmental Impact Statement (EIS) Guidelines Section 4.3.2.2 (e), Nalcor Energy (Nalcor) has undertaken an assessment of the biophysical and socio-economic effects of changes in the sequencing of the Lower Churchill Hydroelectric Generation Project (the "Project") phases in response to IR# JRP.165. Apart from the sequencing of Project phases and as already provided to the Panel, no other feasible alternatives or alternative means of carrying out the Project involving generation facilities at Muskrat Falls and Gull Island have been identified by Nalcor.

The environmental effects of the sequence of Project phases presented in the EIS, Gull Island followed by Muskrat Falls with an overlap in construction, was compared to the biophysical and socio-economic effects of the Project phase sequence of Muskrat Falls followed by Gull Island with an overlap in construction, and the Project phase sequence of Muskrat Falls followed by Gull Island with no overlap in construction.

When conducting the assessment, a comparison of each Valued Environmental Component (VEC) and Key Indicator (KI) was undertaken. Any potential deviations from the predicted environmental effects as presented in the EIS were thoroughly evaluated. The assessment was conducted in accordance with the environmental assessment and methods adopted for the original EIS.

The results of this assessment conclude that there are no material changes to the predicted environmental effects resulting from re-sequencing the Project phases. As a result, the mitigation measures presented in the EIS and subsequent responses to Information Requests (IRs) remain fully valid and unchanged. The following construction sequences are used for the purposes of this assessment:

- **Sequence One (S1)** –The Project phase sequence described in Volume IA, Chapter 4.0 of the EIS; Gull Island generation facility followed by the Muskrat Falls generation facility with an overlap in construction.
- **Sequence Two (S2)** – The Project phase sequence of Muskrat Falls generation facility followed by the Gull Island generation facility with an overlap in construction.
- **Sequence Three (S3)** –The Project phase sequence of Muskrat Falls generation facility followed by the Gull Island generation facility with no overlap in construction.

The full details of the assessment of the biophysical and socio-economic effects resulting from a change in sequencing of Project phases are presented in Attachment A.

a. Changes to the Project Description, Construction (including schedule) and Operation

The S2 and S3 sequences do not result in changes to the scope of the Project or the location of transmission lines, generation facilities, dam heights, areas of inundation, or power output, or the duration of discrete construction or operation activities.

Design modifications to accommodate a change in sequencing of the Project phases include:

- Reconfigure the main power transformer and switchyards (location and basic footprint remain the same)
- Reconfigure interconnecting transmission lines (see “b” below)

The change in sequencing may also require minor adjustments to design details for Gull Island and Muskrat Falls:

- Any implications resulting from a delay in Gull Island providing flow regulation will be considered in establishing the design capacity of the Muskrat Falls spillway. The location and footprint of the Muskrat spillway will remain unchanged.
- Any implications resulting from the presence of the Muskrat Falls reservoir during construction of Gull Island will be considered in establishing the final design of the Gull Island diversion tunnels and cofferdams. The location and footprint of these temporary facilities will remain unchanged.

During the operation and maintenance phase, the water management and operating regime will remain the same for each sequence. Regardless of the sequence, both reservoirs will operate as close to full supply level (FSL) as possible, with minimum fluctuations in water level.

b. Transmission Interconnection Lines

The transmission configuration for both S2 and S3 between Muskrat Falls, Gull Island and Churchill Falls, will follow the same corridor as assessed in the EIS. To accommodate the flexibility in sequencing of the Project phases, the overall right of way width would be widened by 20 m. The incremental increase in right-of-way is approximately 5.3 km^2.

The lines will be developed adjacent to the existing TL240 transmission line, within the same 1-km wide corridor assessed in the original EIS submission.

c. Changes to Accommodation Facilities

There are no changes contemplated to accommodation facilities. Accommodation facilities remain as described in Volume IA, Chapter 4 of the EIS, for each of the sequencing of Project phases contemplated (i.e., S1, S2, and S3).

d. New Cost Estimates

Cost estimates have been updated to reflect the S2 and S3 sequences. Overall, there is no substantial cost difference. Allocation of certain expenditures among Project activities will reflect changes in sequencing resulting in changes to cash flow (the year in which costs are incurred).

Project capital expenditures for S2 and S3 are $6.4 billion (in 2010 dollars), with $2.5 billion on Muskrat Falls construction and associated transmission and $3.9 billion on Gull Island construction. This includes an estimated $2.5 billion spent on labour, $2.9 billion on materials and $1.0 billion on equipment. Capital expenditures totalled $6.5 billion for S1. Any difference between S1 and S2 or S3 is mainly attributed to the transmission component.

e. New Socio-economic Data and Timing (particularly employment, work scheduling approach, labour requirements, goods and services)

Total predicted effects on Economy, Employment and Business from the Project construction have been re-calculated to reflect S2 or S3 sequencing of Project phases and have not materially altered from that indicated in the EIS and subsequent responses to IRs.

- Total Income – Total income effects of S2 or S3 on the Newfoundland and Labrador economy will be over $2.0 billion or approximately $172 million annually. The Project will generate an estimated $337 million in net revenues to the provincial treasury over the life of the Project from the capital expenditures.
- Employment/Labour Requirements – For S2 and S3, construction will generate almost 23,500 person-years of total employment, with direct employment constituting 15,629 person years (5,638 for Muskrat Falls and 9,991 for Gull Island). The average annual employment estimate for the operation and maintenance phases is 280 person-years. These estimates reveal negligible differences from those for S1.
- Work Scheduling Approach – the work scheduling approach remains as described in the response to IR# JRP.161(a).

- Goods and Services – the total goods and services required for the Project will remain as indicated in the EIS and responses to the IRs. Goods and services will change with respect to the time various quantities are required, with a peak in construction Year 7 for S2.

The sequencing of Project phases for S2 or S3 allows for a more gradual increase in economic impact as compared to S1. Investment in construction of the smaller dam first results in lower upfront capital cost.

The changes in sequencing, with or without the temporal gap, will not change the Project activities or the potential interactions of these activities with Physical and Social Infrastructure and Services or Community Health. Sequencing of construction will have an effect on the patterns of use of infrastructure and services in the area, particularly Happy Valley-Goose Bay, as Project-related demands will grow more gradually.

S3 sees a temporal gap between the construction of Muskrat Falls and Gull Island. As a consequence, there are separate and shorter employment and business opportunities associated with the construction of each of them, and this may result in lower levels of in-migration to Upper Lake Melville. The degree to which this is the case will depend on the length of the gap and the perceived certainty of Gull Island construction subsequently proceeding. The longer the gap, and the less certain people are that Gull Island will proceed, the smaller the likely amount of in-migration and hence smaller Project-related demand for Physical and Social Infrastructure and Services.

While the construction schedule is altered as a result of S2 or S3 sequences, the associated effects on Economy, Employment and Business, and on Communities are expected to be the same in terms of their nature, magnitude, geographic extent, frequency, duration, certainty and likelihood, as determined in the EIS.

f. Changes to Reservoir Clearing and Impoundment and Validity of Model Results (mercury, flow, ice modeling, etc.);

Reservoir Clearing

Details regarding the reservoir clearing approach remain as described in the response to IR# JRP.148. For S2 and S3 clearing of the Muskrat Falls reservoir will begin in Year 2. Work crews will start downstream and advance up the reservoir towards the Gull Island site. For S2, clearing of Gull Island reservoir will occur from Year 6 to Year 10. For S3, clearing of the Gull Island reservoir will not overlap with any construction activities associated with Muskrat Falls.

Impoundment

The impoundment strategy for both S2 and S3 for Muskrat Falls and Gull Island reservoirs remains as described in the EIS and in the response to IR# JRP.28. The Muskrat Falls reservoir impoundment is scheduled to begin upon completion of the north and south dams, in Year 6. The Gull Island reservoir impoundment is scheduled to occur 5 years after start of construction of Gull Island. Compensation flow will be provided during impoundment.

Validity of Model Results

- **Mercury Modeling** – There is no change predicted in the peak fish mercury levels for both S2 and S3. This analysis (see IR# JRP.166) shows that peak fish mercury levels will be similar whether the reservoirs are developed in a proximal chronology or independently.

- **Flow Modeling** – There is no change to the expected flow or effects as described in the EIS for the Project. The operating regime described in the EIS for Muskrat Falls of a 39m full supply level will be

maintained, with drawdown to 38.5m as necessary. Hydraulic modeling has predicted that there will be a small increase in the frequency of spills without the regulation provided by Gull Island. This increase in fluctuation will not have a significant effect and will be confined to the period between start of operation of Muskrat Falls and flooding of the Gull Island reservoir. There is no change in the operating regime for Gull Island.

- **Salt water intrusion model** - There is no change from the predicted salt water intrusion modeling as presented in the EIS and subsequent IRs.
- **Ice Modeling –** There is no change in the predicted ice dynamics after Project construction is complete.
- **Sediment Modeling** - The results of the sediment plume analysis for the construction of Muskrat Falls will not be affected by the sequencing of the Project. In S2 and S3, the sediment plume analysis for construction of Gull Island indicated that the presence of the Muskrat Falls reservoir will decrease the potential for transport of silt past Muskrat Falls.

g. Harmful alteration, disruption and destruction of fish habitat and implications for the proposed Fish Habitat Compensation Plan

Habitat Alteration, Disruption or Destruction (HADD)

The S2 and S3 sequencing of Project phases will not alter the footprint or extent of the reservoirs. As a result there is no change in the quantification or type of habitat alteration, disruption or destruction for either S2 or S3.

Fish Habitat Compensation Planning

The existing HADD determination by DFO for the Project addresses both Muskrat Falls and Gull Island as separate reservoirs. In the Fish Habitat Compensation Strategy, the quantity of HADD as well as Project compensatory habitat has been described separately for each individual reservoir. The prediction of no significant effect remains regardless of sequence. Consequently, Nalcor anticipates the continuation of the development of the Fish Habitat Compensation Plan, as well as the present authorization process.

The S2 and S3 sequencing of Project phases do not change the overall quantity or quality of post-Project habitat. Alteration of the sequence of fish habitat compensation construction and monitoring will not affect overall mitigation activities and predicted effectiveness.

The current fish habitat compensation options within the Muskrat Falls reservoir include the enhancement/stabilization of near shore habitat, delta habitat, spawning shoals, and aquatic vegetation. The extent of the water level fluctuations has been determined to be minimal with levels remaining within the elevations stated in the EIS, particularly with the Water Management Agreement in place.

h. Potential Aquatic and Terrestrial Impacts

Aquatic

The interactions between the Aquatic Environment and the Project for S2 and S3 remain the same and the overall quantity of habitat will be the same upon completion of construction. Sequencing will not alter the footprint or extent of the reservoirs. Water management and operating regime of the Project will not change as a result of a change in sequence. As such, environmental effects management described in the EIS and IR responses remain relevant and applicable.

Without the influence of the Gull Island reservoir on heat retention and release, the predicted thermal variability in and downriver of the Muskrat Falls reservoir will initially be moderated between the existing and the final predicted regime with both reservoirs in place. These model results are therefore considered conservatively similar regardless of the construction sequence.

Regardless of the construction sequence, there remains a high level of certainty associated with the prediction of residual environmental effects on Fish and Fish Habitat, given the extent of baseline information and Project information, the understanding of interactions, the nature of the mitigation measures and the resulting environmental effects.

Terrestrial

The overall amount of terrestrial habitat altered and/or lost due to the Project will remain the same regardless of sequence, with the exception of the increase in width of the ROW for the transmission lines associated with S2 and S3. This increase in width represents 5.3 km^2, for a total actual Project footprint of approximately 166 km^2. As indicated in IR# JRP.124, the EIS was based on up to 200 km^2 of habitat being altered or lost as a result of the Project. Even with the addition of the wider right-of-way associated with S2 or S3, the precautionary approach followed in the EIS considers additional disturbance.

A comprehensive assessment of the effects of changes to sequencing of Project phases for change in habitat, change in health, and mortality for the KIs is included in Attachment A.

i. Traditional Land Use and Aboriginal Issues/ Land and Resource Use

The effects predictions resulting from a change in the sequencing of Project Phases remain the same for S2 and S3. Adverse environmental effects associated with increased access, interruption to navigation, Project employment, loss of wildlife habitat and merchantable timber, loss of cabins, loss of ashkui, effects to berry picking and aesthetic effects would still be mitigated where feasible through the measures identified in Volume III of the EIS, Section 5.6.1 and subsequent IRs. Although there will be some local shifting of land use patterns, levels of Land and Resource Use activities throughout the Assessment Area are still likely to be able to continue at the current levels, regardless of Project phase sequencing.

Project interactions with Historic and Archaeological sites and the effects management measures for these sites will not change from that presented in the EIS.

j. Other Relevant Information

An assessment of the bio-physical and socio-economic effect of changes in the sequencing of Project phases has been completed and is fully outlined in Attachment A.

Requesting Organization – Joint Review Panel **Information Request No.: JRP.165**

Information Requested:

Also, please provide a description of the implications of the construction and operation of either Muskrat Falls or Gull Island as stand alone projects in the event that, subsequent to the construction of the first generating facility, market conditions or any other factors affect the feasibility of the second generating facility.

Response:

The implications of construction and operation of either Muskrat Falls or Gull Island as "stand alone projects" on the biophysical environment would be a reduction to the overall effect proportional to the project footprint of each facility and associated infrastructure. The effects predictions and significance determinations remain equally applicable to both components and no change to the mitigation measures would be anticipated.

The implications of construction and operation of either Muskrat Falls or Gull Island as "stand alone projects" on the socio-economic environment would similarly be a reduction in the overall effect proportional to the relative magnitude of each component. The effects predictions and significance determinations would not change and remain equally applicable to each component. No change to the mitigation measures would be anticipated.

No significant residual environmental effects are predicted from the construction of both Gull Island and Muskrat Falls, and given the proportional impacts of the "stand alone projects" no significant residual environmental effects are predicted if only Gull Island or Muskrat Falls proceeds.

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

JOINT REVIEW PANEL

Attachment A

Environmental Effects Assessment of
Changes in the Sequence of Project Phases

IR# JRP.165

January 6, 2011

nalcor energy
LOWER CHURCHILL PROJECT

ENVIRONMENTAL EFFECTS ASSESSMENT OF CHANGES IN THE SEQUENCING OF PROJECT PHASES

January 6, 2011

nalcor energy
LOWER CHURCHILL PROJECT

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION 1-1

2.0 PROJECT DESCRIPTION 2-1

2.1 Overall Project Components 2-5

2.1.1 Muskrat Falls Generation Facility 2-5
2.1.2 Gull Island Generation Facility 2-6
2.1.3 Transmission Lines and Switchyards 2-6

2.2 Construction 2-8

2.3 Workforce 2-24

2.4 Expenditures 2-26

2.5 Operation and Maintenance 2-26

3.0 ENVIRONMENTAL ASSESSMENT APPROACH AND METHODS 3-1

3.1 Approach to Assessing the Effects of the Changes 3-1

3.2 Compliance with EIS Methods 3-1

4.0 ATMOSPHERIC ENVIRONMENT 4-1

4.1 Air Quality 4-1

4.2 Greenhouse Gas Emissions / Climate 4-1

5.0 AQUATIC ENVIRONMENT 5-1

5.1 Introduction 5-1

5.2 Key Indicators 5-1

5.3 Potential Interactions 5-1

5.4 Measurable Parameters 5-4

5.5 Criteria for Describing Environmental Effects 5-4

5.6 Determination of Significance 5-5

5.7 Existing Knowledge 5-6

5.8 Environmental Effects Management 5-6

5.9 Environmental Effects Assessment of the Change in Sequence of Project Phases 5-9

5.9.1 Change in Project Effects - Habitat Quantity 5-9
5.9.1.1 Change in Habitat Quantity during Construction 5-9
5.9.1.2 Change in Habitat Quantity during Operation and Maintenance 5-10
5.9.2 Change in Project Effects - Habitat Quality 5-11
5.9.2.1 Change in Habitat Quality during Construction 5-11
5.9.2.2 Change in Habitat Quality during Operation and Maintenance 5-12
5.9.3 Change in Project Effects - Fish Populations 5-12
5.9.3.1 Change in Distribution and Abundance during Operation and Maintenance 5-13
5.9.4 Change in Project Effects - Fish Health 5-13

5.10 Summary of Change in Residual Environmental Effects and Evaluation of Significance 5-14

5.10.1 Construction 5-14
5.10.2 Operation 5-15
5.11 Cumulative Environmental Effects 5-15
5.12 Accidents and Malfunctions 5-16
5.13 Monitoring and Follow-up 5-16
6.0 TERRESTRIAL ENVIRONMENT 6-1
6.1 Introduction 6-1
6.2 Key Indicators 6-1
6.3 Potential Interactions 6-1
6.4 Measurable Parameters 6-3
6.5 Criteria for Describing Environmental Effects 6-3
6.6 Determination of Significance 6-5
6.7 Existing Knowledge 6-5
6.8 Environmental Effects Management 6-6
6.9 Environmental Effects Assessment of the Change in Sequence of Project Phases 6-8
6.9.1 Change in Project Effects During Construction 6-9
6.9.2 Change in Project Effects during Operation and Maintenance 6-14
6.10 Summary of Change in Residual Environmental Effects and Evaluation of Significance 6-16
6.10.1 Change in Residual Environmental Effects - George River Caribou Herd 6-17
6.10.1.1 Construction 6-17
6.10.1.2 Operation and Maintenance 6-17
6.10.2 Change in Residual Environmental Effects - Red Wine Mountains Caribou Herd 6-18
6.10.2.1 Construction 6-18
6.10.2.2 Operation and Maintenance 6-18
6.10.3 Change in Residual Environmental Effects - Moose 6-18
6.10.3.1 Construction 6-18
6.10.3.2 Operation and Maintenance 6-19
6.10.4 Change in Residual Environmental Effects - Black Bear 6-19
6.10.4.1 Construction 6-19
6.10.4.2 Operation and Maintenance 6-20
6.10.5 Change in Residual Environmental Effects - Beaver 6-20
6.10.5.1 Construction 6-20
6.10.5.2 Operation and Maintenance 6-20
6.10.6 Change in Residual Environmental Effects - Marten 6-20
6.10.6.1 Construction 6-20
6.10.6.2 Operation and Maintenance 6-21
6.10.7 Change in Residual Environmental Effects - Porcupine 6-21
6.10.7.1 Construction 6-21
6.10.7.2 Operation and Maintenance 6-22
6.10.8 Change in Residual Environmental Effects - Canada Goose 6-22
6.10.8.1 Construction 6-22
6.10.8.2 Operation and Maintenance 6-22
6.10.9 Change in Residual Environmental Effects - Surf Scoter 6-22
6.10.9.1 Construction 6-22
6.10.9.2 Operation and Maintenance 6-23

6.10.10 Change in Residual Environmental Effects - Ruffed Grouse 6-23
6.10.10.1 Construction 6-23
6.10.10.2 Operation and Maintenance 6-24
6.10.11 Change in Residual Environmental Effects - Osprey 6-24
6.10.11.1 Construction 6-24
6.10.11.2 Operation and Maintenance 6-24
6.10.12 Change in Residual Environmental Effects - Wetland Sparrows 6-24
6.10.12.1 Construction 6-24
6.10.12.2 Operation and Maintenance 6-25
6.10.13 Change in Residual Environmental Effects - Harlequin Duck 6-25
6.10.13.1 Construction 6-25
6.10.13.2 Operation and Maintenance 6-26
6.10.14 Change in Residual Environmental Effects - Other Species of Concern 6-26
6.10.14.1 Construction 6-26
6.10.14.2 Operation and Maintenance 6-26
6.10.15 Change in Residual Environmental Effects - Herpetiles 6-26
6.10.15.1 Construction 6-26
6.10.15.2 Operation and Maintenance 6-27

6.11 Cumulative Environmental Effects 6-27
6.12 Accidents and Malfunctions 6-28
6.13 Monitoring and Follow-up 6-28

7.0 ECONOMY, EMPLOYMENT AND BUSINESS 7-1
7.1 Introduction 7-1
7.2 Key Indicators 7-1
7.3 Measurable Parameters 7-1
7.3.1 Economy 7-1
7.3.2 Employment 7-1
7.3.3 Business 7-2
7.4 Criteria for Describing Socio-economic Effects – Economy, Employment and Business 7-2
7.5 Determination of Significance 7-3
7.5.1 Economy 7-3
7.5.2 Employment 7-3
7.5.3 Business 7-3
7.6 Potential Interactions 7-3
7.7 Existing Knowledge 7-4
7.8 Socio-economic Effects Assessment of the Change Sequencing of Project Phases – Economy 7-4
7.8.1 Potential Socio-economic Effects of the Change in Sequencing of Project Phases 7-4
7.8.2 Change in Project Effects - Economy 7-5
7.8.2.1 Income 7-5
7.8.2.2 Government Revenues 7-6
7.8.2.3 Effects Management 7-6
7.8.3 Cumulative Socio-economic Effects 7-7
7.9 Socio-economic Effects Assessment of the Change in Sequencing of Project Phases – Employment 7-8

7.9.1 Potential Socio-economic Effects of the Change in Construction Sequence 7-8
7.9.2 Change in Project Effects - Employment 7-8
7.9.3 Cumulative Socio-economic Effects 7-10

7.10 Socio-economic Effects Assessment of the Change in Sequencing of Project Phases – Business .. 7-11

7.10.1 Potential Socio-economic Effects of the Change in Construction Sequence 7-11
7.10.2 Change in Project Effects - Business 7-11
7.10.3 Cumulative Socio-economic Effects 7-11

7.11 Summary of Change in Residual Socio-economic Effects and Evaluation of Significance 7-12

7.11.1 Economy 7-12
7.11.2 Employment 7-13
7.11.3 Business 7-14
7.11.4 Effects Management Measures 7-16

7.12 Accidents and Malfunctions 7-16

7.13 Monitoring and Follow-up 7-16

8.0 COMMUNITIES 8-1

8.1 Introduction 8-1

8.2 Key Indicators 8-1

8.3 Measurable Parameters 8-1

8.3.1 Physical Infrastructure and Services 8-1
8.3.2 Social Infrastructure and Services 8-2
8.3.3 Community Health 8-2

8.4 Criteria for Describing Socio-economic Effects - Communities 8-3

8.5 Determination of Significance 8-4

8.6 Potential Interactions 8-4

8.7 Existing Knowledge 8-5

8.8 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases - Physical Infrastructure and Services 8-5

8.8.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases 8-5
8.8.2 Change in Project Effects – Physical Infrastructure and Services 8-5
8.8.2.1 Effects Management 8-7
8.8.3 Cumulative Socio-economic Effects 8-8

8.9 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases – Social Infrastructure and Services 8-9

8.9.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases 8-9
8.9.2 Change in Project Effects – Social Infrastructure and Services 8-9
8.9.3 Effects Management 8-10
8.9.4 Cumulative Socio-economic Effects 8-10

8.10 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases – Community Health 8-11

8.10.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases 8-11
8.10.2 Change in Project Effects – Community Health 8-11
8.10.3 Cumulative Socio-economic Effects 8-16

8.11 Summary of Change in Residual Socio-economic Effects and Evaluation of Significance 8-16

8.11.1 Physical Infrastructure and Services 8-16
8.11.2 Social Infrastructure and Services 8-17
8.11.3 Community Health 8-19

8.12 Accidents and Malfunctions 8-20

8.13 Monitoring and Follow-up 8-20
8.13.1 Physical Infrastructure and Services 8-20
8.13.2 Social Infrastructure and Services 8-21
8.13.3 Community Health 8-21

9.0 LAND AND RESOURCE USE 9-1
9.1 Introduction 9-1
9.2 Existing Knowledge 9-1
9.3 Key Indicators and Measureable Parameters 9-2
9.4 Criteria for Describing Environmental Effects – Land and Resource Use 9-2
9.5 Determination of Significance 9-3
9.6 Potential Interactions 9-3
9.7 Environmental Effects Assessment 9-5
9.7.1 Potential Environmental Effects of the Change in Construction Sequence 9-5
9.7.2 Change in Potential Effects 9-5
9.7.2.1 Construction 9-5
9.7.2.2 Operation and Maintenance 9-7
9.7.3 Cumulative Environmental Effects Analysis of the Change in Sequencing of Project Phases and Effects Management 9-9
9.8 Summary of Change in Residual Environmental Effects and Evaluation of Significance 9-10
9.8.1 Effects Management Measures 9-10
9.8.2 Change in Residual Environmental Effects Analysis 9-10
9.8.2.1 Construction 9-10
9.8.2.2 Operation and Maintenance 9-11
9.9 Accidents and Malfunctions 9-12
9.10 Monitoring and Follow-up 9-12

10.0 CULTURAL HERITAGE RESOURCES 10-1

11.0 REFERENCES 11-1

LIST OF FIGURES

Page No.

Figure 2-1 Project Schedule S2 2-10
Figure 2-2 Project Schedule S3 2-11
Figure 2-3 Construction Sequence Index 2-12
Figure 2-4 Construction Sequence Year 1 2-13
Figure 2-5 Construction Sequence Year 2 2-14
Figure 2-6 Construction Sequence Year 3 2-15
Figure 2-7 Construction Sequence Year 4 2-16
Figure 2-8 Construction Sequence Year 5 2-17
Figure 2-9 Construction Sequence Year 6 2-18
Figure 2-10 Construction Sequence Year 7 2-19
Figure 2-11 Construction Sequence Year 8 2-20
Figure 2-12 Construction Sequence Year 9 2-21
Figure 2-13 Construction Sequence Year 10 2-22
Figure 2-14 Construction Sequence Year 11 2-23
Figure 2-15 Total Direct Construction Workforce, Gull Island and Muskrat Falls (S2) 2-25
Figure 2-16 Total Direct Construction Workforce, Gull Island and Muskrat Falls (S3) 2-25
Figure 5-1 Schematic of Fish Hg Levels in Two Reservoirs for Different Sequencing of Construction 5-14
Figure 7-1 Composition of Provincial Income (Construction), S2 and S3 7-5
Figure 7-2 Composition of Provincial Income (Operation and Maintenance), S2 and S3 7-6
Figure 7-3 Composition of Project-related Tax Revenues (Construction) 7-7
Figure 7-4 Total Direct Project Employment (Construction), S2 7-9
Figure 7-5 Total Direct Project Employment (Construction), S3 7-10

LIST OF TABLES

Page No.

Table 2-1 Modifications/Interactions: S2 and S3 2-1
Table 5-1 Interaction of the Project with Fish and Fish Habitat 5-2
Table 5-2 Measurable Parameters – Fish and Fish Habitat 5-4
Table 5-3 Summary of Additional Existing Knowledge for Aquatic Key Indicators since the EIS 5-6
Table 5-4 Standard Mitigation Applicable to the Aquatic Environment 5-6
Table 5-5 Project-Specific Effects Management Measures 5-7
Table 5-6 Selected Characteristics of Gull Island and Muskrat Falls Reservoirs 5-9
Table 5-7 Summary of Existing and Predicted Habitat within the Assessment Area, Churchill River 5-10
Table 5-8 Summary of Residual Environmental Effects Assessment for Fish and Fish Habitat 5-15
Table 5-9 Potential Interactions of Future Projects and Activities in the Aquatic Environment Assessment Area 5-15

Table 6-1 Interaction of S2 or S3 with the Key Indicators in the Terrestrial Environment 6-1
Table 6-2 Measurable Parameters for Terrestrial Environment Key Indicators 6-3
Table 6-3 Additional Existing Knowledge for Terrestrial Key Indicators since the EIS 6-5
Table 6-4 Standard Mitigation Applicable to the Terrestrial Environment 6-6
Table 6-5 Additional Specific Effects Management Measures 6-8
Table 6-6 Significance of Residual Environmental Effects as a Result of Change in Sequencing 6-16
Table 6-7 S2 or S3 - Residual Environmental Effects Assessment for the George River Caribou Herd 6-17
Table 6-8 S2 or S3 - Residual Environmental Effects Assessment for the Red Wine Mountains Caribou Herd 6-18
Table 6-9 S2 or S3 - Residual Environmental Effects Assessment for Moose 6-19
Table 6-10 S2 or S3 - Residual Environmental Effects Assessment for Black Bear 6-19
Table 6-11 S2 or S3 - Residual Environmental Effects Assessment for Beaver 6-20
Table 6-12 S2 or S3 - Residual Environmental Effects Assessment for Marten 6-21
Table 6-13 S2 or S3 - Residual Environmental Effects Assessment for Porcupine 6-21
Table 6-14 S2 or S3 - Residual Environmental Effects Assessment for Canada Goose 6-22
Table 6-15 S2 or S3 - Residual Environmental Effects Assessment for Surf Scoter 6-23
Table 6-16 S2 or S3 - Residual Environmental Effects Assessment for Ruffed Grouse 6-23
Table 6-17 S2 or S3 - Residual Environmental Effects Assessment for Osprey 6-24
Table 6-18 S2 or S3 - Residual Environmental Effects Assessment for Wetland Sparrows 6-25
Table 6-19 S2 or S3 - Residual Environmental Effects Assessment for Harlequin Duck 6-25
Table 6-20 S2 or S3 - Residual Environmental Effects Assessment for Other Species of Concern 6-26
Table 6-21 S2 or S3 - Residual Environmental Effects Assessment for Herpetiles 6-27
Table 6-22 Potential Interactions of Future Projects and Activities with Terrestrial Key Indicators in the Terrestrial Environment Assessment Area 6-27
Table 6-23 Potential Interactions of Future Projects and Activities with Terrestrial Key Indicators in the Terrestrial Environment Assessment Area (continued) 6-28
Table 7-1 Measurable Parameters for Economy 7-1
Table 7-2 Measurable Parameters for Employment 7-1
Table 7-3 Measurable Parameters for Business 7-2
Table 7-4 Interaction of the Project with the Key Indicators for the Economy, Employment and Business 7-4
Table 7-5 Potential Interactions of Future Projects and Activities with the Economy 7-7
Table 7-6 Project Employment Effects (Construction Phase), S2 and S3 7-9
Table 7-7 Total Newfoundland and Labrador Employment by Category during Operation and Maintenance, S2 and S3 - Typical Year 7-10
Table 7-8 Summary of Residual Socio-economic Effects Assessment for Economy 7-12
Table 7-9 Summary of Residual Cumulative Socio-economic Effects for Economy 7-13
Table 7-10 Summary of Residual Socio-economic Effects Assessment for Employment 7-14
Table 7-11 Summary of Residual Cumulative Socio-economic Effects for Employment 7-14

Table 7-12 Summary of Residual Socio-economic Effects on Business 7-15
Table 7-13 Summary of Residual Cumulative Socio-economic Effects for Business 7-15
Table 7-14 Proposed Monitoring and Follow-up Programs – Economy, Employment and Business 7-16
Table 8-1 Measurable Parameters for Physical Infrastructure and Services 8-2
Table 8-2 Measurable Parameters for Social Infrastructure and Services 8-2
Table 8-3 Measurable Parameters for Community Health 8-2
Table 8-4 Interactions of the Project with the Key Indicators for Communities 8-4
Table 8-5 Potential Interactions of Future Projects and Activities on Physical Infrastructure and Services 8-8
Table 8-6 Potential Interactions of Future Projects and Activities with Social Infrastructure and Services 8-10
Table 8-7 Summary of Residual Socio-economic Effects Assessment for Physical Infrastructure and Services 8-17
Table 8-8 Summary of Residual Cumulative Socio-economic Effects Significance for Physical Infrastructure and Services 8-17
Table 8-9 Summary of Residual Socio-economic Effects on Social Infrastructure and Services 8-18
Table 8-10 Summary of Residual Cumulative Socio-economic Effects Significance for Social Infrastructure and Services 8-18
Table 8-11 Summary of Residual Cumulative Socio-economic Effects Significance for Social Infrastructure and Services (continued) 8-19
Table 8-12 Summary of Residual Socio-economic Effects on Community Health 8-19
Table 8-13 Summary of Residual Cumulative Socio-economic Effects Significance for Community Health 8-20
Table 8-14 Proposed Community Health Monitoring and Follow-up Programs 8-21
Table 9-1 Measurable Parameters for Land and Resource Use 9-2
Table 9-2 Interactions of the Reversal in Sequencing of Construction with Land and Resource Use 9-4
Table 9-3 Potential Interactions of Future Projects and Activities with Land and Resource Use 9-10
Table 9-4 Summary of Residual Environmental Effects Assessment for Land and Resource Use 9-10
Table 9-5 Summary of Residual Cumulative Environmental Effects Assessment for Land and Resource Use 9-11

APPENDICES

Appendix 1 Contemporary Land Use Maps (Labrador Innu)

1.0 INTRODUCTION

The sequencing of phases of the Lower Churchill Hydroelectric Generation Project (Project) is dependent upon several factors, including the development of markets and market access. Apart from potential changes in sequencing of Project phases, no other feasible alternatives or alternative means of carrying out the Project have been identified by Nalcor Energy (Nalcor). The overall scope of the Project remains the same as described in the Environmental Impact Statement (EIS) and the significance of effects, as they were assessed in the EIS remain valid. [1]

The implications of the sequencing of Project phases have been described and re-evaluated for all Valued Environmental Components (VECs) and Key Indicators (KIs) in the biophysical and socio-economic environment in the following assessment. This report has been organized into ten sections:

Chapter 1: Introduction

Chapter 2: Project Description

Chapter 3: Environmental Assessment Approach and Methods

Chapter 4: Atmospheric Environment

Chapter 5: Aquatic Environment

Chapter 6: Terrestrial Environment

Chapter 7: Economy, Employment and Business

Chapter 8: Communities

Chapter 9: Land and Resource Use

Chapter 10: Cultural Heritage Resources.

[1] Throughout this report, references to the EIS are also intended to include information provided in previous IR responses.

2.0 PROJECT DESCRIPTION

The sequencing of Project phases described in the EIS (labelled S1 for this report) is the construction of the Gull Island generating facility followed three years later by the start of construction of the Muskrat Falls generating facility. For the purposes of this assessment the sequencing of Project phases includes:

- the construction of the Muskrat Falls generating facility followed by the construction of the Gull Island generating facility, with an overlap in construction (S2), and;
- the construction of the Muskrat Falls generating facility followed by the construction of the Gull Island generating facility with no overlap in the construction (S3).

The overall Project description, Project footprint, and interaction predictions described in the EIS and associated responses to information requests remain the same for S2 and S3 except as noted in Table 2-1.

Table 2-1 Modifications/Interactions: S2 and S3

Component	Reference	S2/S3 Modification	Interaction(s) Compared to S1
Gull Island Generation Facility	Section 4.2.1 of EIS	No Change	No Change
Gull Island – Main Dam	Section 4.2.1.1 of EIS	No Change	No Change
Gull Island – Power House	Section 4.2.1.2 of EIS	No Change	No Change
Gull Island – Reservoir and Zones of Clearing	IR# JRP.148	No Change	No Change
Gull Island – Approach Channel	Section 4.2.1.4 of EIS	No Change	No Change
Gull Island – Intakes and Penstock	Section 4.2.1.5 of EIS	No Change	No Change
Gull Island – Tailrace	Section 4.2.1.6 of EIS	No Change	No Change
Gull Island - Spillway	Section 4.2.1.7 of EIS	No Change	No Change
Gull Island – Main Power Transformers and Switchyard	Section 4.2.1.8 of EIS	Switchyard operating voltage modified (Section 2.1.3). Location and footprint remains the same.	No change
Gull Island – Permanent Access	Section 4.2.1.9 of EIS	No Change	No Change
Gull Island – Permanent Accommodations	Section 4.2.1.10 of EIS	No Change	No Change
Gull Island - Security	Section 4.2.1.11 of EIS	No Change	No Change
Muskrat Falls Generation Facility	Section 4.2.2 of EIS	No Change	No Change
Muskrat Falls – North and South Dam	Section 4.2.2.1 of EIS IR# JRP.26S (Alternatives to the Project and Alternative Means)	No Change	No Change
Muskrat Falls - Powerhouse	Section 4.2.2.2 of EIS	No Change	No Change
Muskrat Falls – Reservoir and Zones of Clearing	IR# JRP.148	No Change	No Change
Muskrat Falls – Approach Channel	Section 4.2.2.4 of EIS	No Change	No Change
Muskrat Falls - Intake	Section 4.2.2.5 of EIS	No Change	No Change
Muskrat Falls - Tailrace	Section 4.2.2.6 of EIS	No Change	No Change
Muskrat Falls – Spillway Channel	Section 4.2.2.7 of EIS	No Change	No Change

Table 2-1 Modifications/Interactions: S2 and S3 (continued)

Component	Reference	S2/S3 Modification	Interaction(s) Compared to S1
Muskrat Falls - Spillway	Section 4.2.2.8 of EIS	Spillway capacity subject to detailed engineering. Location and footprint remains the same.	No Change
Muskrat Falls – Main Power Transformer and Switchyard	Section 4.2.2.9 of EIS	Switchyard operating voltage modified (Section 2.1.3). Location and footprint remains the same.	No Change
Muskrat Falls – Permanent Access	Section 4.2.2.10 of EIS	No Change	No Change
Muskrat Falls – Permanent Accommodations	Section 4.2.2.11 of EIS	No Change	No Change
Muskrat Falls - Security	Section 4.2.2.12 of EIS	No Change	No Change
Transmission Lines	Section 4.2.3 of EIS	Transmission line voltage and configuration modified (Section 2.1.3). An additional 20 m of right-of-way would be required and would be within the disturbance area calculated under S1, tower heights are less than or equal to those assessed under S1.	Interaction with landscape aesthetics as compared with S1 which is assessed in Chapter 9
Transmission Lines – Line Routing	Section 4.2.3.1 of EIS IR# JRP.30 (Transmission Line Corridor) IR# JRP.26S (Alternatives to the Project and Alternative Means)	No Change	No Change
Schedule	Section 4.3 of EIS	Schedule modified (Section 2.2)	No Change
Gull Island – Construction Infrastructure	Section 4.4.1.1 of EIS IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.29 (Transportation Infrastructure) IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.148 (Reservoir Clearing)	Downstream cofferdam subject to detailed engineering. Location and footprint remains the same.. .	No Change
Gull Island – Construction Activities and Sequencing	Section 4.4.1.2 of EIS IR# JRP.26 (Alternatives to the Project and Alternative Means) IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.148 (Reservoir Clearing)	No Change (Section 2.2)	No Change

Table 2-1 Modifications/Interactions: S2 and S3 (continued)

Component	Reference	S2/S3 Modification	Interaction(s) Compared to S1
Muskrat Falls – Construction Infrastructure	Section 4.4.1.1 of EIS IR# JRP.29 (Transportation Infrastructure) IR# JRP.148 (Reservoir Clearing) IR# JRP.26S (Alternatives to the Project and Alternative Means)	No Change	No Change
Muskrat Falls – Construction Activities and Sequencing	Section 4.4.2.2 of EIS IR# JRP.26 (Alternatives to the Project and Alternative Means) IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.148 (Reservoir Clearing) IR# JRP.26S (Alternatives to the Project and Alternative Means)	No Change (Section 2.2)	No Change
Transmission Lines – Construction Infrastructure	Section 4.4.3.1 of EIS	No Change	No Change
Transmission Lines – Construction Activities and Sequencing	Section 4.4.3.2 of EIS	No Change	No Change
Material Requirements and Delivery	Section 4.4.4 of EIS IR# JRP.29 (Transportation Infrastructure)	Slight modification of material requirements due to Transmission line reconfiguration (Section 2.2)	Interaction with Economy, Employment and Business may change as compared to S1, with a change in expenditures (assessed in Chapter 7)
Traffic	Section 4.4.5 of EIS IR# JRP.29 (Transportation Infrastructure)	No Change	No Change
Operation and Maintenance	Section 4.5 of EIS IR# JRP. 32 (Project Operating Regime)	No Change	No Change
Gull Island – Operating Regime	Section 4.5.1.1 of EIS IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.32 (Project Operating Regime) IR# JRP.84 (Water Management and Operating Regime) IR# JRP.149 (Project Operating Regime)	No Change	No Change
Gull Island – Monitoring and Maintenance	Section 4.5.1.2 of EIS IR# JRP.31 (Communication Infrastructure and remote Operations of the Facilities)	No Change	No Change
Gull Island - Accommodations	Section 4.5.1.3 of EIS	No Change	No Change

Table 2-1 Modifications/Interactions: S2 and S3 (continued)

Component	Reference	S2/S3 Modification	Interaction(s) Compared to S1
Muskrat Falls – Operating Regime	Section 4.5.2.1 of EIS IR# JRP.28 (Reservoir Filling and Management Strategies) IR# JRP.32 (Project Operating Regime) IR# JRP.84 (Water Management and Operating Regime) IR# JRP.149 (Project Operating Regime)	No Change	No Change
Muskrat Falls – Monitoring and Maintenance	Section 4.5.2.2 of EIS IR# JRP.31 (Communication Infrastructure and Remote Operations of the Facilities)	No Change	No Change
Muskrat Fall - Accommodations	Section 4.5.2.3 of EIS	No Change	No Change
Transmission Line - Inspection and Maintenance	Section 4.5.3.1 of EIS	No Change	No Change
Transmission Line – Vegetation Management	Section 4.5.3.2 of EIS IR# JRP.91	No Change	No Change
Transmission Line – Electromagnetic Fields	Section 4.5.3.3 of EIS	No Change	No Change
Decommissioning and Restoration	Section 4.6 of EIS IR# JRP.41 (Decommissioning) IR# JRP.111 (Rehabilitation Programs) IR# JRP.111S (Rehabilitation Programs) IR# JRP.150 (Decommissioning)	No Change	No Change
Construction Site Restoration	Section 4.6.1 of EIS	No Change	No Change
Primary Construction Sites	Section 4.6.1.1 of EIS	No Change	No Change
Dewatering and Sediment Control Structures	Section 4.6.1.2 of EIS	No Change	No Change
Temporary Access	Section 4.6.1.3 of EIS	No Change	No Change
Borrow Pits and Quarries	Section 4.6.1.4 of EIS	No Change	No Change
Spoil Areas	Section 4.6.1.5 of EIS	No Change	No Change
Potential Future Modifications	Section 4.7 of EIS	No Change	No Change
Environmental Management	Section 4.8 of EIS	No Change	No Change
Environmental Management System	Section 4.8.1 of EIS	No Change	No Change
Environmental Protection and Mitigation	Section 4.8.2 of EIS	No Change	No Change
Environmental Protection Plan	Section 4.8.2.1 of EIS IR# JRP.114 (Environmental Protection Plans)	No Change	No Change
Environmental Orientation	Section 4.8.2.2 of EIS	No Change	No Change
Development of Specific Environmental Protection Plans	Section 4.8.2.3 of EIS	No Change	No Change
Standard Environmental Protection Procedures	Section 4.8.2.4 of EIS	No Change	No Change

Table 2-1 Modifications/Interactions: S2 and S3 (continued)

Component	Reference	S2/S3 Modification	Interaction(s) Compared to S1
Construction Workforce	Section 4.9.1 of EIS	Construction workforce modified (Section 2.3)	Interaction with Economy, Employment and Business may change as compared to S1, with a change in employment levels (assessed in Chapter 7)
Operation Workforce – Generation Sites	Section 4.9.2.1 of EIS	No Change	No Change
Operation Workforce – Transmission Lines	Section 4.9.2.2 of EIS	No Change	No Change
Expenditures	Section 4.10 of EIS	Construction Expenditures Modified (Section 2.4)	Interaction with Economy, Employment and Business may change as compared to S1, with a change in expenditures (assessed in Chapter 7)
Construction	Section 4.10.1 of EIS	Construction Expenditures Modified (Section 2.4)	Interaction with Economy, Employment and Business may change as compared to S1, with a change in expenditures (assessed in Chapter 7)
Operations	Section 4.10.2 of EIS	Operations Expenditures Modified (Section 2.4)	Interaction with Economy, Employment and Business may change as compared to S1 due to change in rate of expenditures (assessed in Chapter 7)
Accidents and Prevention	Section 4.11 of EIS IR# JRP.145 (Accidents and Malfunctions)	No Change	No Change
Waste Management	Section 4.11.1 of EIS	No Change	No Change
Spill of Hazardous Material	Section 4.11.2 of EIS	No Change	No Change
Dam Failure	Section 4.11.3 of EIS IR# JRP.96 (Inundation and Flood Mapping) IR# JRP.162 (Dam Break)	No Change	No Change
Forest Fire	Section 4.11.4 of EIS	No Change	No Change
Worst-case Scenario	Section 4.11.5 of EIS	No Change	No Change

2.1 Overall Project Components

The Scope of the Project remains as:

- Muskrat Falls dam, generation facility and reservoir;
- Gull Island dam, generation facility and reservoir; and
- Switchyards and transmission line(s) between Muskrat Falls, Gull Island and Churchill Falls.

2.1.1 Muskrat Falls Generation Facility

No changes will be made to the size, height, or location of the components of the Muskrat Falls generation site resulting from S2, S3 sequencing of Project phases. It remains comprised of the following components:

- a north and south roller compacted concrete dam;

- a close-coupled intake and powerhouse on the south shore of the river;
- an approach channel which will direct the water from the reservoir into the power intakes;
- power intakes which will direct the water to the turbines;
- draft tubes which will discharge the water into the tailrace; and
- a spillway for the passage of water in excess of power generation requirements.

As stated in the EIS, construction of the north and south dams will result in the formation of a 59 km long reservoir. At full supply level (FSL), the area of inundation will be 41 km², resulting in a reservoir with a total surface area of 101 km². The elevation of the reservoir will be 39.0 m above sea level (masl) at FSL and 38.5 masl at low supply level (LSL).

For S2, these components are the same as presented in the EIS and the sequencing of the Project has no effect on the selection of these components.

For S3, these components are the same as presented in the EIS and the sequencing of the Project and a delay in the construction of the Gull Island generating facility and associated gap in the construction schedule would have no effect on the selection of these components.

The potential for a delay of construction of Gull Island, and the absence of attenuation from the Gull Island reservoir, to affect the modelled Probable Maximum Flood (PMF) calculation for Muskrat Falls will be considered during detailed design. If necessary, the flow capacity of the Muskrat Falls spillway will be adjusted accordingly.

2.1.2 Gull Island Generation Facility

No changes to the size, height, or location of the components of the Gull Island generation site result from S2 or S3 sequencing of Project phases. It remains comprised the following components:

- a single concrete faced rock filled dam (CFRD) which will span the river:
- a powerhouse within the dam structure on the downstream side;
- an approach channel which will direct water from the reservoir into the power intakes;
- five penstocks which will connect the power intakes to the turbines;
- draft tubes which will discharge the water into the tailrace; and
- a spillway for the passage of water in excess of power generation requirements.

Construction of the main dam will form a 232 km long reservoir from the Gull Island generating facility to the tailrace for the Churchill Falls generating facility. The elevation of the reservoir will be approximately 125 masl at FSL and 122 masl at LSL. At FSL, the area of inundation will be 85 km², resulting in a total surface area of 213 km².

For both S2 or S3, these components are the same as presented in the EIS.

2.1.3 Transmission Lines and Switchyards

Transmission Lines

Transmission infrastructure interconnection from Muskrat Falls, Gull Island and Churchill Falls generating facility is still required for both S2 or S3.

In the EIS, the transmission line configuration for S1 is:

- a 60 km double-circuit 230 kV transmission line connecting generation facilities at Muskrat Falls and Gull Island;
    - lattice steel-type towers from Gull Island to Muskrat Falls with two lines on one tower (i.e., a double-circuit line). The towers would be approximately 40 m high with an average span of 380 m between towers.
    - conductors with a minimum ground clearance of 7.3 m over roads and 6.7 m over other areas, in accordance with design standards for this voltage class transmission line
- a 203 km single-circuit 735 kV transmission line connecting generation facilities at Gull Island and the existing Churchill Falls generating facility
    - lattice steel-type towers approximately 50 m high, with an average span of 500 m between towers
    - minimum conductor ground clearance of 18 m over roads and 14 m over other areas

Power system analysis has indicated that the proposed transmission line infrastructure for S2 or S3 must be modified and would require the construction of:

- two (2) 60 km long 345 kV single circuit transmission lines from Muskrat Falls to Gull Island
    - lattice steel-type towers approximately 40 m high, with an average span of 400 m between towers.
    - minimum conductor ground clearance of 9.1 m over roads and 6.7 m over other areas, in accordance with design standards for this voltage class transmission line
- two (2) 203 km long single circuit transmission lines from Gull Island to Churchill Falls
    - subject to confirmation in detailed design, one line constructed to 735 kV standards
        - lattice steel-type towers approximately 50 m high, with an average span of 500 m between towers
        - minimum conductor ground clearance of 18 m over roads and 14 m over other areas
    - one line constructed to 345 kV standards
        - lattice steel-type towers approximately 40 m high, with an average span of 400 m between towers.
        - minimum conductor ground clearance of 9.1 m over roads and 6.7 m over other areas, in accordance with design standards for this voltage class transmission line

Line Routing

The optimal line corridor determined using the constraint mapping approach, as described in the original EIS, remains the preferred alternative for line routing.

The lines will follow a relatively direct corridor from the switchyards and generally run parallel to the existing 138 kV transmission line between Happy Valley-Goose Bay and Churchill Falls.

The transmission line(s) would be located within the same one km wide corridor assessed in the original EIS submission. The actual cleared right-of-way would be approximately 100 m in addition to the existing right-of-way, which is approximately 20 m in width. The total cleared right-of-way would be 120 m. In the original EIS

submission the total cleared right-of-way was anticipated to be approximately 100 m in width. For most of its length, the right-of way will be adjacent to the existing transmission line right-of-way.

Muskrat Falls Switchyard

In the original EIS, the main power transformers were to raise the generation voltage to 230 kV. Collector lines would connect the transformers to a 230 kV switchyard. The 230 kV switchyard would connect to an outgoing double-circuit 230 kV transmission line to Gull Island.

Due to the reconfiguration of the transmission lines, the power transformers for S2 or S3 would need to raise the generation voltage to 345 kV. Collector lines would then connect the transformers to the 345 kV switchyard. The 345 kV switchyard would connect to two outgoing 345 kV transmission lines to the Churchill Falls generating facility.

The overall footprint of the switchyard would not change in the S2 or the S3 scenario.

Gull Island Switchyard

In the original EIS, the main power transformers were to raise the generation voltage to 230 kV, with collector lines transmitting power to a 230 kV/735 kV switchyard. The passage across the river would require constructing two 230 kV double-circuit and one single-circuit 230 kV overhead transmission lines.

Due to the reconfiguration of the transmission lines the power transformers for S2 or S3 would need to raise the generation voltage to 345 kV. Collector lines would transmit the power to a 345 kV switchyard. The passage across the river would require constructing two 345 kV double-circuit and one single-circuit 345 kV overhead transmission lines.

The switchyard would receive the collector lines from the Gull Island powerhouse, as well as the two 345 kV lines from the Muskrat Falls generating facility. The switchyard would connect the 345 kV collector lines with the 345 kV line(s) from Muskrat Falls to Churchill Falls.

The overall footprint of the switchyard would not change in the S2 or S3 scenario.

2.2 Construction

The proposed Construction schedules for S2 and S3 are as follows:

- S2 Schedule: An overall schedule for S2 is provided in Figure 2-1. Construction will commence when all the prerequisite sanctions and environmental approvals are in place. Construction of Muskrat Falls would commence in Year 1 and would be completed by the end of Year 7. Construction of Gull Island would begin in Year 5 and be completed in Year 12, at which time the Project would be fully operational. Transmission lines for Muskrat Falls to Churchill Falls and tie in to Gull Island would be constructed from Year 2 to Year 9.
- S3 Schedule: An overall schedule for S3 is provided in Figure 2-2. Construction will commence when all prerequisite sanctions and environmental approvals are in place. There would be no overlap in the construction of the two generating facilities. The sequence of construction activities for each generating facility would remain the same as S2 (i.e., in duration and sequencing of construction activities), however the overall Project timeline would be extended. The S3 schedule (Figure 2-2) shows Gull Island starting, with no overlap in construction, at Year 11 for illustrative purposes only.

Figures 2-3 to 2-14 illustrates the annual sequencing of construction for S2. The major activities are indicated, including reservoir preparation, generation, and transmission infrastructure with Muskrat Falls-related

construction preceding Gull Island. For S3, there would be no overlap in construction activities for the Muskrat Falls and Gull Island facilities.

Generation Facilities

For each generating facility (Gull Island and Muskrat Falls) the nature of the work activities, timing and the order in which they occur would not be modified. Changing the sequencing of the construction phases of the generating facilities would have an effect on the overall Project schedule. Associated environmental mitigations and rehabilitation would not change from the information provided in the EIS and associated IR responses.

The change in sequencing of construction for S2 and for S3 does not result in a modification to construction infrastructure requirements including the requirement for construction accommodations complexes. For the construction of the Gull Island facility the temporary construction access infrastructure, main accommodations complex, material storage and laydown areas, fuelling and fuel storage, explosives, concrete and crushing plants, borrow pits and quarries, and spoil material areas would not be modified. Analysis of the cofferdams and the diversion facility to determine if modification is required due to the presence of the Muskrat Falls reservoir will be determined during detailed engineering.

For S2 construction of the Gull Island facility commences in Year 5. For S3 construction of the Gull Island facility does not commence until after the completion of construction at the Muskrat Falls generating facility (i.e., no overlap in the construction of the two generating facilities).

Transmission Lines

For S2, Construction of the transmission lines is scheduled from Year 2 to Year 9, with limited activity later in the construction schedule to connect the Gull Island generating facility to the transmission line. For S3 the interconnect of the Gull Island generating facility would not overlap with construction activities at Muskrat Falls. Other element of transmission lines include:

- For S2 and S3, the same access trails proposed in the original EIS would be used. No additional access trails or stream crossings would be required.
- For S2 and S3, the transmission construction camp configuration would be the same as was proposed for S1.
- For S2 and S3, the same marshalling yard configuration would be used.
- For S2 and S3, the same borrow pits and quarries would be utilized.

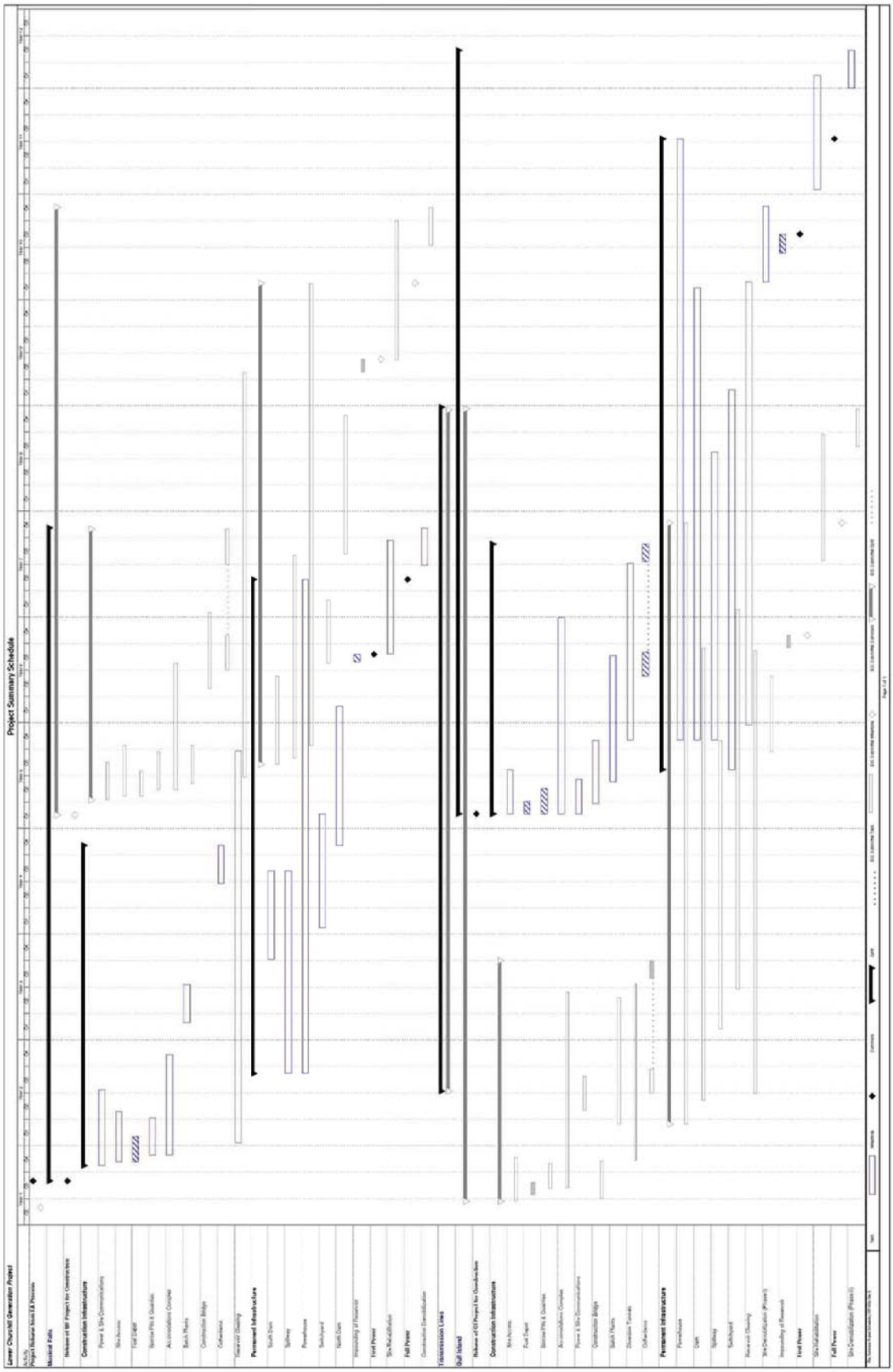


Figure 2-1 Project Schedule S2

Figure 2-2 Project Schedule S3

Figure 2-3 Construction Sequence Index

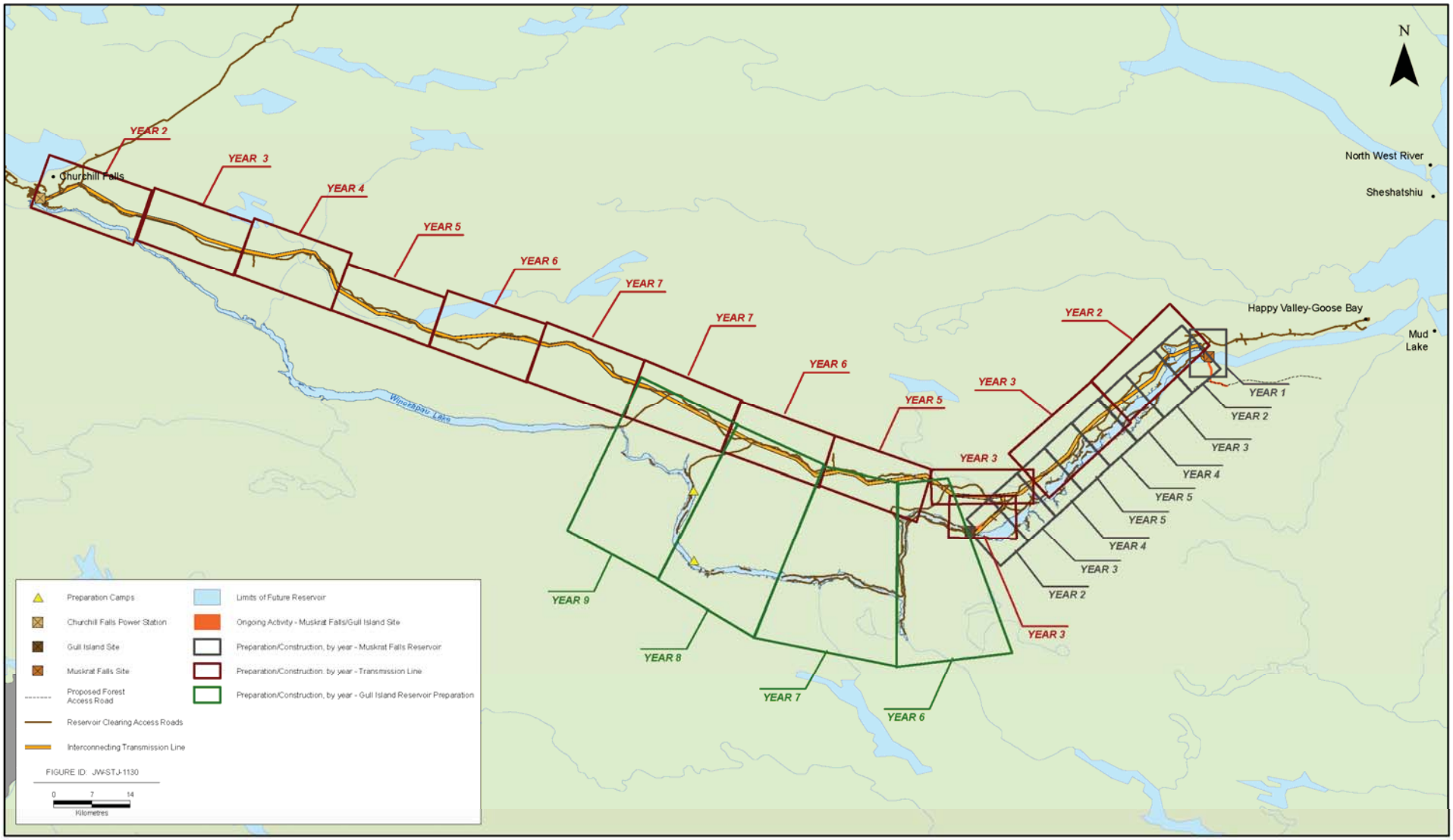


Figure 2-4 Construction Sequence Year 1

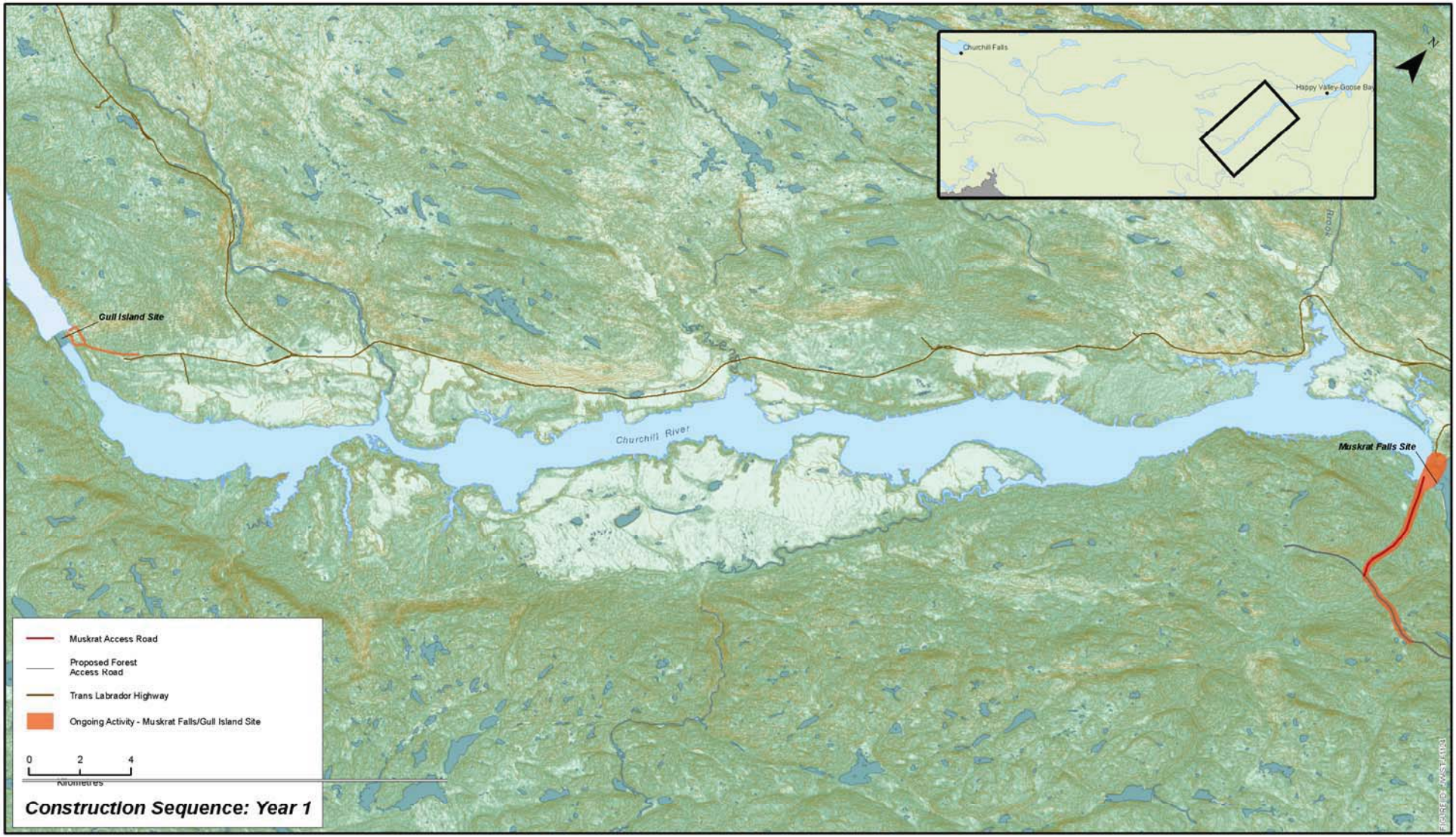


Figure 2-5 Construction Sequence Year 2

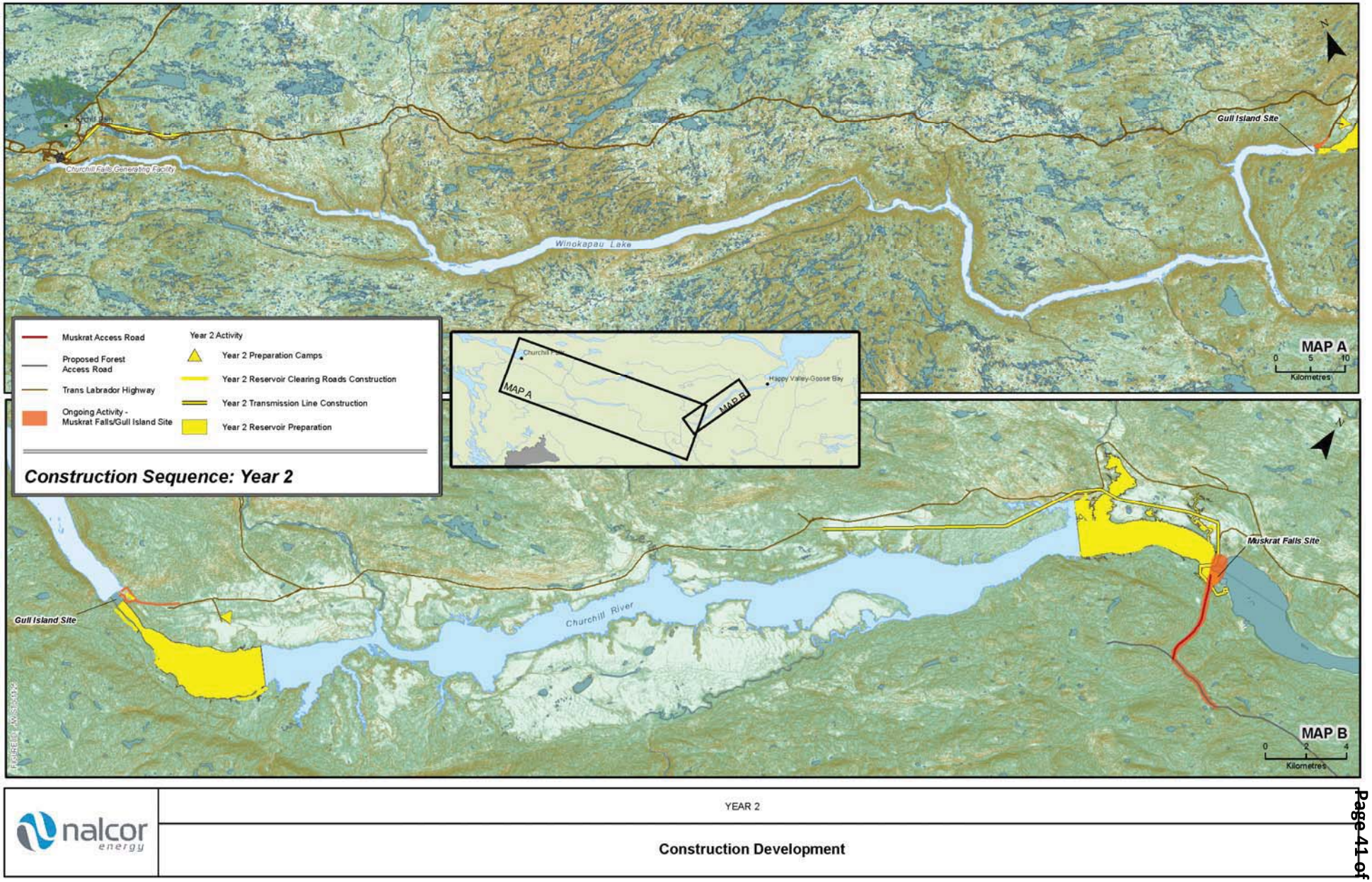


Figure 2-6 Construction Sequence Year 3

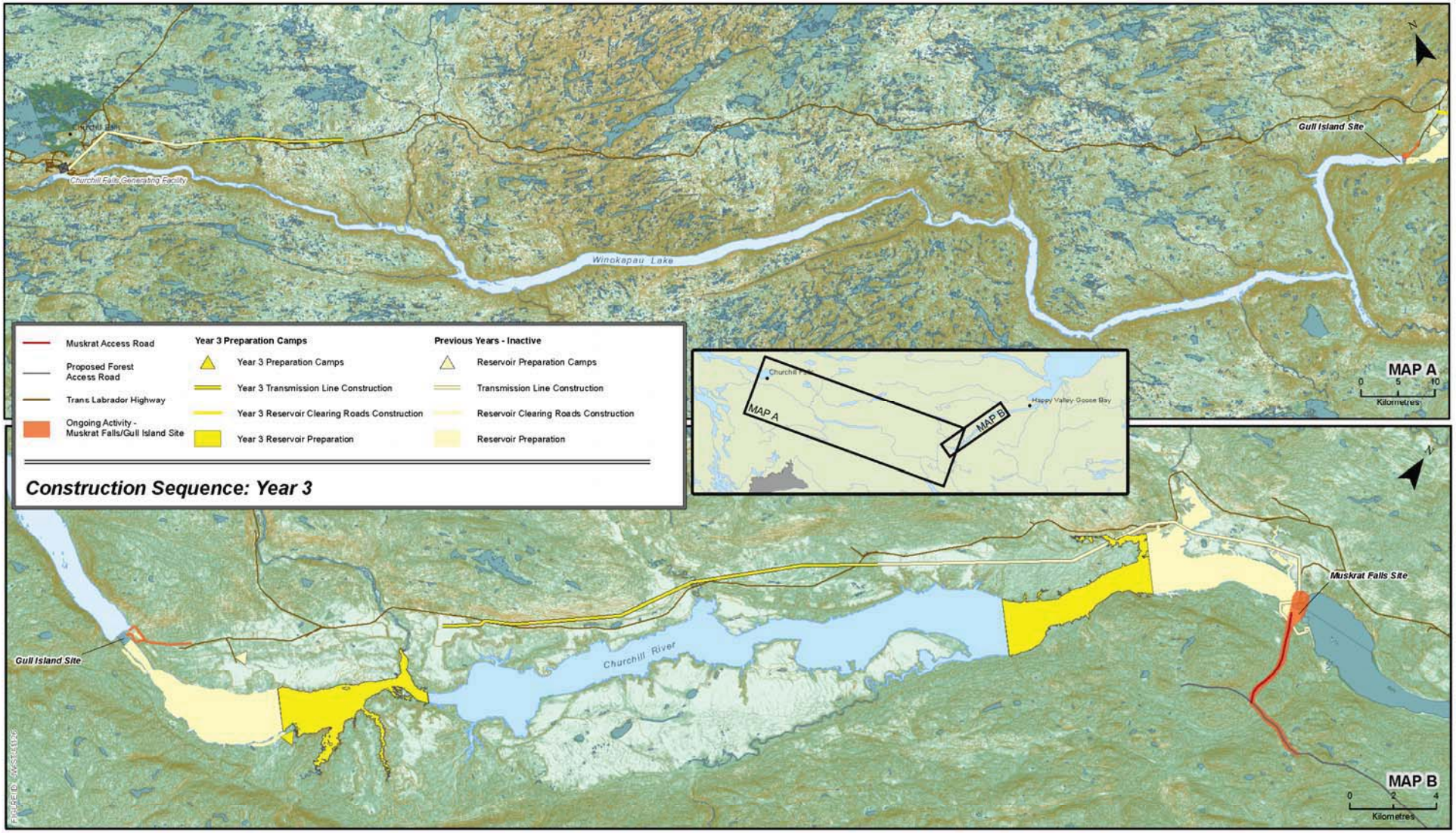


Figure 2-7 Construction Sequence Year 4

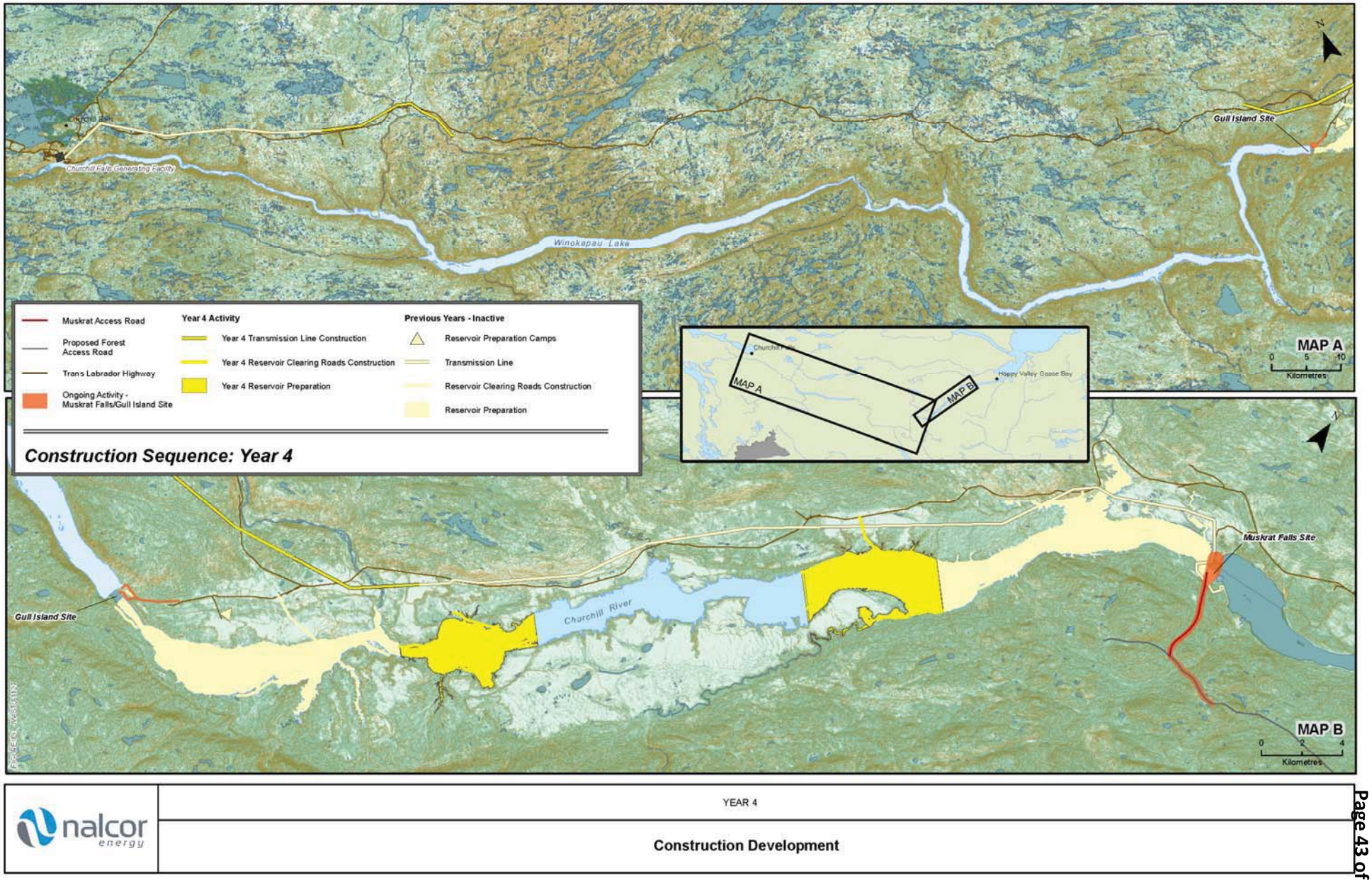


Figure 2-8 Construction Sequence Year 5

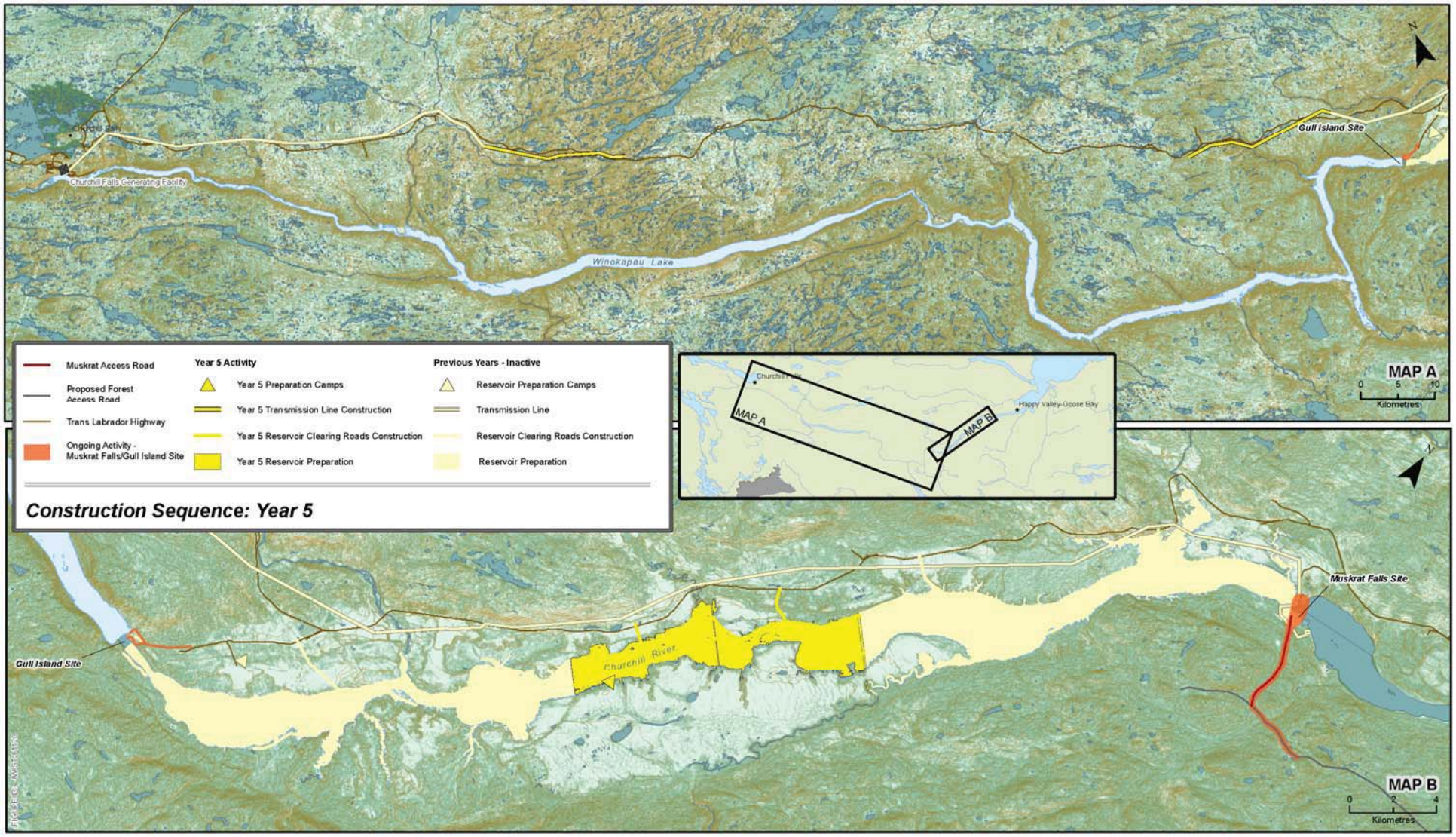


Figure 2-9 Construction Sequence Year 6

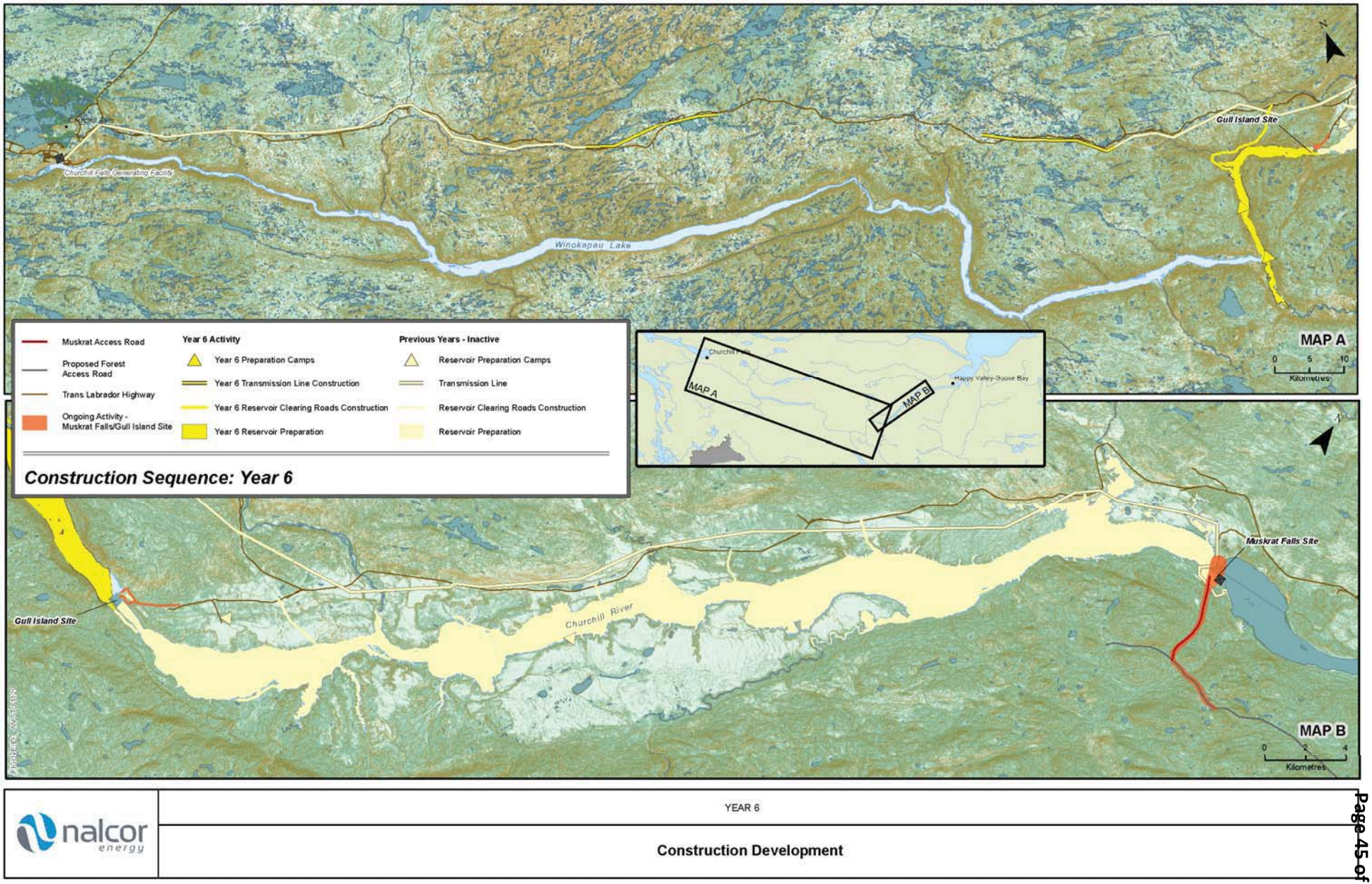


Figure 2-10 Construction Sequence Year 7

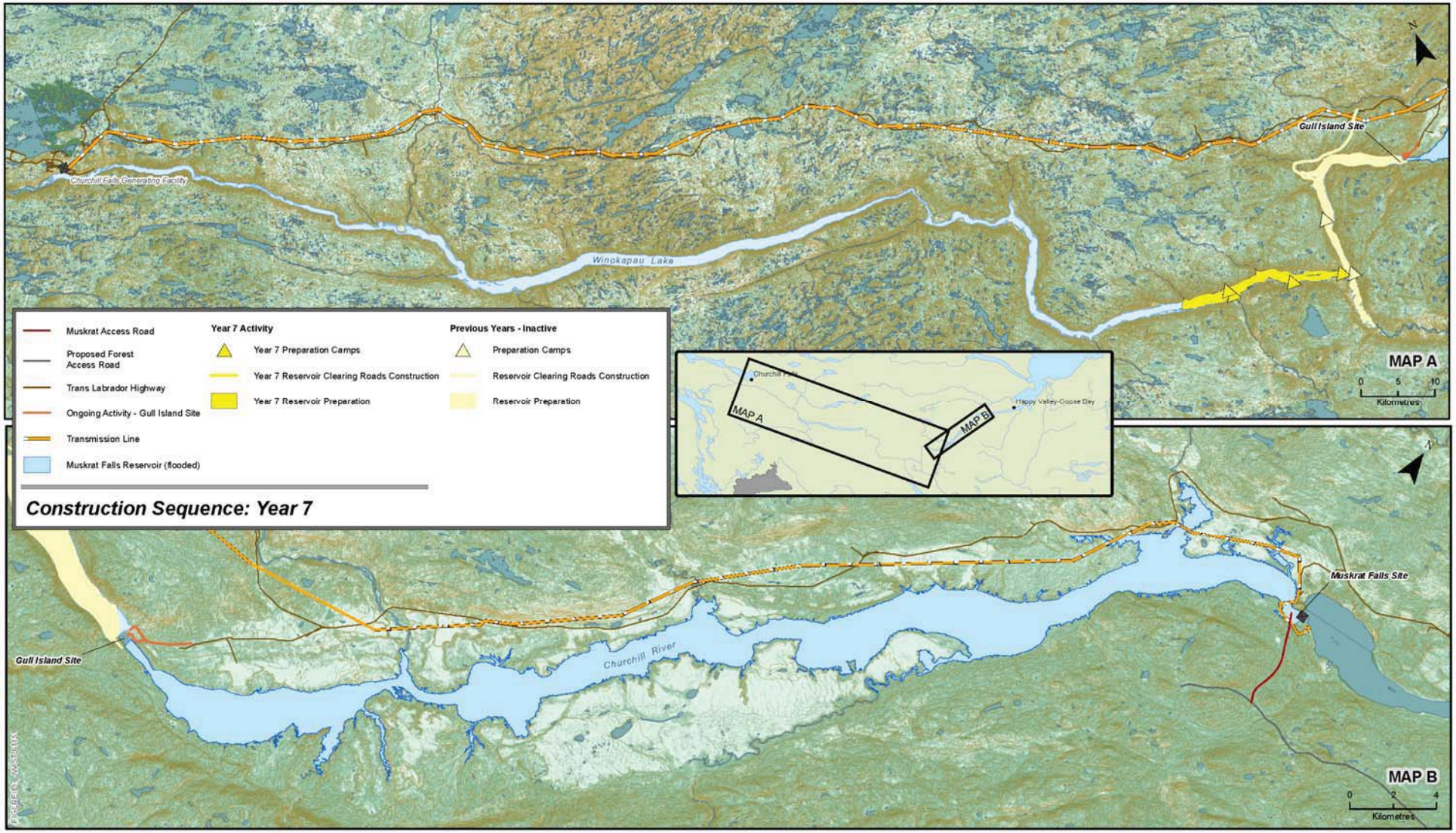


Figure 2-11 Construction Sequence Year 8

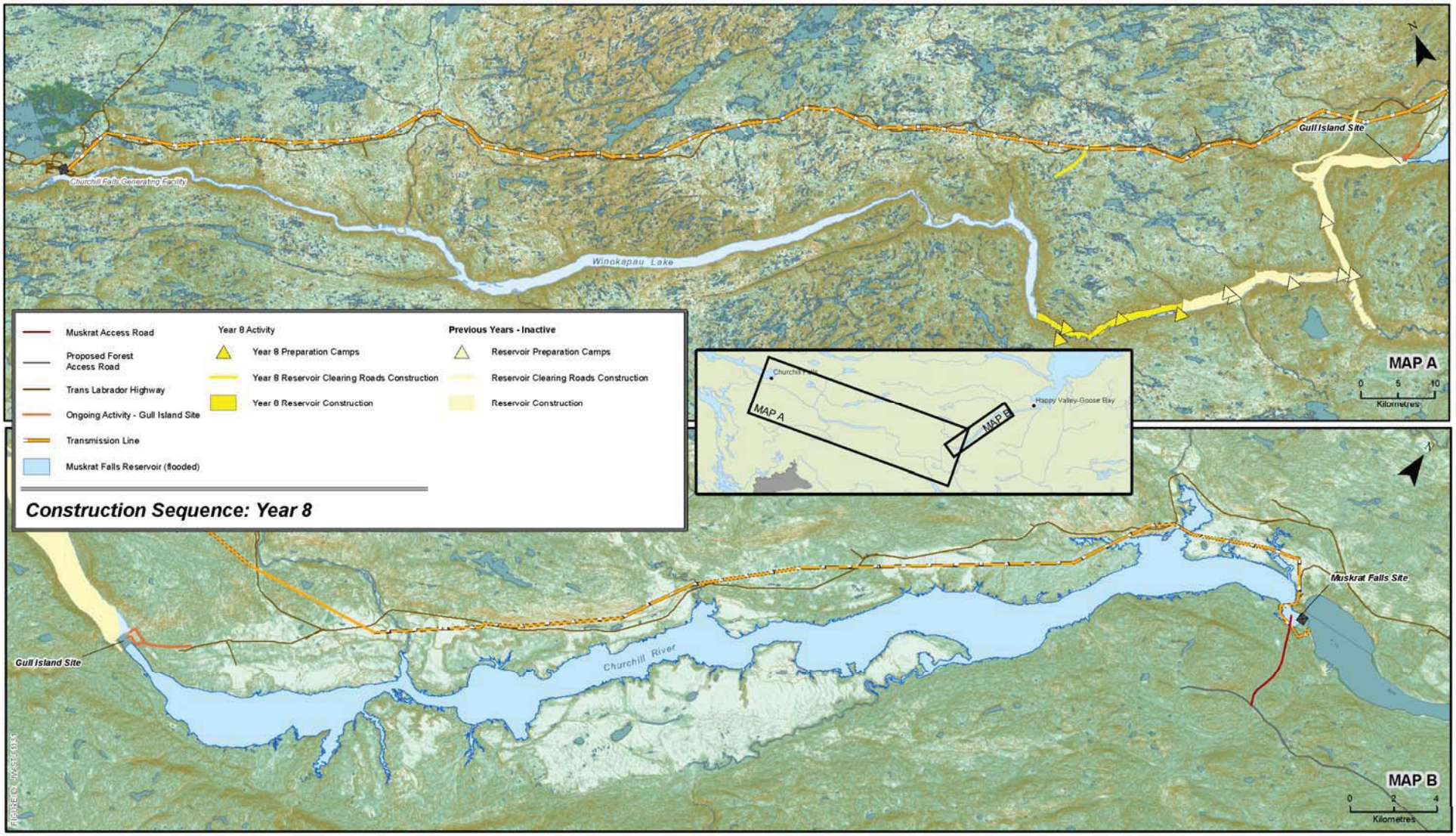


Figure 2-12 Construction Sequence Year 9

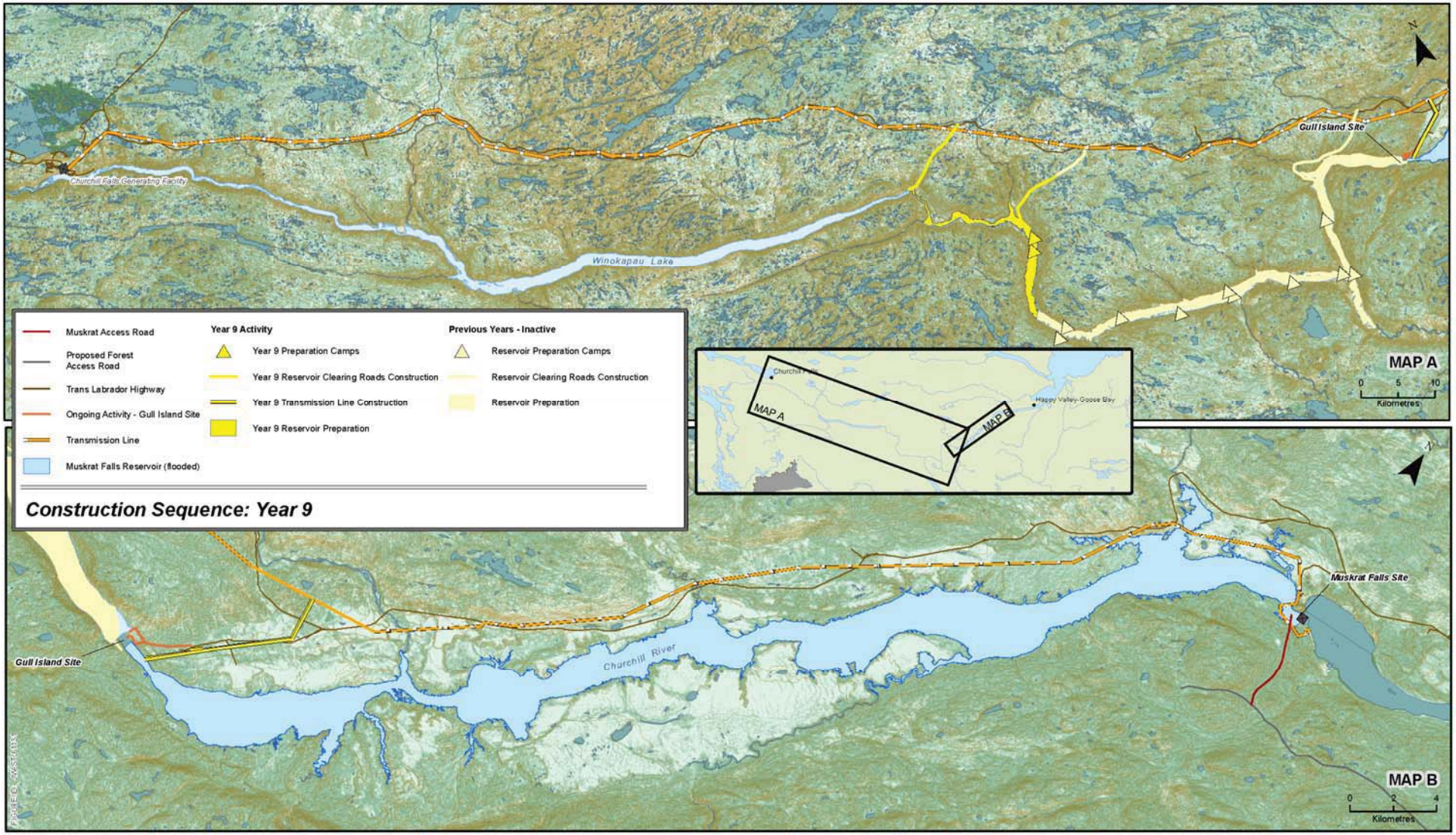


Figure 2-13 Construction Sequence Year 10

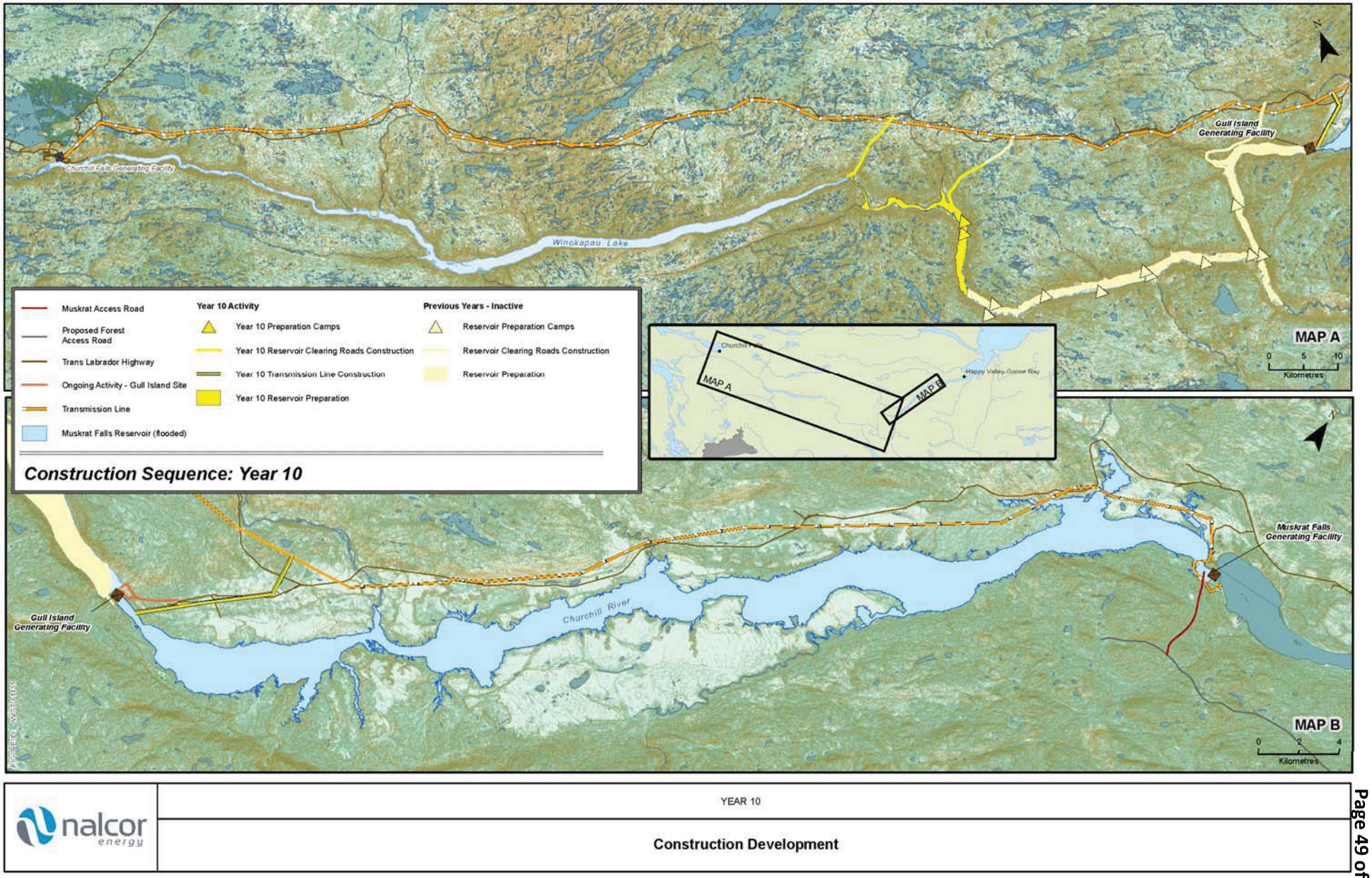
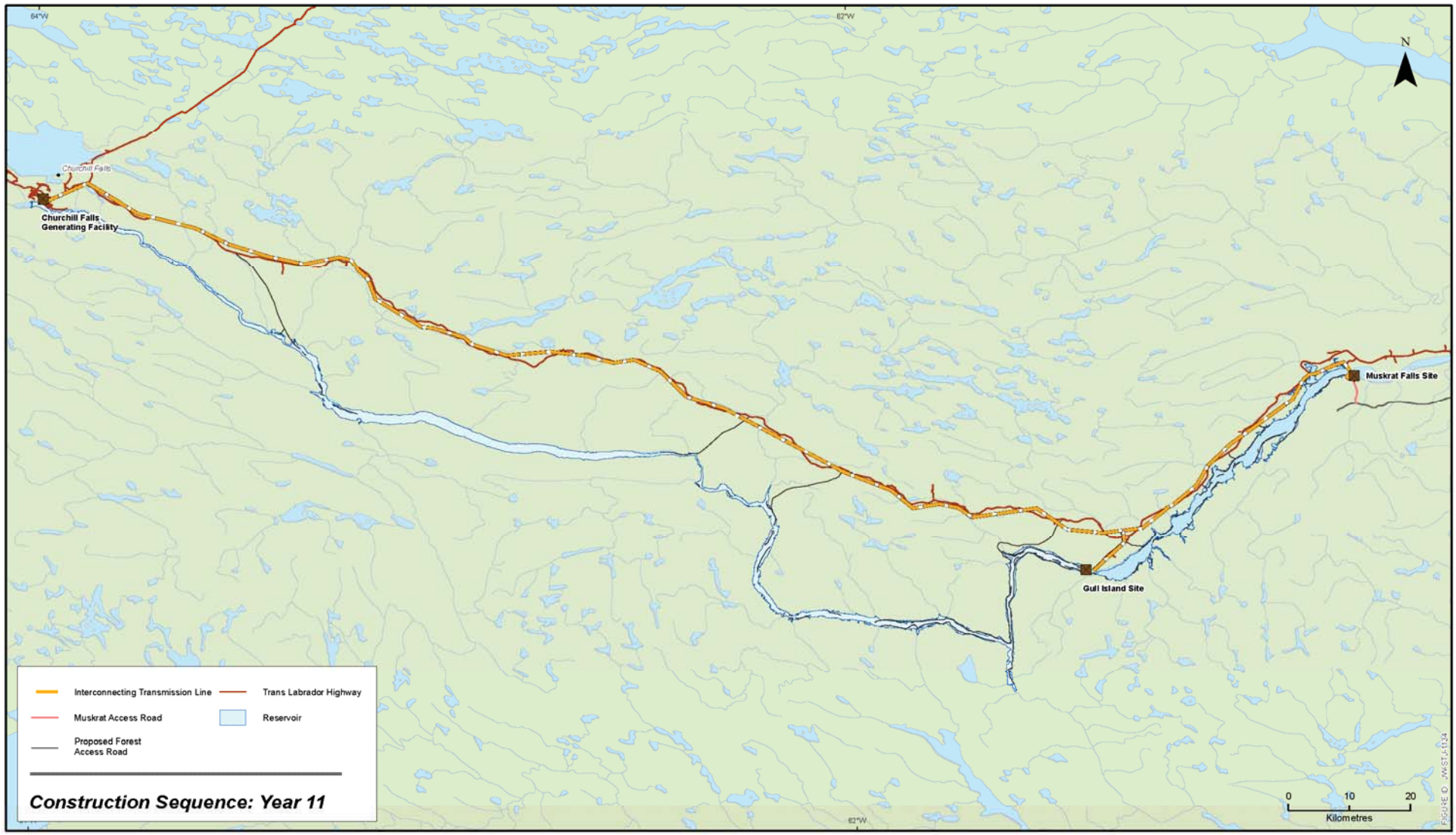


Figure 2-14 Construction Sequence Year 11



nalcor energy

YEAR 11

Construction Development

Expenditures

For each of Gull Island and Muskrat Falls, expenditures will vary year by year commensurate with the level of engineering and construction activity.

For Muskrat Falls and as the Project approaches sanction in Year 1, financial commitments will be made for long lead items including turbines, generators and transmission line hardware. In Year 1, mobilization for site infrastructure will commence in order to construct the on-site accommodations complexes, utilities and other support infrastructure including warehouses, maintenance shops, access roads and bridges. Main civil works will occur in Years 2 through 4, with installation and commissioning of the turbines in Years 5 through 6. Activity levels and expenditures for permanent equipment, construction material, construction equipment and labour will vary over and throughout each of these years consistent with the planned activity indicated in the Project Schedule. Peak annual expenditures for Muskrat Falls during the construction phase are estimated to be approximately $740 million in Year 4. For Gull Island the construction sequence will lag the start of Muskrat Falls construction by some three years.

Peak annual expenditures for Gull Island during the construction phase are estimated to be approximately $720 million during Year 7. The combined peak annual expenditure is expected to occur in Year 6 when $935 million of expenditures are expected. With the exception of the combined peak expenditure level, the total costs and peaks for each project component are expected to be the same for S2.

Material Requirements and Delivery

The materials required would not significantly change due to re-sequencing of the Project. The peak demand on infrastructure will be no different than for S1.

2.3 Workforce

The total workforce for the construction phase of S2 is illustrated in Figure 2-15. At peak, during Year 7, an average of over 2,300 personnel will be employed in construction, with monthly peaks reaching approximately 2,800 persons.

For S3, the total employment is expected to be the same, however, the time phasing and the peaks will be different as illustrated in Figure 2-16. Peak employment for Muskrat Falls is expected in Year 6 with total direct employment averaging over 1,660 persons, with monthly peaks approaching 2,000 persons. For Gull Island, peak employment is expected to reach an average monthly level of 1,900 in Year N+8 with monthly peaks of over 2,200 persons.

Figure 2-15 Total Direct Construction Workforce, Gull Island and Muskrat Falls (S2)

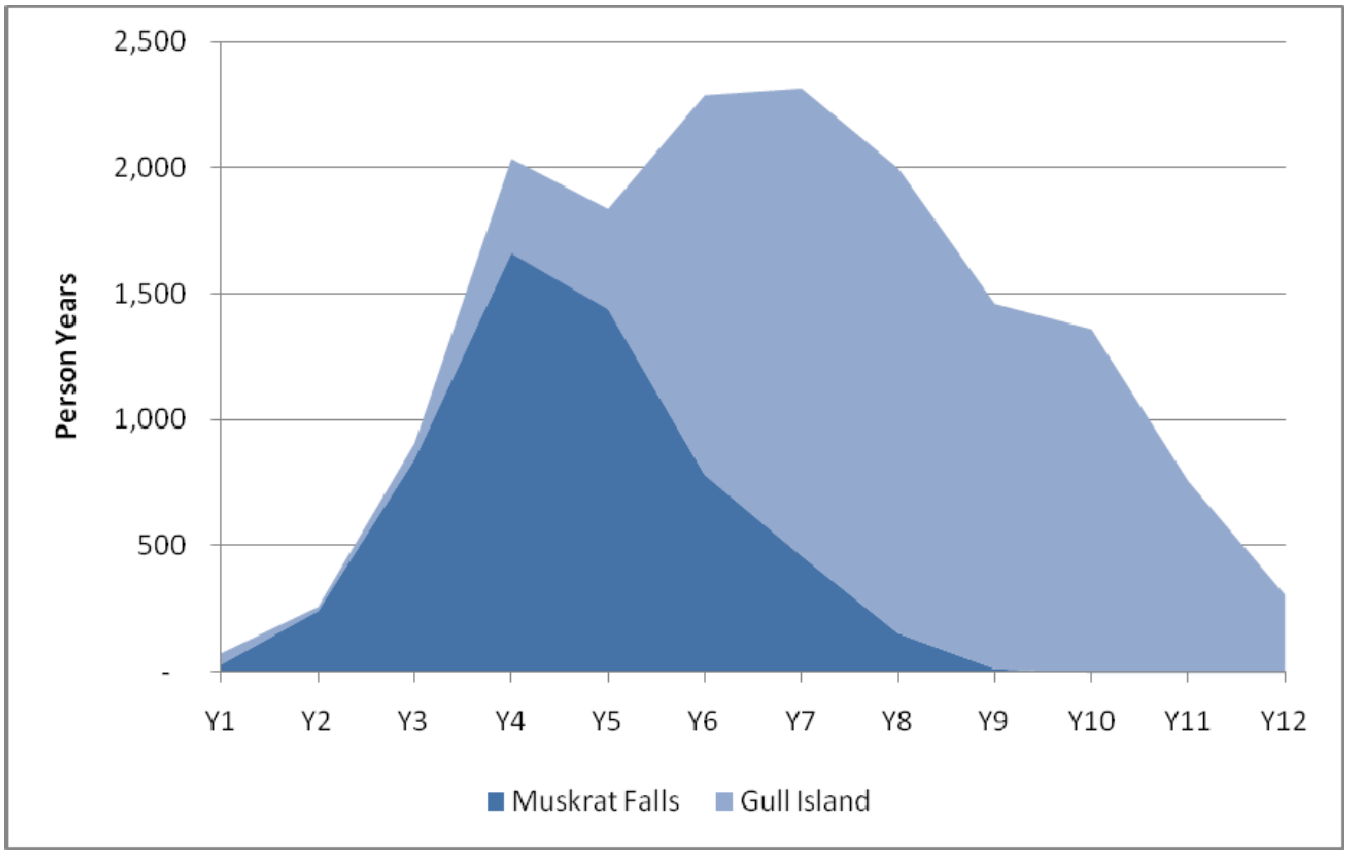
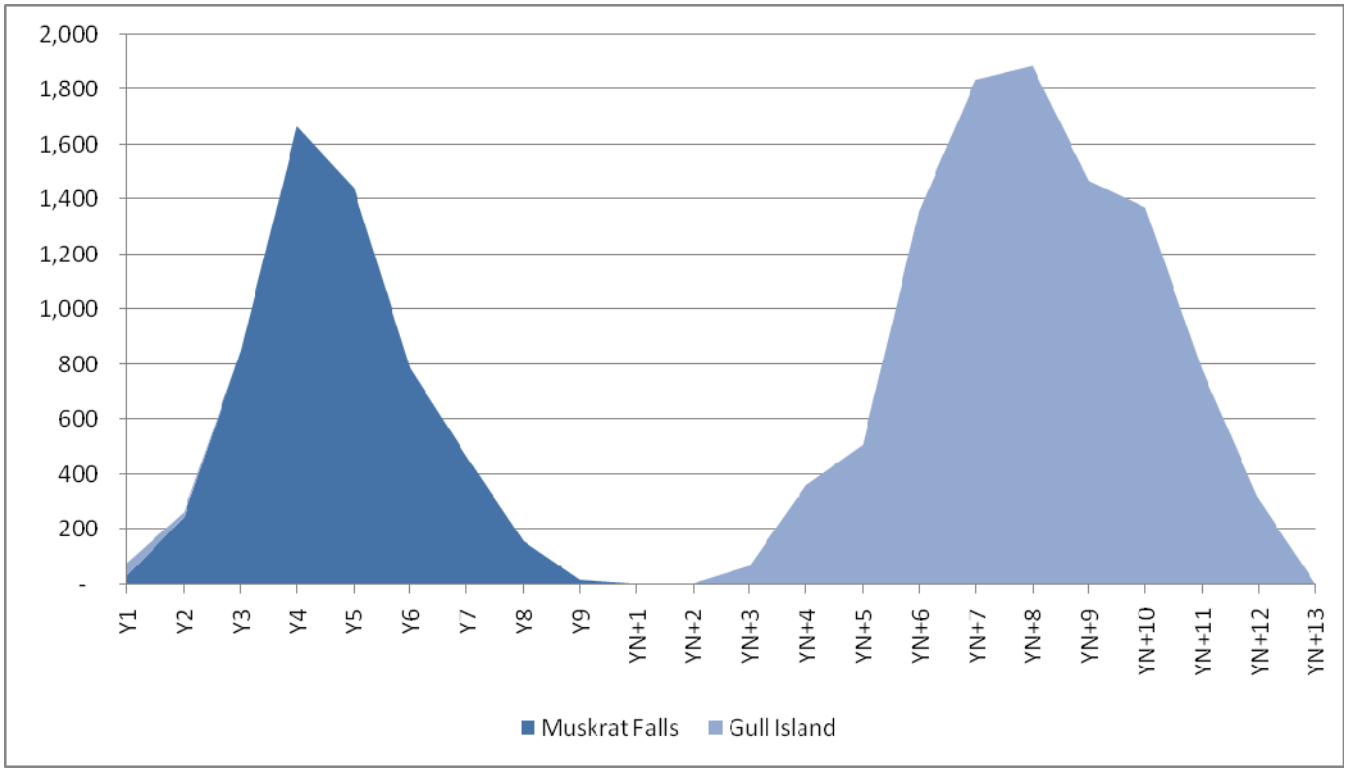


Figure 2-16 Total Direct Construction Workforce, Gull Island and Muskrat Falls (S3)



2.4 Expenditures

The estimated capital cost for Muskrat Falls including the 2 x 345 kV transmission line to Churchill Falls is approximately $2.5 billion in 2010 Canadian dollars. Capital costs for Gull Island and the associated switchyard upgrade costs are estimated at $3.9 billion in 2010 Canadian dollars. These estimated amounts cover all costs up to the point of full commissioning of each plant, excluding interest during construction and are identical for both S2 and S3.

These cost estimates are based on the total engineering and construction planning investigations completed to-date.

Annual operating costs are anticipated to be constant over the life of the generation plants due in part to the implementation of routine and preventive maintenance plans. The estimated annual operating cost for Muskrat Falls and the associated transmission is approximately $17 million annually in constant (2010) Canadian dollars. Once Gull Island is operational, total operating costs will increase by $14 million for total annual operating costs of $31 million for both facilities.

2.5 Operation and Maintenance

The operating regime for Muskrat Falls and Gull Island, as outlined in the EIS, would not change for S2 or S3. The Muskrat Falls generating facility would normally operate between a LSL of 38.5 masl and a FSL of 39.0 masl. The Gull Island generating facility would normally operate between LSL of 122 masl and a FSL of 125 masl as outlined in the EIS.

For S3, without Gull Island dam in place to provide regulation of the inflow to the Muskrat Falls reservoirs, spills would be expected to be more frequent, especially during the spring.

There are no changes anticipated in maintenance activities from a change in sequencing of Project phases.

3.0 ENVIRONMENTAL ASSESSMENT APPROACH AND METHODS

This report is supplementary to the EIS and previous IR responses. The approach and methods to assess the biophysical and socio-economic effects of changes in the sequencing of Project phases therefore rely on, and are consistent with, the environmental assessment approach and methods used in the EIS (Volume IA, Chapter 9). The analysis in this report has been implemented with a precautionary approach and the determination of significance of effects remains based on Nalcor's commitment to sustainability (Volume IA, Section 9.11).

3.1 Approach to Assessing the Effects of the Changes

The effects of the changes in construction sequence are assessed for each of the VECs and KIs to determine if there was a difference in the predicted effects compared to S1, as assessed in the EIS. The effects of the changes were assessed by:

- establishing Project description changes (Table 2-1 of this report);
- determining the difference (if any) in the Project interactions with VECs and KIs;
- reviewing and consolidating all aspects of the environmental assessment for S1, including the EIS, IR responses and any additional relevant information;
- determining the changes in effects (if any) caused by sequencing; and
- determining the changes in significance (if any) of adverse residual effects.

Effects to changes in cumulative effects and effects resulting from accidents and malfunctions are also assessed.

To best address IR# JRP.165, the effects assessment focuses on the changes in the Project description from that described in the EIS. Relevant sections of the EIS or IRs are referenced where applicable to avoid redundancy.

3.2 Compliance with EIS Methods

To ensure consistency and rigor this report was prepared using the same methodology and approach as the EIS. S2 and S3 Project sequencing does not change the VECs and KIs selected for this analysis and they remain the same as those used in the EIS and subsequent IR responses. Likewise, the same measureable parameters, Project activities and physical works, criteria for describing effects, and significance definitions are used. The approach and methods are also compliant with the requirements of the *Canadian Environmental Assessment Act* (CEAA) and the *Newfoundland and Labrador Environmental Protection Act* and its Regulations.

Models were updated where necessary to provide revised projections resulting from the change in sequence. These include Economics, Mercury, Hydrology, and Ice Dynamics.

4.0 ATMOSPHERIC ENVIRONMENT

The S2 or S3 construction sequencing of the Muskrat Falls and Gull Island facilities does not influence aspects that relate to potential environmental effects of the Project on the Atmospheric Environment. This is because the size and location of the main components remain the same, and the methods and effort to build them remain the same. The analysis presented in the EIS (S1) and the responses to Information Requests to date remain valid for S2 or S3. The conclusions are not expected to change as a result of a change in sequencing of the Project phases.

The following provides more detail on environmental effects on air quality and greenhouse gas (GHG) emissions / climate for both construction and operation, associated with S2 or S3 compared to S1.

4.1 Air Quality

The S1 assessment of air quality in the EIS focused on the construction phase since the emissions of air contaminants during operation are expected to be nominal. The release of air contaminants to the atmosphere during construction arises from the combustion of fossil fuel used in the heavy equipment, trucks and vehicles needed to move material to the site and at the site, and from fugitive dust generation during the clearing, grubbing, crushing and movement of material at the site. These activities and the associated emissions are not likely to change substantively due to S2, S3 sequencing of Project phases. In S2, there will be an overlap in the construction of the two facilities, and in activities associated with emissions. As with S1, there is not likely to be any overlap in potential environmental effects on air quality because of the distance between the two site locations. In S3, there is no overlap in construction and any potential environmental effects on air quality are expected to be similar to or less than those presented in the EIS for S1.

4.2 Greenhouse Gas Emissions / Climate

In the assessment of GHG / climate in the EIS (i.e., S1), releases to the atmosphere were estimated for both construction, and operation and maintenance phases.

Emissions of GHG during construction were estimated for the heavy equipment and associated fuel consumption to prepare the reservoir and infrastructure. Because the locations, means, and level of effort to construct the Project has not changed, there are no changes to heavy equipment use and associated fuel consumption. Therefore, no changes are predicted to emissions during construction.

Emissions of GHG during operation for S1 was estimated using carbon modeling, examining the long-term trends in GHG emissions from the Churchill River watershed at Gull Island and Muskrat Falls. The GHG emissions released from each facility (i.e., Gull Island and Muskrat Falls) were modeled separately to compare differences, and then combined over the long term to provide a quantitative prediction for the Project.

For S2 or S3, there would be a difference in the timing of the releases of GHG from each phase, (i.e., the release rate curves would shift according to the order of building the phases). For S2, the emissions of GHGs from the Muskrat Falls reservoir and the associated watershed would commence earlier than from the S1 presented in the EIS and, since the GHGs from the watershed would be released over a smaller area than the Gull Island reservoir initially, the quantity of GHG released to the atmosphere might be less initially, compared with the potential emissions if Gull Island were constructed first (S1). Nevertheless, the total emissions reported in S1 of the EIS over the long term would not change substantively. Thus, the conclusions regarding the potential environmental effects are not expected to change for S2 (compared to S1).

Similarly, for S3, the release rate curves would shift according to the order of reservoir creation. The emissions of GHG from Muskrat Falls would start earlier than described in the EIS (S1) and be released in lower quantities over the short term. Similar to S2, the total emissions as reported in the EIS over the long term are not likely to change substantively, understanding that the Gull Island facility will be built at some point in the future.

5.0 AQUATIC ENVIRONMENT

5.1 Introduction

The purpose of this chapter is to present the assessment of the predicted effects on the Aquatic Environment resulting from a change in sequencing of the Project phases (S2 and S3) relative to S1. Within the Aquatic Environment VEC, the same aquatic KI species / populations that were described and evaluated in Volume IIA (Chapter 2) and Volume IIA (Chapter 4) of the EIS were used to assess the change in sequence of constructing the two hydroelectric generation facilities associated with the Project. Where differences exist from the original assessment because of differences in the Project description or new information since submission of the EIS, such differences are evaluated in terms of the significance of effects.

Many aspects of the Project will interact with the Aquatic Environment and have the potential to result in measurable environmental effects. This assessment will examine whether changes to Project sequence will result in differences to the physical alteration of the habitat (effects on aquatic habitat quantity and quality), change in species distribution (habitat utilization), or change in fish health effects such as mercury accumulation.

The Aquatic Environment was originally selected as a VEC because Project activities will interact with aquatic species and habitats within the lower Churchill River, regardless of construction sequence. Both scenarios (S2 and S3) are described in Chapter 2 of this report. While the sequence of construction has the potential to interact with the aquatic environment key indicators differently than described for S1, the key indicators remain as described in Volume IIA, Chapter 4 of the EIS. Any additional information as a result of ongoing monitoring has also been included or referenced where necessary to assist in the assessment. Among other regulatory requirements, the Project will still require authorization from DFO for the Harmful Alteration, Disruption or Destruction (HADD) of fish habitat regardless of sequence.

The Aquatic Environment Assessment Area remains the same as that described in the EIS. The assessment of S1, S2, or S3 all consider the freshwater, fish species, aquatic vegetation and substrates within and near the river system. Further discussion on the downriver extent of study areas as well as the assessment area is provided in IR# JRP.43, IR# JRP.152 and IR# JRP.166.

5.2 Key Indicators

The rationale for the selection of KIs is the same as was presented in Volume IIA, Section 4.2 of the EIS and in IR# JRP.41. In order to remain consistent with ongoing Fish Habitat Compensation Planning (as described in IR# JRP.153), this assessment relies on the existing fish assemblage as well as each species life-cycle stage in order to expand on the ecosystem approach used and presented in Chapter 4 of Volume IIA of the EIS.

5.3 Potential Interactions

For S2 and S3, there is no change in the scope of Project activities and Physical Works and the same interactions with the KIs would apply as was identified in S1 and described in the EIS (Volume IIA, Section 4.2) (Table 5-1). From Table 2-1, the only confirmed change in the footprint of the Project for S2 and S3 is the wider right-of-way associated with the interconnecting transmission lines. This would result in an incremental alteration or loss of terrestrial habitat of less than 6 km^2.

Regardless of the sequencing of Project phases, the rankings of the potential interactions have not changed. Those interactions ranked as 0 (such as expenditures and employment) do not interact with the aquatic environment.

Likewise, those interactions ranked as 1 would still be considered to be limited in extent, and/or standard procedures are expected to mitigate any potential effects. In all cases, the rating of an interaction as 1 is based on the professional experience and knowledge of the study team and its confidence that there is no possibility for a significant adverse residual environmental effect to occur, or for the effect to contribute measurably to the cumulative environmental effects of the Project. Each interaction rated as 1 has been evaluated at a screening level in Volume IIA, Section 4.3 of the EIS. The adverse environmental effects of those ranked as 1 will be mitigated so the residual effects will be **not significant**; therefore, no further environmental assessment is required. While some assessors may indicate aspects of activities ranked as 0 to have potential interaction with the aquatic environment (e.g. concrete production), their interactions would remain at a maximum ranking of 1 and therefore not significant given standard procedures to mitigate potential effects (see IR# JRP.118).

Table 5-1 Interaction of the Project with Fish and Fish Habitat (reproduced from Table 4-1 in Volume IIA, of the EIS)

Project Activities and Physical Works	Fish and Fish Habitat
Construction	
Upgrading and Constructing Site Access Roads	1
Site Preparation and Construction of Site Buildings	1
Excavation for and Installation of Generation Components	2
Concrete Production	0
Transmission Line Construction	1
Site Water Management	1
Camp Operations	0
Vehicle Traffic onsite	0
Quarrying and Borrowing	1
Reservoir Preparation	1
Impounding	2
Employment	0
Transportation and Road Maintenance	1
Expenditures	0
Operation and Maintenance	
Water Management and Operating Regime	2
Operation of Generation Facilities	2
Site Waste Management	0
Inspection, Maintenance and Repairs along Proposed Transmission Line	1
Employment	0
Transportation, Presence and Maintenance of Access Roads	1
Expenditures	0
Accidents and Malfunctions[A]	
Dam Failure	2
Forest Fire	2

Table 5-1 Interaction of the Project with Fish and Fish Habitat (continued)

Key:

0 No interaction will occur. Assessment of environmental/socio-economic effects is not required

1 Identified interactions that are well understood, are subject to prescribed environmental protection measures or normal regulatory processes, and/or which can be mitigated/optimized through the application of standard environmental protection or socio-economic management measures and practices. Based on past experience and professional judgement, the potential environmental/socio-economic effects resulting from these interactions are rated not significant

2 Identified interactions that may result in more substantive environmental or socio-economic effects and/or public or regulatory concern. These interactions require more detailed analysis and consideration in the environmental assessment, in order to predict, mitigate and evaluate potential environmental/socio-economic effects

[A] Accidents and Malfunctions are addressed in Volume IIB, Chapter 6

Any interaction that has the potential to result in a measurable environmental effect is ranked 2. As these interactions were assessed for S1 in Volume IIA of the EIS, only the differences associated with the potential for significant adverse residual effects and to determine requirements for Project-specific mitigation and follow-up are discussed further. The interaction differences associated with S2 or S3 are assessed according to three effects categories:

- change in habitat quantity and quality;
- change in fish distribution and abundance; and
- change in fish health.

Project Activities for Further Assessment of Change in Habitat Quantity and Quality

The following Project activity interactions with Fish and Fish Habitat that are rated as 2 in Table 5-1 are assessed for their potential to change habitat quantity:

- excavation for and installation of generation components;
- impounding;
- water management and operating regime; and
- operation of generation facilities.

For S2 and S3, the construction and operation of the Gull Island generating facility and reservoir will not change compared to S1. As a result, no impact on aquatic VEC's will occur.

Impounding a river results in increases in surface area and associated changes in water depths and velocities. The physical change in water surface area will be used as a measure of change in habitat. Existing knowledge about the biological, chemical and physical attributes of the future habitat area have been presented in Volume IIA, Section 4.7 in the EIS and IR# JRP.153. While constructing the Muskrat Falls facility first (S2 or S3) will affect the timing of each reservoir being created, the overall quantity of habitat will remain the same upon completion of construction.

There is no change to the water management and operating regime or operation and maintenance activities. Therefore, the potential for either to affect the productivity of available fish habitat does not change.

Project Activities for Further Assessment of Change in Fish Distribution and Abundance

The following Project activity interactions with Fish and Fish Habitat that are ranked as 2 in Table 5-1 are assessed for their potential to change fish distribution and abundance:

- excavation for and installation of generation components;

- impounding;
- water management and operating regime; and
- operation of generation facilities.

For S2 or S3, the only identified Project activity that would change its interaction with fish distribution and abundance related to a change in construction sequence is a change in impoundment sequencing.

Post-Project fish distribution and abundance has been described using measures of habitat utilization. Habitat utilization predictions have been further described since submission of the EIS in February 2009 and have been submitted to DFO in a Fish Habitat Compensation Strategy and to the Panel as IR# JRP.153.

Project Activities for Further Assessment of Change in Fish Health

The Project interactions with Fish and Fish Habitat that are ranked as 2 in Table 5-1 are assessed for their potential to change fish health for the following Project activity: water management and operating regime during operation and maintenance; however, the water management and operating regime of the Project will not change as a result of a change in sequence.

5.4 Measurable Parameters

Measurable parameters were identified in Volume IIA, Section 4.4 of the EIS, and remain the same for S2 and S3 (Table 5-2).

Table 5-2 Measurable Parameters – Fish and Fish Habitat (adapted from Table 4-2 in Volume IIA of the EIS)

Key Indicator	Measurable Parameter
Fish and Fish Habitat	• habitat quantity in hectares for both riverine and standing water habitat types within the Assessment Area. Habitat types have been characterized by substrate, gradient and other relevant descriptions • fish populations – change in population (i.e. abundance) for all species and LCSs. This has enabled the development of comprehensive habitat utilization indices (HUI) for every existing and predicted habitat type within the lower Churchill River. The method used for this is described in Section 4.8.2.1 and in AMEC-Sikumiut (2007) • fish mortality - estimates are based on knowledge of fish movements (by species) as well as project turbine descriptions and literature sources that indicate survival rates of fish passage through hydroelectric generation structures • habitat quality is measured and characterized by three physical parameters: – temperature has been measured and the thermal regime modelled throughout the Assessment Area. Surveys have been conducted within and beyond the proposed impoundment zone, allowing this index to be modelled and compared to post-impoundment levels – total suspended solids (TSS) surveys have been conducted within and beyond the proposed impoundment zone, along the length of the river to characterize levels (mg/L). Sufficient related parameters have been measured to support modeling to predict changes in TSS and thereby characterize the future environment – total phosphorus in water (mg/L) has been measured and modelled to provide an indicator of primary production in the system • fish health has been measured as mercury body burden levels (µg/L) from sub-sampled fish of various species, by size class, within each habitat type. Surveys have been conducted within and beyond the proposed impoundment zone, allowing these indices to be modelled and compared to post-impoundment levels

5.5 Criteria for Describing Environmental Effects

Environmental effects of S2 and S3 are characterized and described using the same descriptors as in Volume IIA, Section 4.5 of the EIS:

- nature: the long term environmental effects of the Project on Fish and Fish Habitat.
  - adverse
  - positive

  - neutral
- magnitude: the extent of change in the quantity of Fish and Fish Habitat from the baseline state.
  - low: less than five percent change within the Assessment Area
  - moderate: five to 25 percent change within the Assessment Area
  - high: greater than 25 percent change within the Assessment Area
- geographic extent: the physical area within which interactions are expected to occur.
  - site-specific: confined to the Project footprint
  - local: confined to the lower Churchill River valley
  - regional: environmental effect occur throughout the Assessment Area and beyond
- duration: the period of time the environmental effect will occur.
  - short term: less than one generation
  - medium term: approximately one generation
  - long term: two or more generations
  - permanent: considered to exist in perpetuity
- frequency: the number of times the Project will have an environmental effect on Fish and Fish Habitat.
  - occurs once
  - occurs sporadically at irregular intervals
  - occurs on a regular basis and at regular intervals
  - continuous
- reversibility: whether the adverse environmental effects are reversible or irreversible.
  - reversible
  - irreversible
- ecological context: the general characteristics of the area with respect to existing levels of human activity in the Assessment Area.
  - undisturbed: area relatively or not adversely affected by human activity
  - disturbed: area has been previously disturbed by human development or human development is still present
- level and degree of certainty of knowledge.
  - low: low level of certainty
  - high: high level of certainty
- likelihood.
  - unlikely: significant adverse environmental effect not likely to occur
  - likely: significant adverse environmental effect likely to occur

5.6 Determination of Significance

The determination of significance remains the same as that described for S1 in the EIS. A significant adverse residual environmental effect is of sufficient magnitude, duration, frequency, geographic extent and/or irreversibility as to cause a change in a measurable parameter within the Assessment Area, such that conditions may not stabilize to their original levels within several generations of the fish assemblage that depend on that measurable parameter.

5.7 Existing Knowledge

The existing knowledge presented In Volume IIA of the EIS, along with that presented in subsequent IR submissions, remains valid in that the change in sequencing of [project phases does not change the nature of the potential interactions with fish and fish habitat. Table 5-3 presents a consolidated summary of existing knowledge related to potential changes in the various parameters.

Table 5-3 Summary of Additional Existing Knowledge for Aquatic Key Indicators since the EIS

Key Indicator	Existing Knowledge		
	Habitat Quantity and Quality	Fish Distribution and Abundance	Fish Health
Fish and Fish Habitat	IR# JRP.43, IR# JRP. 44, IR# JRP.45, IR# JRP.6, IR# JRP.32, IR# JRP.53, IR# JRP.64, IR# JRP.49s, IR# JRP.55, IR# JRP.56, IR# JRP.90, IR# JRP.107, IR# JRP. 89, IR# JRP.63, IR# JRP.119, IR# JRP.120, IR# JRP.148, IR# JRP.149, IR# JRP.150, IR# JRP.152, IR# JRP.153, IR# JRP.159	IR# JRP.44, IR# JRP.51, IR# JRP.47, IR# JRP.49, IR# JRP.50, IR# JRP.52, IR# JRP.153, IR# JRP.123, IR# JRP.51, IR# JRP.121	IR# JRP.20, IR# JRP.21, IR# JRP.66, IR# JRP.156, IR# JRP.166

5.8 Environmental Effects Management

The nature of the interactions between the aquatic environment and the Project will not change because of a change in construction sequence. As such, the environmental effects management (both standard and project-specific) for the Project as described in the EIS remain valid. A summary of standard effects management during construction, operation and maintenance applicable to the Aquatic Environment is provided in Table 5-4.

Table 5-4 Standard Mitigation Applicable to the Aquatic Environment (adapted from Table 4-7 in Volume IIA of the EIS)

Project Aspect	Standard Mitigation / Design
Site Personnel and Environmental Awareness	A no harvesting policy will be implemented for all employees. Periodic Environmental Awareness Sessions will be conducted for all construction personnel during the construction of the Project. Tailgate environmental briefings will be held daily in association with the tailgate safety sessions. The education aspect of environmental protection will be stressed by Nalcor in addition to the compliance monitoring program
Surface Disturbance	There will be a physical surface disturbance (the reservoirs, access roads, camps and facilities) within an area of approximately 250 km^2. Nalcor will limit the surface disturbances using Environmental Site Monitors who will supervise (for compliance) all activities described in the EPP. Where possible, limited surface disturbance has been built into the design of the Project. Mitigation to reduce the environmental effect and reduce the potential occurrence of dust, turbidity and sedimentation will be detailed in the Project EPP. The control of siltation, erosion and runoff from construction sites is addressed in standard practices and guidelines such as the *Guidelines for Protection for Freshwater Fish Habitat* (Gosse et al. 1998), *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1993) and the *Environmental Guidelines for General Construction Practices* (Water Resources Management Division 1997). All discharges of runoff from construction activities will conform to the *Environmental Control Water and Sewage Regulations, 2003* under the *Water Resources Act* (O.C. 2003-231). DFO also provides several guideline publications
Vegetation Management	If used, herbicides will be sprayed by hand from the ground to control drift. Herbicides will not be sprayed near water bodies. Staff will be certified consistent with *Herbicide Control Regulations*
Hazardous Materials	All fuelling facilities will be approved, constructed and operated in accordance with the *Storage and Handling of Gasoline and Associated Products Regulations* CNR 775/96. Necessary approvals will be obtained from the Newfoundland and Labrador Department of Government Services (NLDGS)

Table 5-4 Standard Mitigation Applicable to the Aquatic Environment (continued)

Project Aspect	Standard Mitigation / Design
Blasting	Mitigation to reduce the environmental effect of blasting will be detailed in the EPP. Blasting is a highly regulated construction activity because it has the potential to generate damage to both the environment and to people. As such, both DFO and the industry have developed very prescriptive guidelines and best practices. The calculated level of each charge as well as the amount of blasting required will mitigate adverse residual environmental effects. Blasting protocols will be designed to be as efficient and effective as possible, using publications such as: the *Technical Report for the Use of Explosives Near Canadian Fisheries Water* (Wright and Hopky 1998), *the Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador* (Gosse et al. 1998) and DFO's *Mitigation of Seismic Noise in the Marine Environment - Statement of Canadian Practice* (Fisheries and Oceans 2007, Internet site)

Project-Specific Effects Management Measures

For S2 and S3, Project-specific management measures do not change compared to S1. A listing of Project-specific management measures proposed for this Project is provided in Table 5-5. These have been slightly enhanced from that presented in the original EIS to reflect advances in the overall Fish Habitat Compensation Strategy (i.e., IR# JRP.153).

Table 5-5 Project-Specific Effects Management Measures (adapted from Table 4-8 in Volume IIA of the EIS)

Project Component / Activity	Specific Mitigation / Design
Aquatic Disturbance	Impounding the reservoirs is currently scheduled to occur between August and October, a time of least sensitivity and compensation flow at 30% Mean Annual Flow will be provided for downstream fish and fish habitat
	Removal of vegetation during reservoir preparation may moderate nutrient release into the aquatic system; however all activities will conform to existing Forestry Guidelines for the protection of fish habitat in Newfoundland and Labrador (Scruton et al. 1997)
Habitat Enhancement / Compensation	Measures will be taken to facilitate development of delta, littoral, shoreline and mid-channel features to assist in reducing the time to stabilization and increase habitat use. Habitat creation at selected sites within the Assessment Area will also be completed to provide adequate habitat features (refer to IR# JRP.153)

Aquatic Disturbance

The change in sequencing of Project phases, and hence sequencing of reservoir impoundment, does not alter the final footprint, extent of the reservoirs, or duration of impounding a reservoir (i.e., impoundment would not be intentionally accelerated or extended). Once each reservoir is ready for impoundment, it would be completed as quickly as possible providing for 30% of the existing MAF. For S2 and S3, the composition of habitat available to fish upriver would remain unaltered until the Gull Island reservoir is inundated.

There is no change in impoundment strategy associated with S2 or S3 relative to S1 other than the schedule. The flows below each dam will be reduced so that each reservoir will fill with water. As stated in responses to IR# JRP.28 and IR# JRP.148, non-mobile life-cycle stages would be most susceptible to effects related to inundation, as they cannot respond to habitat reduction / dewatering. In general, the most sensitive life-cycle stages are those that are associated with spawning (i.e., egg incubation / development and hatching). The extent of the effect on these stages would be more sensitive downstream of the reservoirs as eggs that are incubating within the reservoir footprint would not be dewatered during inundation. As a result, reservoir impoundment has the potential to cause a short-term disruption of fish habitat downriver of each reservoir as flows could be reduced.

A compensation flow of 30% of the existing Mean Annual Flow (MAF) will also be provided to maintain downstream fish habitat during impoundment. This equates to a compensation flow of 546 m^3/s at Muskrat Falls and 534 m^3/s at Gull Island reservoirs, respectively regardless of construction sequence.

The habitat affected during the Muskrat Falls reservoir inundation will be similar regardless of impoundment sequence as water from upstream will be restricted at the Muskrat Falls dam to fill the reservoir and flows during that time will be reduced below Muskrat Falls. The absence of the Gull Island facility upstream does not affect this.

For S2 and S3, the habitat affected during the impoundment of the Gull Island facility will be less with a change in sequence. With the filling of the Muskrat Falls reservoir first, the habitat below the Gull Island dam (i.e., within the footprint of the Muskrat Falls reservoir) would no longer be dewatered as described in IR# JRP.28 (e.g., Figures 4a-7a) but would remain the formed Muskrat Falls reservoir. Compensation flow could still be passed through the Gull Island dam facility and the Muskrat Falls reservoir to accommodate that habitat below Muskrat Falls. In this respect, a sequence with Muskrat Falls constructed / inundated first reduces the overall potential effect on Fish and Fish Habitat. Habitat downstream of the Muskrat Falls facility during impoundment of both reservoirs would remain as described in previous information (e.g. IR# JRP.28 and IR# JRP.148).

During reservoir impoundment, saltwater intrusion into the river below Muskrat Falls from Goose Bay has been identified as an issue. Modelling of the extent of intrusion was completed and described in Hatch (2008) as well as the response to IR# JRP.43. With a 30 percent MAF compensation release during the filling of both reservoirs, intrusion of higher salinity water is predicted to remain near its natural extent at the mouth of the lower Churchill River (river chainage -3 km) regardless of a change in sequencing of Project phases.

Habitat Enhancement / Compensation

Aspects of Project features and/or predicted future conditions have resulted in a HADD determination by DFO. For S2 and S3, there is no change contemplated for the HADD nor the Fish Habitat Compensation Strategy. Details of the HADD and Fish Habitat Compensation Strategy to address it are provided in IR# JRP.153 and summarized below.

The habitat within the HADD determination is sub-divided into two categories;

- habitat that would be destroyed (i.e. would no longer have any productive capacity as fish habitat); and
- habitat that would be altered in terms of its characterization and hence its utilization / productive capacity.

The habitat that would be destroyed includes that under the direct footprint of both the Muskrat Falls and Gull Island generating facilities. Habitat quantities have been determined at 7.30 and 26.03 hectares (ha), respectively and this does not change for S2 or S3 relative to S1.

Due to the predicted lag in stabilization and concern related to future habitat utilization within the newly formed reservoirs at the time of the determination, DFO also considered any altered fish habitat (in this case, existing Intermediate, Fast, Stream and Littoral habitat types) within the footprint of each reservoir to constitute a portion of the determination. While DFO has recognized that post-project habitat will be utilized by fish species and hence to be included in the compensation planning, the determination is considered cautionary. As a result, the HADD and associated compensation options have already been sub-divided by reservoir and therefore a change in construction sequence will not affect the Strategy, Plan or Authorization process.

The Strategy currently presents habitat specific criteria for each species present and demonstrates how these specific criteria would be met through habitat creation / enhancement within each reservoir. Options

assessment and discussions with DFO and stakeholders have determined that the more applicable compensation options are those that remain within, or as close to, the ecological habitats being affected. This is also consistent with DFO's Practitioner's Guide to Habitat Compensation (Fisheries and Oceans 2007, Internet site). On that basis, the lacustrine and riverine options as outlined in the strategy have been prepared by a team of fisheries biologists and design engineers and is based on extensive fisheries surveys, fish habitat compensation experiences of experts in the field, other relevant studies, consultation with DFO and consultation with stakeholders.

5.9 Environmental Effects Assessment of the Change in Sequence of Project Phases

Following a detailed review of Project Components (Table 2-1), the changes associated with S2 and S3, in comparison to S1, include:

- site preparation and construction of site buildings
- excavation for and installation of generation components
- transmission line construction
- employment
- transportation and road maintenance
- expenditures

None of these changes have any effect on the Aquatic Environment.

5.9.1 Change in Project Effects - Habitat Quantity

S2 and S3 sequencing of Project phases does not change the overall quantity of post-Project habitat. For S2 and S3, a change in construction sequence would change the timing and order of habitat destruction (i.e. dam construction at Muskrat Falls first) and alteration (i.e. inundation at Muskrat Falls first) with respect to each reservoir as described for S1 in Volume IA, Section 4.3 and 4.4 of the EIS.

5.9.1.1 Change in Habitat Quantity during Construction

For S2 and S3, basic characteristics of the Muskrat Falls and Gull Island reservoirs do not change relative to S1 and are as provided in Table 5-6. Changes in habitat quantity will be most affected during construction when the development of the facilities infill habitat, reservoir impoundments increase the aerial extent of available aquatic habitat, and reservoir filling temporarily reduces downriver flows. Extensive habitat within the assessment area will remain unaltered, and habitat will be created within the Muskrat Falls and Gull Island reservoirs. The quantity of aquatic habitat affected because of the Project is the same regardless of construction sequencing. The Project will result in a net increase in the quantity of aquatic habitat within the reservoir boundaries and there will be no change in habitat quantity outside the balance of the Assessment Area below Muskrat Falls or above the existing Churchill Falls tailrace.

Table 5-6 Selected Characteristics of Gull Island and Muskrat Falls Reservoirs (reproduced from Volume IA, Table 4-9 of the EIS)

Site	Reservoir Length (km)	Flooded Area (km^2)	Original Area (km^2)	Total Area (km^2)	Mean Depth (m)	Hydraulic Residence Time (days)
Gull Island	232	85 (<1 percent wetland)	115	200	21	26

Table 5-6 Selected Characteristics of Gull Island and Muskrat Falls Reservoirs (continued)

Site	Reservoir Length (km)	Flooded Area (km^2)	Original Area (km^2)	Total Area (km^2)	Mean Depth (m)	Hydraulic Residence Time (days)
Muskrat Falls	60	41 (6 percent wetland)	60	101	12	7
Total	292	126 (2 percent wetland)	175	301	-	33
Source: Data from Nalcor, except wetland areas (from ELC GIS) Note: Flooded areas are at full supply levels						

For S1, S2, and S3, there will be a 11,865 ha increase of fish habitat as a result of the formation of the Muskrat Falls and Gull Island reservoirs; 3,652 ha at Muskrat Falls reservoir and 8,213 ha at the Gull Island reservoir. A summary of the total habitat, by habitat type, for both existing and post-impoundment within the Assessment Area is provided in Table 5-7. The table includes the habitat that is within the direct boundary of the facilities and reservoirs, as well as the habitat that will remain unchanged (and still accessible) to all fish species in the lower Churchill River. As shown, regardless of construction sequence, there will be a net reduction in fast velocity habitat and a net increase in slower and lacustrine habitat. This net change in habitat quantity is further assessed within the context of potential environmental effects on fish distribution and abundance (i.e., population) within the Assessment Area (Section 5.9.3).

Table 5-7 Summary of Existing and Predicted Habitat within the Assessment Area, Churchill River (reproduced from Table 4-13 in Volume IA of the EIS)

	Lacustrine		Main Stem			Tributary			Stream (ha)	Total (ha)
	Littoral (ha)	Profundal (ha)	S (ha)	I (ha)	F (ha)	S (ha)	I (ha)	F (ha)		
Muskrat Falls Reservoir										
Existing[A]	0.00	0.00	5,590.41	0.00	774.26	112.39	26.42	11.78	15.11	6,530.37
Predicted[A]	0.00	0.00	9,262.36	57.34	0.00	832.40	20.37	7.89	1.81	10,182.17
Net Change	0.00	0.00	+3,671.95	+57.34	-774.26	+720.01	-6.05	-3.89	-13.30	3,651.80
Gull Island Reservoir										
Existing[A]	287.81	5,393.07	2,398.91	2,265.98	3,094.55	661.83	271.68	388.31	16.72	14,176.36
Predicted[A]	444.08	14,187.79	6,275.53	588.05	92.58	792.84	241.50	368.98	0.31	22,991.66
Net Change	+156.27	+8,794.72	+3,876.62	-1,677.93	-3,001.97	+131.01	-30.18	-19.33	-16.41	8,212.80
Notes: [A] Includes available habitat within the Assessment Area S = Slow I = Intermediate F = Fast										

5.9.1.2 Change in Habitat Quantity during Operation and Maintenance

Once the facilities are constructed and the reservoirs are impounded, the water management and operating regime of the generation facilities will have limited environmental effect on habitat quantity because water level fluctuations will be stable and similar in range to existing conditions.

The change in sequencing of Project phases would not affect the final operating regime of the Project nor the overall quantity of aquatic habitat. The timing of when habitat change and availability would occur would

change with the re-sequencing of construction as habitat within Muskrat Falls would be inundated first. While this may alter the sequence of fish habitat compensation construction and monitoring, it would not affect overall mitigation activities and predicted effectiveness.

5.9.2 Change in Project Effects - Habitat Quality

Changes to habitat quality are expected to be the same for S2 and S3 compared to S1. Physical changes in water quality are anticipated due to reservoir formation and, in particular, due to inundation of terrestrial vegetation and erosion of unstable shorelines. While a change in construction sequence would change the timing of inundation with respect to each reservoir as described for S1 in Volume IA, Sections 4.3 and 4.4 of the EIS, it does not change the overall quality of post-Project habitat. Likewise, a change in period between construction of the two phases as described in S3 would likely change the timing of stabilization, but it would not change the overall quality of post-Project habitat.

5.9.2.1 Change in Habitat Quality during Construction

Several specific construction activities, common to S1, S2 and S3, are predicted to result in losses of dam material to the river, which will be transported downstream and affect TSS and river bottom substrate composition. For both Muskrat Falls and Gull Island construction, these activities include initiation of flow diversions, Phase I of main cofferdam construction, Phase II of main cofferdam construction (closure) and installation of temporary construction bridges. For the Gull Island Generation Facility, additional activities related to initial spillway channel and powerhouse tailrace flow would also generate material loss to the river. There would however, be a slight change in the predicted downstream distribution of material from the Gull Island dam site as a result of Muskrat Falls reservoir being created first and present downstream. This is described below.

Muskrat Falls Dam

Common to S1, S2, and S3, bed material at Muskrat Falls, ranging in size from pebbles (0.4 to 6.4 cm in size) to silt (less than 0.01 cm in size), will be lost to the river at the construction site and deposited in the pool downstream of Muskrat Falls. Silt could settle to the bottom of the pool and later would be re-suspended and transported downstream; either due to natural turbulence or similar ice conditions to that at Gull Lake (i.e., hanging dam formation). The predicted material loss at Muskrat Falls, in terms of both quantity and distribution downriver, as described in Volume IIA, Section 4.12.1.2 would not be affected by a change in sequencing of Project phases because the presence (or absence) of the Gull Island dam and reservoir upriver would not affect the material used for construction at Muskrat Falls, nor would it affect the river flows that would distribute it.

Gull Island Dam

Common to S1, S2, and S3, bed material at Gull Island (ranging in size from cobble to silt) would be lost to the river from the construction site and deposited at the western end of the Muskrat Falls reservoir (i.e., near the upstream end of Gull Lake). Under S1, without the Muskrat Falls reservoir in place, the modeling results indicate that silt material that settles in the Gull Lake area, particularly within the Deep Hole, would most likely be re-suspended and transported out of the lake during winter, similar to naturally occurring phenomenon. That is, in typical winter conditions, a hanging dam forms within Gull Lake in the Deep Hole, which causes flow patterns to change in the lake, including the Deep Hole. The water velocity typically increases under the ice cover sufficient to scour the bottom and remove smaller sized materials. However, under S2 and S3, with the formation of Muskrat Falls reservoir before Gull Island reservoir is constructed, velocities would be reduced and a stable ice cover would form over the Muskrat Falls reservoir, therefore a hanging dam would no longer develop and hence

settled material would remain in place. For S3, any change in period between construction of Muskrat Falls and Gull Island would not affect this.

The environmental effect of construction on TSS levels within the Assessment Area is still predicted to be short term and reversible, regardless of sequencing of Project phases. In addition, the deposition of cobble and smaller materials in the area of the Gull Island tailrace and upper Gull Lake area is still predicted to provide additional spawning and rearing substrate for many species in the Muskrat Falls reservoir.

5.9.2.2 Change in Habitat Quality during Operation and Maintenance

Changes to sequencing of Project phases will not affect the final operating regime of the Project as described in Volume IA, Section 4.5 of the EIS and in IR# JRP.149. Therefore, for S2 and S3, there are no changes expected to habitat quality predictions associated with operation and maintenance of the project.

While there is no overall change in the prediction of habitat quality, under S2 and S3 in the period between operation of Muskrat Falls and completion of Gull Island, predicted habitat quality in and downriver of Muskrat Falls reservoir will initially be moderated between the existing and the final predicted regime with both reservoirs in place. Most post-Project model outputs for the Muskrat Falls reservoir and downriver (e.g. temperature, TSS, TP) included upriver input from Gull Island reservoir because it was to be constructed first. That is, predicted Muskrat Falls reservoir parameter values are the result of inflow from a stabilizing Gull Island reservoir as well as the processes occurring within the Muskrat Falls reservoir itself. In this respect, it is reasonable to assume that the peaks currently predicted in the Muskrat Falls reservoir are conservative overestimates if the construction sequence was changed. For example, for S2, Muskrat Falls reservoir would be inundated four years prior to the Gull Island reservoir and therefore during that time, the initial increase in thermal mass within the river due to reservoir water storage would be less (compared to Gull Island reservoir creation). Without the influence of the Gull Island reservoir on heat retention and release, the predicted thermal variability in and downriver of Muskrat Falls reservoir will initially be moderated between the existing and the final predicted regime with both reservoirs in place. These model results are therefore considered valid and conservatively similar regardless of the construction sequence.

The potential changes in the physical habitat characteristics such as depth and velocity have all been modelled and presented in IR# JRP.153 separately for both the Muskrat Falls and Gull Island reservoirs. They are also not predicted to differ as a result of a change in construction sequencing. For S3,a delay in construction and inundation of the Gull Island reservoir, long enough for parameters to return to baseline variability, may require consideration to further future assessment or a revised separate assessment of the second facility prior to construction. For example, the TSS concentrations in Muskrat Falls reservoir are predicted to fall below the maximum TSS concentration predicted for Gull Island reservoir approximately 20 years after inundation. If the delay between reservoir inundations becomes greater than this, a second, albeit smaller pulse of TSS would occur for an additional 5-6 years beyond the overall timeframe currently predicted for a consecutive construction sequence.

5.9.3 Change in Project Effects - Fish Populations

As stated in Volume IIA, Section 4.13 of the EIS, there are three important aspects of the Project that need to be considered when addressing the potential environmental effects of development on fish populations:

1. the post-impoundment fish habitat;
2. stabilization and productive capacity of the modified habitats; and

3. possible constraints such as migration barriers and entrainment imposed by the Project on attaining the productive capacity of the future aquatic ecosystem.

For S1, S2, and S3, changes in fish abundance and distribution are anticipated due to reservoir formation. While a change in sequence of Project phases would change the timing of inundation with respect to each reservoir as described for S1 in Volume IA, Sections 4.3 and 4.4 of the EIS, it does not change the overall abundance and distribution of post-Project habitat.

5.9.3.1 Change in Distribution and Abundance during Operation and Maintenance

The water management/operating regime of the reservoirs, as well as the operation of the facilities themselves, may affect future fish populations within the Assessment Area, however, a change in construction sequence will not affect the final operating regime of the Project as described in Volume IA, Section 4.5 of the EIS and in IR# JRP.149. As a result, changes in habitat utilization and mortality as a result of a change in sequencing of Project phases are not likely to occur.

5.9.4 Change in Project Effects - Fish Health

Changes in fish health as a result of predicted mercury body burden increases is anticipated as a result of the Project as described in IR# JRP.20, IR# JRP.21, IR# JRP.78 and IR# JRP.156. Peak fish mercury concentrations during reservoir operation may increase as a result of the Project, within the range observed for other boreal reservoirs (Schetagne et al. 2003; Jacques Whitford 2006; Bodaly et al. 2007). In response to IR# JRP.21a, and confirmed in IR# JRP.156 and IR# JRP.166, the estimated peak fish Hg concentrations for Gull Island and Muskrat Falls Reservoirs are 2.3X to 4.8X (depending on standard fish length) above baseline values. It has been conservatively predicted that peak fish mercury levels in the river between Muskrat Falls and the confluence with Goose Bay will the same as experienced in the Muskrat reservoir.

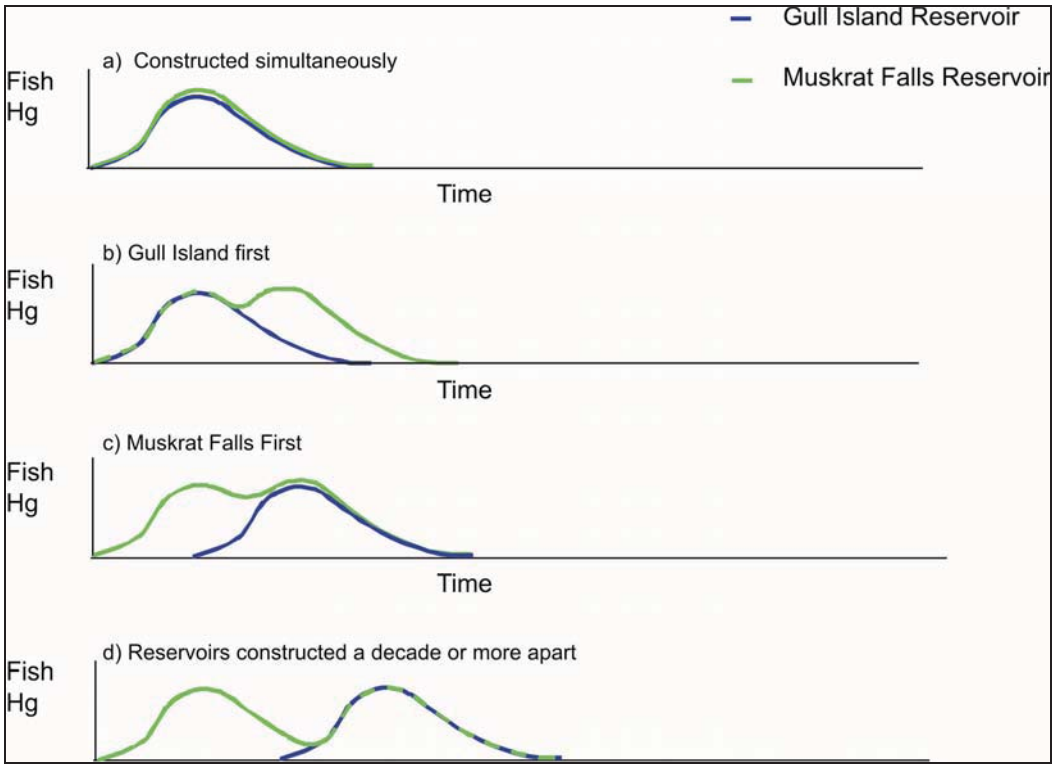
While a change in sequence of Project phases would change the timing of terrestrial inundation with respect to each reservoir as described for S1 in Volume IA, Section 4.3 of the EIS, it does not change the overall quantity of inundation and predicted mercury body burden levels. A discussion of the downstream extent, regardless of construction sequence, is provided in IR# JRP.166.

For S3, without any overlap in construction, the two reservoirs were reviewed with respect to its potential effect on body burden levels. In general, an increase in the gap between construction of both reservoirs has the potential to extend the duration of elevated mercury levels but not increase the magnitude. Figure 5-1 presents a schematic of the various sequences and their effect on fish body burden.

Inundation of the Muskrat Falls reservoir will not affect Gull Island fish Hg concentrations.

If the two reservoirs are staggered in time, it could extend the period of elevated fish Hg in Muskrat Falls reservoir. Note that it has been conservatively assumed that the fish Hg trends observed in Muskrat Falls could also occur downstream until significant dilution occurs, so the sequencing effects on Muskrat Falls could occur downstream as well. The delineation of the potential downstream effects are presented in IR# JRP.166.

Figure 5-1 Schematic of Fish Hg Levels in Two Reservoirs for Different Sequencing of Construction



5.10 Summary of Change in Residual Environmental Effects and Evaluation of Significance

Regardless of the sequence of Project phases, there remains a high level of certainty associated with the prediction of residual environmental effects on Fish and Fish Habitat, given the extent of baseline and Project information, the understanding of interactions, the nature and extent of mitigation measures and the resulting residual environmental effects. Whenever technical limitations existed, conservative assumptions and estimates were selected regarding baseline conditions and predictions. Monitoring commitments have also been considered where the extent of effect has been predicted but some uncertainty exists in model results. Additional discussion regarding the downstream extent of potential effects is provided in response to IR# JRP.166.

5.10.1 Construction

For S2 and S3, Project activities during construction, including the construction of the facilities and infrastructure and impoundment of the reservoirs, are expected to have neutral effects on Fish and Fish Habitat compared to S1. This is mainly because the footprint of the Project will not change. The Fish Habitat Compensation Strategy (see IR# JRP.153) remains valid and the foundation for moving forward on compensation planning.

For S2 and S3, the residual environmental effect of the Project on Fish and Fish Habitat during construction remains as predicted; **not significant** (Table 5-8) regardless of sequencing of Project phases.

Table 5-8 Summary of Residual Environmental Effects Assessment for Fish and Fish Habitat (adapted from Table 4-24 in Volume IIA of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Neutral	Neutral
Magnitude	High	High
Geographic Extent	Local	Regional
Duration / Frequency	Permanent, Continuous	Permanent, Continuous
Reversibility	Irreversible	Irreversible
Ecological Context	Disturbed	Developed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not Applicable	Not Applicable
Notes: Definitions for criteria are provided in Section 6.5 Methods explained in Volume IA, Chapter 9 of the EIS		

5.10.2 Operation

Operation and maintenance activities are no different between S1, S2, and S3 relative to potential interactions with Fish and Fish Habitat. For S2 and S3, there are no changes to the quality of the aquatic habitat (physical formation and stabilization), fish populations (utilization of the reservoirs and mortality) as well as fish health (mercury evolution) compared to S1. While the magnitude of effects on fish and fish habitat is predicted to be high, fish utilization will occur within the habitat of the reservoirs along with that outlined in the fish habitat compensation strategy.

The residual environmental effects of the Project on Fish and Fish Habitat during operations and maintenance remains as predicted; **not significant** (Table 5-8) regardless of sequencing of Project phases.

5.11 Cumulative Environmental Effects

The results of the cumulative environmental effects analysis as presented in Volume IIA, Section 4.16 of the EIS and in the responses to IR# JRP.112 will not likely change as a result of a change in the sequencing of Project phases. The same Project activities and interactions will occur, albeit in a reversed order.

Ongoing and likely future projects and activities that could act in combination with the Project to result in cumulative environmental effects (i.e., change in Fish and Fish Habitat) remain the same as those identified in Volume IIA, Section 4.16 of the EIS (Table 5-9).

Table 5-9 Potential Interactions of Future Projects and Activities in the Aquatic Environment Assessment Area (reproduced from Table 4-23, Volume IIA, Section 4.16)

Other Project or Activity	Spatial Overlap	Temporal Overlap
Trans Labrador Highway (TLH)	Black Rock Bridge is located on the lower Churchill River approximately 20 km below Muskrat Falls	Construction is complete and will operate on a continual basis
Cultural and Recreational Land Use	Boating and angling currently occurs sporadically throughout the Assessment Area	Boating can occur throughout the open water season while angling can occur throughout the year

The change in sequencing of Project phases does not change the analysis of cumulative effects resulting from the Project in combination with other projects and activities presented in Table 5-9 and as assessed in Volume IIA, Section 4.16 of the EIS and in response to IR# JRP.112, or the management and mitigation for the cumulative effects.

5.12 Accidents and Malfunctions

Regardless of the sequencing of Project phases, the significance of the residual environmental effects on Fish and Fish Habitat resulting from an accident or malfunction is likely not to change from those assessed in Volume IIB, Section 6.5 of the EIS or in the response to IR# JRP.145 because there will not be an increase in magnitude, geographic extent, duration or frequency of the effect (with respect to habitat quantity and quality, fish distribution and abundance, and fish health). Therefore, in the unlikely event of a dam failure, the adverse residual environmental effect would be **significant**. In the unlikely event of a forest fire or other fire, accidental release of solid or liquid waste, or a hazardous material spill, the adverse environmental effects would be **not significant**.

5.13 Monitoring and Follow-up

The same EEM programs proposed around Fish and Fish Habitat in the EIS (i.e., S1) and IR# JRP.153, would apply for either S2 or S3. Environmental effects monitoring programs are proposed around Fish and Fish Habitat for the Aquatic Environment VEC. As outlined in the CEAA, these EEM programs are designed to verify the environmental effect predictions and determine the effectiveness of mitigation measures.

The follow-up monitoring activities proposed are described for many of the measureable parameters where future conditions were modelled. Environmental monitoring will be included as a large component of any required fish habitat compensation plan. The areas of compensation works will also be monitored to determine if the physical attributes of the habitat are being maintained (e.g., substrate placement, habitat stability, ice timing) and utilized. In addition, the model predictions regarding reservoir formation and stabilization will require a rigorous monitoring program to confirm that the reservoir and fish species will respond as predicted. Long term (at least for the 20-year stabilization period) monitoring of reservoir conditions as well as the response by the fish community (e.g., entrainment, mercury levels in biota) will allow an adaptive management approach to be applied to the reservoir. The frequency of monitoring may vary based on each parameter being investigated (e.g., continuously, annually, bi-annually) but the information will allow any potential negative conditions to be detected, and addressed, before they become irreversible. This program will be part of the *Fisheries Act* 35(2) Authorization and has been identified in the Fish Habitat Compensation Strategy (IR# JRP.153).

6.0 TERRESTRIAL ENVIRONMENT

6.1 Introduction

The purpose of this chapter is to present the assessment of the predicted effects on the Terrestrial Environment resulting from a change in sequencing of the Project phases (S2 and S3) relative to S1. Within the Terrestrial Environment VEC, the same terrestrial KI species/populations that were described and evaluated in Volume IIA (Chapter 2) and Volume IIB (Chapter 5) of the EIS were used to assess a change in sequencing of constructing the two hydroelectric generation facilities associated with the Project. Where differences exist from the original assessment because of differences in the Project description or new information since submission of the EIS, such differences are evaluated in terms of the significance of effects.

Many aspects of the Project will interact with the Terrestrial Environment and have the potential to result in measurable environmental effects. This assessment will examine whether changes in sequencing of Project phases will result in differences to the physical alteration of the landscape (effects on terrestrial habitat quantity and in some cases, quality).

6.2 Key Indicators

The rationale for the selection of KIs is the same as was presented in Volume IIB, Section 5.2 of the EIS and IR# JRP.41. In addition, Herpetiles were also selected as a KI as a result of IR# JRP.10.

6.3 Potential Interactions

For S2 and S3, there is no change in the scope of Project activities and Physical Works and the same interactions with the KIs would apply as was identified in S1 and described in the EIS (Volume IIB, Section 5.2) (Table 6-1). Regardless of the construction sequence, essentially the same wildlife habitat will be altered or lost over the course of the construction phase. The only exception under S2 or S3 will be the wider right-of-way (additional 20 m) associated with the interconnecting transmission lines resulting in less than 6 km^2 of additional habitat altered or lost. These Project VEC interactions presented in Table 6-1 are derived from Volume IIB, Section 5.3 of the EIS, and IR# JRP.10.

Table 6-1 Interaction of S2 or S3 with the Key Indicators in the Terrestrial Environment (adapted from Volume IIB, Table 5-3 of the EIS, and IR# JRP.10)

Project Activities and Physical Works	Caribou	Moose	Black Bear	Beaver	Marten	Porcupine	Canada Goose	Surf Scoter	Ruffed Grouse	Osprey	Wetland Sparrows	Harlequin Duck	Other Species of Concern	Herpetiles
Construction														
Upgrading and Constructing Site Access Roads (Explain)	1	2	2	2	2	2	1	1	2	1	2	1	2	2
Site Preparation and Construction of Site Buildings	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Excavation for and Installation of Generation Components	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Concrete Production	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Transmission Line Construction (Explain)	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 6-1 Interaction of S2 or S3 with the Key Indicators in the Terrestrial Environment (continued)

Project Activities and Physical Works	Caribou	Moose	Black Bear	Beaver	Marten	Porcupine	Canada Goose	Surf Scoter	Ruffed Grouse	Osprey	Wetland Sparrows	Harlequin Duck	Other Species of Concern	Herpetiles
Construction														
Site Water Management	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Camp Operations	1	1	2	1	1	1	1	1	1	1	1	1	1	1
Vehicular Traffic on-site	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Quarrying and Borrowing	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Reservoir Preparation	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Impounding (Explain)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Employment (Explain)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation and Road Maintenance	2	2	2	2	2	2	2	2	2	1	1	1	1	2
Expenditures (Explain)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation and Maintenance														
Water Management and Operating Regime	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Operation of Generation Facilities	1	1	1	1	1	1	1	1	1	1	1	1	2	1
Site Waste Management	1	1	2	1	1	1	1	1	1	1	1	1	1	1
Inspection, Maintenance, Repairs along Transmission Line	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Employment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation / Presence and Maintenance of Access Roads	2	2	2	2	2	2	2	2	2	1	2	1	2	2
Expenditures	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accidents and Malfunctions[A]														
Dam Failure	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Forest Fire	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Key:

0 No measurable interaction will occur. Assessment of environmental effects is not required

1 Identified interactions that are well understood, are subject to prescribed environmental protection measures or normal regulatory processes, and/or which can be mitigated/optimized through the application of standard environmental protection management measures and practices. Based on past experience and professional judgement, the potential environmental effects resulting from these interactions are rated not significant

2 Identified interactions that may result in more substantive environmental effects and/or public or regulatory concern. These interactions require more detailed analysis and consideration in the environmental assessment, in order to predict, mitigate and evaluate potential environmental effects

[A] Accidents and Malfunctions are addressed in Volume IIB, Chapter 6 of the EIS

A description of the modifications to Project components to facilitate S2 or S3 is presented in Chapter 2 of this report. Regardless of the change in sequencing of Project phases, the Project interaction rankings remain the same as presented for S1 in Volume IIB, Table 5-3 of the EIS, and IR# JRP.10. The interactions that do not have a measurable interaction with the KI are ranked as 0, and Project-related environmental effects are unlikely. As with S1, these interactions are not considered further in the assessment.

Interactions ranked 1 indicate their relatively limited extent, and/or standard procedures exist to mitigate any potential effects. In all cases, the rating of an interaction as 1 is based on the professional experience and knowledge of the study team and its confidence that there is no possibility for a significant adverse residual effect to occur, or for the effect to contribute measurably to the cumulative environmental effects of the Project.

Any interaction that has the potential to result in a measurable environmental effect is ranked 2. As these interactions were assessed for S1 in Volume IIB of the EIS and IR# JRP.10, only the differences associated with the potential for significant adverse residual effects and to determine requirements for Project-specific mitigation and follow-up are discussed further. The interaction differences associated with S2 or S3 are assessed according to three effects categories:

- change in habitat and distribution or abundance;
- change in health; and
- mortality.

6.4 Measurable Parameters

Measurable parameters identified for S1 in Volume IIB, Section 5.4 of the EIS, are the same for S2 or S3 (Table 6-2).

Table 6-2 Measurable Parameters for Terrestrial Environment Key Indicators (adapted from Table 5-4 in Volume IIB of the EIS)

Key Indicators	Description
Measurable Parameter - Change in Habitat	
Caribou, Moose, Black Bear, Marten, Porcupine, Ruffed Grouse, Wetland Sparrows, Other Species of Concern, and Herpetiles	Quantity (proportion) of primary habitat within the Assessment Area that will be altered or lost because of the Project. Note that while there are other sources of habitat loss associated with the Project, the reservoirs are the main source and focus of the assessment
Canada Goose, Surf Scoter and Harlequin Duck	Quantity (proportion) of staging and breeding habitat (i.e., the amount of open water available in the spring at traditionally used staging areas) within the Assessment Area that will be altered or lost because of the Project
Beaver and Osprey	Number (proportion) of breeding sites (i.e., active colonies for Beaver and active nests for Osprey) within the Assessment Area that will be altered or lost because of the Project
Measurable Parameter - Change in Health	
Osprey and Otter	Hazard quotient (HQ) as determined through an ecological risk assessment (ERA) for Osprey and otter. These are two vulnerable species as they are directly in the aquatic food chain feeding almost exclusively on fish
All Other KIs	The life history of the other KIs is compared to the life history of Osprey and otter to provide a relative indication of the potential for change in health
Measurable Parameter – Mortality	
All KIs	Number of fatalities as a proportion of the population present in the Assessment Area

6.5 Criteria for Describing Environmental Effects

The environmental effects of changes to sequencing of Project phases (S2 or S3) use the same descriptors as for S1 in Volume IIB, Section 5.5 of the EIS:

- nature: the long term environmental effects of the Project on the KI (adverse, positive or neutral).

- magnitude: the extent of change from the baseline state.
  - for Caribou:
    - low: no measurable change in habitat availability or population size relative to baseline conditions
    - moderate: measurable change in habitat availability or population size relative to baseline conditions that does not cause management concern
    - high: measurable change in habitat availability or population size relative to baseline conditions that does cause management concern
  - for other KIs:
    - low: <five percent of Assessment Area population or habitat will be exposed to the effect
    - moderate: five to 25 percent of Assessment Area population or habitat will be exposed to the effect
    - high: >25 percent of Assessment Area population or habitat will be exposed to the effect
- geographic extent: the physical area within which interactions are expected to occur.
  - site-specific: environmental effects confined to the Project footprint
  - local: environmental effects confined to the Assessment Area
  - regional: environmental effects occur throughout the Assessment Area and beyond
- duration: the period of time the environmental effect will occur.
  - short term: less than one generation
  - medium term: one or two generations
  - long term: occurring over several generations
  - permanent
- frequency: the number of times the Project will have an environmental effect.
  - occurs once
  - occurs sporadically at irregular intervals
  - occurs on a regular basis and at regular intervals
  - continuous
  - not likely to occur
- reversibility: whether the adverse environmental effects are reversible or irreversible.
  - reversible
  - irreversible
- ecological context: the general characteristics of the area with respect to existing levels of human activity in the Assessment Area.
  - undisturbed: area relatively or not adversely affected by human activity
  - disturbed: area has been previously disturbed by human development or human development is still present
- level and degree of certainty of knowledge.
  - low: low level of certainty
  - high: high level of certainty
- likelihood.
  - unlikely: significant adverse residual environmental effect not likely to occur
  - likely: significant adverse residual environmental effect likely to occur

6.6 Determination of Significance

The definition of significance for the assessment of S2 or S3 is the same as S1 completed in the EIS.

- For either the GR or RWM Caribou Herds, a significant adverse residual environmental effect from the Project is one that would cause a population decline, such that the viability or recovery of the Herd is threatened.
- For all other Terrestrial Environment KIs a significant adverse residual environmental effect from the Project would cause a decline such that sustainable population cannot be maintained within the Assessment Area.

A residual adverse environmental effect that does not meet the above criteria is not significant.

6.7 Existing Knowledge

Volume IIB, Section 5.7 of the EIS presented existing knowledge related to the three effects under consideration (i.e., the alteration or loss of habitat, health, and mortality) for S1. All of this existing knowledge is relevant for the assessment of S2 or S3. Where new information is available since the submission of the EIS in February 2009 (e.g., from Information Requests, ongoing work by Nalcor or others), it is referenced in Table 6-3 for each KI.

Table 6-3 Additional Existing Knowledge for Terrestrial Key Indicators since the EIS

Key Indicator	Existing Knowledge Habitat	Existing Knowledge Health	Existing Knowledge Mortality
George River Caribou Herd	IR# JRP.93, IR# JRP.122, IR# JRP.124, IR# JRP.125, IR# JRP.126 and IR# JRP.157 Minaskuat Inc. 2009a	IR# JRP.22,, IR# JRP.156, IR# JRP.166 and IR# JRP.166	IR# JRP.38 and IR# JRP.157
Red Wine Mountains Caribou Herd	IR# JRP.93, IR# JRP.122, IR# JRP.124, IR# JRP.125, IR# JRP.126 and IR# JRP.157 Minaskuat Inc. 2009a	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38 and IR# JRP.157
Moose	IR# JRP.9, IR# JRP.92, IR# JRP.101, IR# JRP.102, IR# JRP.124, IR# JRP.125 and IR# JRP.126 Minaskuat Inc. 2009b	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38
Black Bear	IR# JRP.9, IR# JRP.38, IR# JRP.124, IR# JRP.125 and IR# JRP.126 Minaskuat Inc. 2009c	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38
Beaver	IR# JRP.101, IR# JRP.102, IR# JRP.124, IR# JRP.125, IR# JRP.126 and IR# JRP.128	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38, IR# JRP.110 and IR# JRP.128
Marten	IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38 and IR# JRP.110
Porcupine	IR# JRP.102, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38
Canada Goose	IR# JRP.48, IR# JRP.65, IR# JRP.64, IR# JRP.124, IR# JRP.125, IR# JRP.126, IR# JRP.129 and IR# JRP.154	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38, IR# JRP.94 and IR# JRP.95
Surf Scoter	IR# JRP.48, IR# JRP.64, IR# JRP.65, IR# JRP.124, IR# JRP.125, IR# JRP.126, IR# JRP.129 and IR# JRP.154	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38, IR# JRP.94 and IR# JRP.95
Ruffed Grouse	IR# JRP.102, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38, IR# JRP.94 and IR# JRP.95

Table 6-3 Additional Existing Knowledge for Terrestrial Key Indicators since the EIS (continued)

Key Indicator	Existing Knowledge Habitat	Existing Knowledge Health	Existing Knowledge Mortality
Osprey	IR# JRP.48, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.94 and IR# JRP.95
Wetland Sparrows	IR# JRP.64, IR# JRP.101, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# 94, IR# JRP.95 and IR# JRP.101
Harlequin Duck	IR# JRP.48, IR# JRP.64, IR# JRP.65, IR# JRP.105, IR# JRP.124, IR# 125, IR# JRP.126, IR# JRP.129 and IR# JRP.154	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.38, IR# JRP.94, IR# JRP.95 and IR# JRP.105
Other Species of Concern	IR# JRP.64, IR# JRP.69, IR# JRP.101, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.94 and IR# JRP.95
Herpetiles	IR# JRP.10, IR# JRP.64, IR# JRP.101, IR# JRP.124, IR# JRP.125 and IR# JRP.126	IR# JRP.10, IR# JRP.22, IR# JRP.156 and IR# JRP.166	IR# JRP.10

6.8 Environmental Effects Management

Consistent with the EIS, the assessment of the effects of changes to the sequencing of Project phases has the same environmental objective of maintaining a high standard of environmental responsibility and performance through the implementation of a comprehensive environmental management system. Following the guiding principles of Preventing Pollution, Improve Continually and Comply with Legislation, Nalcor is committed to eliminating and reducing adverse environmental effects. As this Project has been under consideration since the 1960s and considerable review and study of the sites is available, the Project has evolved to reflect advances in technology and an enhanced understanding of the existing environment. At a minimum, this Project design considers the best practices under current industry standards for environmental protection and mitigation. Through continued design refinement and optimization of the Project, additional mitigation strategies are also part of the iterative planning process.

For S2 and S3, there is no change in approach and scope for environmental effect management. The first step of Project construction will be to implement an EPP in accordance with the EMS. The EPP will specifically describe, for site personnel, the appropriate procedures consistent with legislation and best practices to reduce environmental effects. The Project will be constructed with the principle of designed environmental mitigation systems. Aspects of the Project such as siltation and erosion control will be designed and provided as technical specifications in contracts. This will allow the guidelines and standards set out in the EPP to be met in a practical and measurable manner.

Standard effects management measures for S2 and S3 are the same as for S1. An updated summary of the standard effects management measures during both construction and operation and maintenance applicable to the Terrestrial Environment for S1 (Volume IIB, Table 5-9 of the EIS) is in Table 6-4.

Table 6-4 Standard Mitigation Applicable to the Terrestrial Environment (adapted from Table 5-9 of the EIS)

Project Component / Activity	Standard Mitigation / Design
Site Personnel and Environmental Awareness	A no harvesting policy for site personnel will be implemented (IR# JRP.38), harassment of wildlife will be prohibited, and no firearms will be allowed on-site. As well, no pets will be permitted on-site. Periodic Environmental Awareness Sessions will be conducted for all construction personnel. Tailgate Environmental briefings will be held daily in association with the Tailgate Safety sessions. The education aspect of environmental protection will be stressed by Nalcor in addition to the compliance monitoring program

Table 6-4 Standard Mitigation Applicable to the Terrestrial Environment (continued)

Project Component / Activity	Standard Mitigation / Design
Surface Disturbance	Nalcor will limit surface disturbance using environmental site monitors who will supervise (for compliance) all activities described in the EPP. Limited surface disturbance is included in the design of the Project. For example, during the 1975 construction start, a 30 ha site was cleared and grubbed for the camp; the camp for the construction of the proposed Gull Island development will be in the same location. Existing roads, quarries, borrow pits and existing transmission line corridor will be used where possible. Activities will be scheduled around sensitive periods. Habitat construction or creation of anthropogenic features such as ditches, settling ponds and borrow pit ponds would occur early in the construction phase to provide adequate time for plant communities to establish before flooding of the reservoirs
Access Roads	All temporary access roads will restrict access for safety and security reasons and work areas will be posted. Speed limits will also be posted and communicated to workers. The construction roads for reservoir clearing will be located in such a way as to minimize the length and number of roads outside the flood zone. The majority of the road infrastructure will be flooded once the reservoir is impounded
Noise	All vehicles and generators will have exhaust systems regularly inspected and mufflers will be in good operating condition
Rehabilitation Following Construction	Following construction, rehabilitation of work sites, including the wider transmission line (compared to S1), quarries and borrow pits and construction infrastructure will be in accordance with Rehabilitation Plans and the Project EPP. Natural revegetation of disturbed surfaces will be encouraged, where applicable, and where required and appropriate active revegetation will be conducted (soil and terrain conditions permitting). Periodic inspections subsequent to rehabilitation of the construction sites will measure the success of these measures. Rehabilitation of borrow areas will include restoration of natural drainage and re-establishment of stable gradients. Where land is compacted, Nalcor will arrange to loosen up the ground to make it suitable for the introduction of trees or shrub plants. Permanent drainage patterns will be established through grading, which will also reduce erosion. When temporary access roads are no longer required, bridges at stream crossings will be removed. Bridge structures will be temporary in nature. The road surface will be scarified to promote the natural regeneration of a productive forest. Roadside ditches will be filled in except where they may remain as habitat for Herpetiles (Table 5-5). Stream banks around disturbed areas will be stabilized for erosion protection
Blasting	All blasting will be undertaken in compliance with the appropriate permits and approvals, and include the use of blasting mats. Explosives will be used in a manner that will minimize damage or defacement of landscape features, trees and other surrounding objects will be used to control the scatter of blast material beyond the limits of the work site. Blasting patterns and procedures will minimize shock or instantaneous peak noise levels
Construction Camps - Waste Management	Sewage treatment at the accommodation complexes will be in accordance with guidelines set out by the Province, to provide an environmentally acceptable sewage effluent for discharge. Solid waste will be stored in bear-proof containers and transported on a regular basis to the landfill at Happy Valley-Goose Bay (subject to the approval of the municipality). A recycling program will be implemented at the camp to reduce the amount of solid waste generation. Temporary camps will have their own on-site water and electrical power as well as facilities for sewage treatment, garbage and disposal
Hazardous Materials	All fuelling facilities will be approved, constructed and operated in accordance with the *Storage and Handling of Gasoline and Associated Products Regulations* CNR 775/96. Necessary approvals will be obtained from the Newfoundland and Labrador Department of Government Services
Quarries and Borrow Pits	Standard mitigations and permitting will be conducted and completed for all quarries and borrow areas as per the Project EPP and Rehabilitation Plans
Transmission Line Vegetation Management	Any herbicide use will be by hand and sprayed from the ground to control drift. Trees and tall shrubs will be cut and herbicide applied to stumps

Additional KI-specific effects management measures for S2 and S3 are presented in Table 6-5 and are essentially those for S1 and described in the EIS (Volume IIB, Table 5-10).

Table 6-5 Additional Specific Effects Management Measures (adapted from Table 5-10 of the EIS)

Key Indicator	Effects Management Measures
Caribou, Moose, Beaver, Canada Goose, Osprey, Harlequin Duck	Reservoir preparation will remove (where feasible) forest cover such that the reservoir surface (and littoral zone) will provide unimpeded access for wildlife. Refer also to IR# JRP.148
Caribou, Moose, Beaver, Wetland Sparrows, Species of Concern	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. Refer also to IR# JRP.101 and IR# JRP.148
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 the breeding season for both reservoirs. Refer also to IR# JRP.95
Beaver, Moose, Canada Goose, Surf Scoter, Ruffed Grouse, Wetland Sparrows, Species of Concern	At the inflow areas for major tributaries, special measures (e.g., scarification, earth works) will encourage development and re-establishment of delta areas and wetlands
Caribou	Nalcor will continue its participation on the Labrador Woodland Caribou Recovery Team regarding the RWM Herd and support of related research such as the telemetry monitoring program. Nalcor will also encourage the Province to maintain the ban on hunting during incursion of the GR Herd into the RWM Herd range. Further, access to facilities and Project activities will be controlled, limiting potential disturbance when individual Caribou are present
Moose, Osprey, Wetland Sparrows	Reservoir preparation will be designed to avoid sensitive wildlife areas / habitats during sensitive periods (e.g., Moose in wintering areas, Osprey breeding season) using set-back distances where appropriate. Refer also to IR# JRP.148
Caribou, Moose, Black Bear	Nalcor will conduct wildlife surveillance prior to blasting, and will discontinue blasting in the presence of high densities of animals (Caribou, Moose, Black Bear)
Black Bear	Procedures to be included in the EPP will consist of protocols for proper food storage and waste management, personnel awareness and training, and equipping personnel away from camps with warning devices. Electric fencing will be placed around selected sites with a high level of attractants (e.g., site waste management facilities). A protocol will be described in the EPP for a Black Bear management decision process. Blasting would not be initiated during winter to minimize possible effects on nearby Black Bear dens or cause animals (particularly cubs) to vacate such areas during cold temperatures
Beaver	Nalcor will live-trap and relocate Beaver from active colonies within the proposed reservoir prior to flooding
Osprey (Bald Eagle)	Nalcor will replace physically disturbed Osprey nests (approximately 11 in both reservoirs) within 800 m by artificial platforms. Activities within 200 m of active nests will be strictly controlled (Volume IA, Section 4.8.2.4)
Ruffed Grouse	Nalcor will encourage formation of / create hardwood forest adjacent to the Muskrat Falls Reservoir. Refer also to IR# JRP.102
Wetland Sparrows, Species of Concern and Herpetiles	Nalcor 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 strip
Herpetiles	Nalcor will undertake an amphibian relocation program to move individuals from the flood zone into newly created habitat in wetlands (e.g., creating and enhancing riparian marsh), along transmission line (by excavating pools), and borrow pits (suitable sites will be rehabilitated as pond and marsh habitat once decommissioned)

6.9 Environmental Effects Assessment of the Change in Sequence of Project Phases

For S2 and S3, the only difference for the terrestrial environment relative to S1 evaluated in the EIS is a temporal reallocation of activities and effects associated with construction. This assessment examines temporal changes related to the sequence of Project phases and those implications on the terrestrial effects predictions described in the EIS.

The Project components (Table 2-1) affected by the S2, S3 construction sequences compared to S1 are:

- site preparation and construction of site buildings
- excavation and installation of generation components
- transmission line construction
- employment
- transportation and road maintenance
- expenditures

The width of the right-of-way for the interconnecting transmission line would be increased compared to S1. The result would be an incremental increase in alteration or loss of terrestrial habitat less than 6 km^2. As indicated in IR# JRP.124, the EIS was based on up to 200 km^2 of habitat being altered or lost as a result of the Project. The reservoirs were estimated to account for approximately 126 km^2 of habitat being altered or lost. The interconnecting transmission line and other Project components in S1 amounted to 35 km^2, for a total actual Project footprint of 161 km^2. Even with the addition of the wider right-of-way associated with S2 or S3, the precautionary approach followed in the EIS considers additional disturbance.

None of the other changes have any effect on the Terrestrial Environment.

For S2 and S3, during operation and maintenance, there is no change in the potential for the Project to result in habitat changes relative to S1. The same water management and operating regimes will result in water levels in the reservoir being similar. Inspection, maintenance and repairs along transmission line will result in similar physical changes to habitat, as well as short-term disturbances from noise and human presence. Transportation / presence and maintenance of access roads during operation would also contribute in the same manner to localized noise and potential disturbance of wildlife.

6.9.1 Change in Project Effects During Construction

The effect of S2 or S3 sequencing result in a different sequence of construction activities within the same spatial footprint (i.e., surficial disturbance as presented in the EIS for S1), therefore the end result on habitat quantity related to S2 or S3 will be similar to that of S1.

The potential for direct health-related effects on KIs would be the same with either S2 or S3 in terms of possible contaminants associated with site waste management and camp operations.

Mortality potential during Project construction of either S2 or S3 is no different than for S1 and could occur through the same mechanisms as identified in the EIS. The same mitigation measures apply to S2 or S3 as suggested for S1 (Table 6-4; IR# JRP.38).

For S3, there is no overlap in construction, therefore the length of time between the completion of Muskrat Falls generation facility and the initiation of Gull Island construction may mitigate the adverse effects on wildlife habitat within the Assessment Area population. The longer this interim period, the longer the recovery period for the Assessment Area population (e.g., alternative habitat for displaced wildlife) from activity associated with Muskrat Falls before the Gull Island component is initiated.

Discussion of effects during construction of sequencing of Project phases on each KI is as follows:

George River Caribou Herd

Under S2 and S3, construction would first start at Muskrat Falls which is located further from, and would pose less overlap with the occasional winter movements of the GR Herd. The effects of the change in sequencing of Project phases on habitat for the GR herd would be to slightly delay or defer the S1 predicted effect.

No difference in potential health effects is anticipated with either S2 or S3.

In addition to deferred effects on habitat associated with the later start of the Gull Island component of the Project, there would also be a similar delay in any related mortality effects through either S2 or S3. Once construction and impounding of both reservoirs is complete, the Project footprint of S2 and/or S3 would be the same as was assessed for S1 in the EIS. The longer interval before construction starts at Gull Island under S3, would mean that any overlap with the occasional winter movements of the GR Herd in this area would be similarly delayed.

Red Wine Mountains Caribou Herd

Overall, the broad scale disruption of Caribou movements across the Project footprint are not expected during construction of either S1, S2, or S3.

The sequencing of S2 or S3 will result in activities occurring in reverse order compared to S1, but that the spatial overlap would be the same.

A stated in the EIS, habitat loss of 0.3 percent of the winter range and 0.4 percent of the calving and post-calving ranges will be affected directly by vegetation clearing in the reservoirs and along the transmission line corridor. Under S2 or S3, the smaller Muskrat Falls reservoir would be developed first affecting 40.6 km^2 of the seasonal range of this herd followed by the Gull Island reservoir affecting >85.2 km^2 of the seasonal ranges.

The increased width (i.e., 20 m) of the ROW for the transmission lines associated with S2 or S3 represents an increase of less than 6 km^2. This increase is covered by the EIS for S1 where the assessment area was conservatively estimated to be 200 km^2.

Moose

There is no expected change to the loss of forest cover during reservoir preparation or access road construction associated with S2 or S3. Once the reservoirs are filled under S1, S2 or S3, the same quantity of primary fall and winter Moose habitat will be permanently transformed into open water. For S2 and S3, the difference will be that the greater alteration associated with the larger Gull Island reservoir would occur in reverse order and possibly be delayed with S3.

The transmission line route will intersect with wetlands in the area and result in the loss or disturbance of primary spring and summer Moose habitat, possibly reducing suitability for this species during construction. The increased width (i.e., 20 m) of the ROW for the transmission lines associated with S2 or S3 represents an increase of less than 6 km^2. This increase is covered by the EIS for S1 where the assessment area was conservatively estimated to be 200 km^2.

Effects of construction activities for S2 and S3 (i.e., site preparation and construction of site buildings, excavation for and installation of generation components, transmission line construction, quarrying and borrowing, and transportation and road maintenance) that result in temporary or permanent displacement of Moose to other habitats are the same as for S1.

Black Bear

The area of habitat alteration is no different relative to sequencing of Project phases. Once either S1, S2 or S3 is complete, approximately 90.0 km^2, or 0.5 percent of primary Black Bear spring-summer habitat in the Assessment Area (and 7.5 percent of the primary habitat in the lower Churchill River valley) will be transformed into open water. Approximately three times as much primary spring-summer habitat would be inundated in the larger Gull Island reservoir. Under S2 and S3 there would be a delay to effects to a greater area and thus portion of animals and primary habitat (i.e., 69.7 km^2 in Gull Island versus 20.3 km^2 in Muskrat Falls).

The transmission line route that passes through forest could result in loss or alteration of habitat and the presence and reproductive success of Black Bear. Because much of the transmission line area occurs in forested habitat, primary and secondary Black Bear habitat will be affected, with disturbance possibly reducing suitability for Black Bear during construction. The increased width (i.e., 20 m) of the ROW for the transmission lines associated with S2 or S3 represents an increase of less than 6 km^2. This increase is covered by the EIS for S1 where the assessment area was conservatively estimated to be 200 km^2.

Beaver

For S2 and S3, clearing of forests and disturbance from human presence and harvesting equipment during primary reservoir preparation and impounding will result in the same alteration and loss of habitat for Beaver as assessed in S1.

Mitigation and subsequent effect from inundation would occur in a different sequence for S2 or S3, but consist of the same effort compared to the EIS. The few active colonies affected by the reservoirs (Minaskuat Inc. 2008a) will need to be surveyed in advance and addressed during reservoir preparation of either sequence in Project phases.

Marten

There is no change in the quantity of habitat under S2 or S3 compared to S1. Once the reservoirs are complete, approximately 86.2 km^2, or 2.0 percent of the primary Marten habitat in the Assessment Area (11.6 percent of the lower Churchill River valley) will be transformed into open water. Over twice as much primary habitat for Marten exists in the Gull Island reservoir (69.7 km^2) compared to the Muskrat Falls reservoir (24.5 km^2). The change in sequencing of Project phases from S1 will therefore result in a delay to a greater portion of the primary habitat being affected in S2 or S3.

Much of the transmission line construction will be within a forested area, so there will be effects to primary and secondary Marten habitat, with disturbance possibly reducing suitability for Marten during construction. The increased width (i.e., 20 m) of the ROW for the transmission lines associated with S2 or S3 represents an increase of less than 6 km^2. This increase is covered by the EIS for S1 where the assessment area was conservatively estimated to be 200 km^2.

Porcupine

There is no change in habitat quantity for S2, S3 sequencing compared to S1. Over three times as much primary habitat for Porcupine exists in the Gull Island reservoir (69.7 km^2) compared to the Muskrat Falls reservoir (17.7 km^2). The change in sequencing will therefore result in a delay to a greater portion of the primary habitat for Porcupine being affected in S2 or S3. Other related changes regardless of sequencing of Project phases include the disturbance of adjacent habitat due to noise, dust and human presence. The species is at greatest risk in spring because individuals may concentrate in new edge habitat. The EPP will include employee orientation and

measures aimed at the awareness of this sensitivity (i.e., that Porcupine will be attracted to such areas) to minimize vehicle collisions, for example.

The transmission line construction between the two generation facilities and Churchill Falls Power Station will alter habitat. The increased width (i.e., 20 m) of the ROW for the transmission lines associated with S2 or S3 represent an increase of 5.3 km^2 that is considered to be a negligible incremental increase to the area considered in the EIS.

Canada Goose

For S2 and S3, there is no change compared to S1. The amount of primary habitat lost through the creation of the reservoirs is 2.4 km^2 or 6.3 percent of the primary habitat within the lower Churchill River valley (0.3 percent of the primary habitat within Assessment Area). The majority of the primary habitat for Canada Goose (2.2 km^2) would be lost within the Muskrat Falls reservoir. Thus, the reversal in sequencing for S2 or S3, would result in the majority of predicted effects occurring earlier in the Project than proposed in S1.

Consistent with the *Migratory Birds Convention Act* and associated regulations (Environment Canada 2007), a management plan will be developed and implemented to address this issue. Changes in distribution and abundance will be a function of the availability and productivity of alternate breeding sites within the lower Churchill River watershed or Assessment Area.

Surf Scoter

Loss of breeding habitat for Surf Scoter will be relatively slight (compared to other KIs) and some of the associated disturbances may be temporary or inconsequential. Hence, S1, S2, and S3 are similar in terms of their effect on breeding habitat. This species does use the lower Churchill River for staging (and possibly foraging) in spring. The reversal in sequencing with S2 and S3, would result in a shift of ice cover between the Muskrat Falls and Gull Island reservoirs. Displaced individuals will move to occupy other available habitat upstream of Muskrat Falls reservoir (until the Gull Island reservoir is complete) or elsewhere in the lower Churchill watershed once construction is complete.

Ruffed Grouse

There is no change to habitat for Ruffed Grouse for S2 or S3 compared to S1. Approximately 2.7 km^2, or 2.5 percent of the primary Ruffed Grouse habitat in the Assessment Area (9.9 percent within the lower Churchill River valley), will be affected following construction. Of this, the majority (2.2 km^2) is located within the Muskrat Falls reservoir. Thus, the reversal in sequence associated with S2 or S3, will result in the majority of the primary habitat that will be lost as a result of the Project, to occur earlier in the construction phase.

The transmission line between the Muskrat Falls and Gull Island facilities and Churchill Falls power station will alter predominantly coniferous forest so the recovering areas or edge will probably be of higher quality for Ruffed Grouse.

Osprey

There is no change in size of the reservoirs or the operating regime associated with S2 and S3 compared to S1. No other changes to effects on Osprey are predicted as a result of a change in sequencing of the project phases.

Artificial platforms will replace approximately 11 Osprey nests affected by reservoir preparation, whereas four will be within 200 m of the new shorelines and could be displaced. In total, artificial platforms will replace 9.4 percent of the known Osprey nests within the Project footprint. As most of these are within the Gull Island reservoir, this mitigation activity would be delayed until later in the construction phase of S2 or S3.

No existing Osprey nests on trees occur within 800 m of the transmission line route between the two generation facilities and Churchill Falls power station, but individuals will likely attempt to establish nests on these transmission structures (artificial platforms). Thus, a positive alteration of habitat is anticipated, regardless of the ROW width, particularly where water bodies with suitable and accessible fish stocks exist, but where suitable nesting substrate was previously limited.

Wetland Sparrows

Reservoir preparation and inundation for S2 and S3 is the same as for S1. Therefore, there is no change in effects on habitat predicted. There are approximately similar amounts of primary habitat lost in the Muskrat Falls reservoir (7.2 km^2) and the Gull Island reservoir (8.2 km^2), therefore a change in sequencing of Project phases is not expect to change the rate of habitat alteration, although in S3 there would be a delay to alteration in the Gull Island reservoir.

Any sections of the new transmission line that pass through wetlands could result in loss or alteration of habitat affecting the presence and breeding success of Wetland Sparrows. Primary habitat in the area of the transmission line construction (including the wider right-of-way associated with S2 or S3) is relatively scarce, so the implications of an increased ROW is considered negligible.

Harlequin Duck (Species of Concern)

For S2 and S3, reservoir preparation (IR# JRP.148) is no different than that for S1. Effects to Harlequin Duck would only occur if Project activities occur near breeding sites, and even there it will likely be in the form of temporary sensory disturbance, rather than loss or alteration of habitat directly used by Harlequin Duck. Given that most breeding rivers are adjacent to the Gull Island reservoir, such potential disturbance would occur later in the construction phase associated with S2 or S3. Furthermore, any potential loss of breeding habitat to the Project will be minimal, given that all known breeding sites are above the projected level of the reservoirs (IR# JRP.105).

The only spatial overlap expected with Harlequin Duck is where transmission line construction crosses the Cache and Metchin rivers, and this does not change with S2, S3 sequencing compared to S1. Sensory disturbance near breeding or staging sites represents a temporary reduction in habitat quality for Harlequin Duck. Given the wider ROW (i.e., 20 m), this is expected to be a negligible incremental increase in overlap.

Other Species of Concern

The total area and percentage of available primary habitat lost to inundation is the same for S1, S2, and S3. The effects of sequencing of Project phases on the alteration of habitat is to change the order, and timing of alteration:

- 11.6 km^2 or 3.2 percent of the primary habitat in the lower Churchill River valley and 0.1 percent of the Assessment Area for Common Nighthawk. The majority of this lost habitat is within the Gull Island reservoir (10.7 km^2) compared to the Muskrat Falls reservoir (0.9 km^2);
- 14.3 km^2 or 60.6 percent of the primary habitat in the lower Churchill River valley and 0.4 percent of the Assessment Area for Olive-sided Flycatcher. Similar amounts of lost primary habitat occur within the Muskrat Falls reservoir (6.1 km^2) and the Gull Island reservoir (8.2 km^2);
- 76.4 km^2 or 9.2 percent of the primary habitat in the lower Churchill River valley, or 1.8 percent of the Assessment Area for Gray-cheeked Thrush. The majority of this lost habitat is within the Gull Island reservoir (58.7 km^2) compared to the Muskrat Falls reservoir (17.7 km^2) ; and

- 16.6 km^2 or 26.9 percent of the primary habitat in the lower Churchill River valley, or 1.8 percent of the Assessment Area for Rusty Blackbird. Similar amounts of lost primary habitat occur within the Muskrat Falls reservoir (8.2 km^2) and the Gull Island reservoir (8.4 km^2).

Because most of the other bird species of concern regularly (Common Nighthawk, Rusty Blackbird) or occasionally (Olive-sided Flycatcher, Gray-cheeked Thrush) nest on or near the ground, vegetation removal during clearing of a wider transmission ROW could disturb nests. Consistent with current regulations, Nalcor will develop and implement a management plan to address this concern. Because the percentage of suitable habitat within this narrow zone of influence is small, the magnitude of this environmental effect will be low for birds at risk.

Herpetiles

Reservoir preparation and inundation for S2 and S3 is the same as for S1. Reservoir creation will result in both a direct loss of breeding, foraging and hibernation habitat as well as a reduction in the quality of riparian habitat that re-establishes following completion of the flooding process. Much of the most productive amphibian habitat is situated in the floodplain of the lower Churchill River (i.e., within and adjacent to the Muskrat Falls reservoir). Reservoir creation has the greatest potential to cause adverse effects to amphibian populations in the Project area. The reversal in sequencing with S2 or S3 will result in effects to the majority of primary aquatic habitat occurring earlier in the construction phase.

The amphibian species present in Labrador require a combination of breeding, foraging and hibernation habitats. Transmission line construction can result in disturbance of wetlands that may reduce their ability to support amphibians. However, rutting of wetland habitat can also create pools that provide amphibian habitat.

6.9.2 Change in Project Effects during Operation and Maintenance

For S2 and S3, there will be little difference in the terrestrial environment effects associated with the operation and maintenance phase of the Project relative to S1. This is mainly because there will be minimal disturbance or change in terrestrial habitat during Project operation and maintenance. Furthermore, during the operation and maintenance phase, the water management and operating regime will be identical with either S1, S2 or S3.

Implications for Terrestrial KIs

The change in sequencing of Project phases with S2 or S3 does not change the overall effects predictions of the Project operation and maintenance, nor planned mitigations. However, reordering the phases and potentially imposing a delay in Gull Island (no overlap in construction) will result in a change to the order and timing of alteration (S2) and potentially a further delay in alteration associated with Gull Island (S3). Some specific points include:

- Note that the wider transmission line associated with S2 or S3 (about 20 m wider than evaluated in S1) would still not be expected to form a barrier to movement, especially if low shrub cover regenerates in the corridor, providing visual cover for Caribou from either the GR Herd or the RWM Herd.
- The LCP analysis (Minaskuat Inc. 2009a) to determine possible crossing locations along the lower Churchill River, and whether these locations are clumped or widely distributed, would apply to either S1, S2, or S3. Due to a decrease in water velocity and the related increase in stable ice cover during the winter, the effects of the reservoirs on Caribou movement during operation and maintenance are expected to be positive.
- Moose density is not expected to increase because of sequencing of Project phases, suggesting that wolf density and predation pressure on Caribou will also not increase. Loss of key riparian habitat along the lower Churchill River will be detrimental to Moose; however, reservoir clearing and the creation of early

succession habitats may help sustain regional numbers. Development of the transmission line right-of-way (20 m wider with S2 or S3) is not expected to substantially increase forage availability for Moose; therefore, numbers along the corridor should not increase appreciably, resulting in little or no increase in the local wolf population and subsequent predation on Caribou.

- Site waste management that may attract Black Bear to either the Muskrat Falls or Gull Island accommodations buildings, will be not be an issue during operation and maintenance because there will be few employees generating domestic waste on-site. Therefore, this is not an issue for comparison between sequencing options for Project phases. Regardless, proper waste management procedures along with employee training from the onset of construction will reduce or eliminate this environmental effect. As well, once permanent facilities are established, it will be easier to enforce and maintain proper waste management procedures.
- As the water management and operating regime will be the same under either S1, S2, or S3 this will be similar to post construction conditions (particularly at Gull Island Reservoir) and not have an effect on Beaver.
- The same water management and operating regime will allow for the enhancement of the viability of new shorelines as travel corridors for Marten or Porcupine.
- Canada Geese typically breed soon after arrival at its breeding territory, fuelled more by fat reserves than local foraging (Wege and Raveling 1983; Bromley and Jarvis 1993). Therefore, while the change of ashkui may cause a shift in distribution, it is not expected to have an adverse affect on the reproductive success for Canada Geese breeding outside of the lower Churchill River valley nor is this effect expected to differ as a result of sequencing of Project phases. Increased water depth in summer reduces the quality of habitat for summer moulting. Loss of breeding or staging habitat will result in individuals shifting their distribution. The extent to which this will also change abundance depends on the capacity of remnant habitat to support displaced individuals.
- There is no change in predicted effects to Surf Scoter associated with change to sequencing of Project phases. While large areas of open water currently occur along the lower Churchill River, survey data indicate that most Surf Scoter are found at the confluences of major tributary rivers, including in the Muskrat Falls reservoir (e.g., Penas River) or in the Gull Island reservoir (e.g., Minipi River, Beaver Brook, Cache River and Metchin River). Late-nesting waterfowl species typically rely on food sources in staging and breeding areas to maintain and enhance body condition to meet the energy demands of reproduction. Newbury (2006) reported that spring staging Surf Scoter at Fig Lake within the Assessment Area spent 30 percent of its daily activity feeding. Given that Surf Scoter selects more productive habitats at the confluence of the tributaries, it is most likely the birds were using these sites for foraging as well as resting. IR# JRP.64 reviews the implications of changing water depth and velocity on benthic invertebrate species in both the Muskrat Falls and Gull Island Reservoirs. Some adjustment of the use of traditional spring staging sites may occur along affected portions of the Churchill River.
- Water management and operating regimes in the reservoirs may encourage establishment of primary succession species of sufficient height to attract Ruffed Grouse, in a manner consistent with fluctuations associated with existing conditions. The relative stability of both reservoirs (compared to existing conditions) will provide conditions for the establishment of primary habitat over 10 to 15 years. Thus, such areas would develop sooner in the more productive area for Ruffed Grouse around Muskrat Falls associated with S2 or S3.
- The operating regime in the reservoirs will result in increases in fish populations over 20 to 30 years, followed by stable production at or near baseline levels. Thus, the reservoirs will provide long-term foraging opportunities for Osprey. These opportunities are the same relative to S1.

- The similar water management and operating regime between S1, S2, and S3 would not influence the quality of the remaining (post-construction) primary habitat for breeding purposes. IR# JRP.64 reviews the implications of changing water depth and velocity on benthic invertebrate species in both the Muskrat Falls and Gull Island Reservoirs. The implications vary by species. Swamp Sparrow is the most insectivorous, but forages along the river edge infrequently. Song Sparrow is most often along the river, but has a more diverse diet and can therefore be expected to adapt readily to a reduction in benthic fauna. Lincoln's and Savannah Sparrows forage primarily in stagnant wetlands, and in terms of foraging would be largely unaffected by changes from riverine to lacustrine habitat (IR# JRP.64).
- For most of the breeding season Harlequin Duck are limited to tributaries that will remain largely unchanged and not vary between S1, S2 or S3. Some adults may briefly stage on the lower Churchill River in spring, but the period is sufficiently short that changes in benthic invertebrate abundance are unlikely to be of concern (IR# JRP.64). Harlequin Duck will have available open water and not encounter additional energy costs.
- Common Nighthawk will be attracted to infrastructure as part of the operation of generation during operation and maintenance where individuals forage on flying insects attracted to the illuminated areas. This attraction would begin earlier at Muskrat Falls under S2 or S3. IR# JRP.64 reviews the implications of changing water depth and velocity on benthic invertebrate species in both the Muskrat Falls and Gull Island Reservoirs. Olive-sided Flycatcher forage primarily along forest/wetland edges and shows low dietary reliance on benthic fauna (Altman and Sallabanks 2000; IR# JRP.64). The breeding density of Rusty Blackbird foraging is generally along the edge of smaller water bodies (Avery 1995) in the lower Churchill River valley is limited.
- During the operational phase of the Project some suitable amphibian habitat may develop along the margins of the reservoir. The value of these areas as amphibian habitat would depend on the timing and consistency of drawdown events and the nature of the substrates. Drawdown areas containing shallow pools and dense vegetation would provide good habitat particularly if they remain drawn down during the period when amphibians are active.

6.10 Summary of Change in Residual Environmental Effects and Evaluation of Significance

Regardless of the sequence of Project phases, there is a high level of certainty associated with the prediction of residual environmental effects on each of the KIs, given the extent of baseline information, Project information, the understanding of interactions, the nature of the mitigation measures, and resulting environmental effects. Whenever technical limitations existed, conservative assumptions and estimates were selected regarding the baseline conditions.

Project modifications needed to facilitate a change in the sequencing of Project phases are not sufficiently material to change the interactions of the Project activities with the VEC or KI. Because of the sequencing, there are changes in the order of effects for S2 and S3, and therefore the order or emphasis on mitigation measures planned. However, there are no changes to residual environmental effects and evaluation of significance arising from a change in the sequencing of Project phases (Table 6-6).

Table 6-6 Significance of Residual Environmental Effects as a Result of Change in Sequencing

Key Indicator	S1 Construction Phase	S1 Operation and Maintenance Phase	Change for S2 and S3
George River Caribou Herd	Not Significant	Not Significant	No Change
Red Wine Mountain Caribou Herd	Not Significant	Not Significant	No Change
Moose	Not Significant	Not Significant	No Change

Table 6-6 Significance of Residual Environmental Effects as a Result of Change in Sequencing (continued)

Key Indicator	S1 Construction Phase	S1 Operation and Maintenance Phase	Change for S2 and S3
Black Bear	Not Significant	Not Significant	No Change
Beaver	Not Significant	Not Significant	No Change
Marten	Not Significant	Not Significant	No Change
Porcupine	Not Significant	Not Significant	No Change
Canada Goose	Not Significant	Not Significant	No Change
Surf Scoter	Not Significant	Not Significant	No Change
Ruffed Grouse	Not Significant	Not Significant	No Change
Osprey	Not Significant	Not Significant	No Change
Wetland Sparrows	Not Significant	Not Significant	No Change
Harlequin Duck (Species of Concern)	Not Significant	Not Significant	No Change
Other Species of Concern	Not Significant	Not Significant	No Change
Herpetiles	Not Significant	Not Significant	No Change

6.10.1 Change in Residual Environmental Effects - George River Caribou Herd

6.10.1.1 Construction

For S2 and S3, there is no change in the predicted residual environmental effects to the GR Herd relative to S1. Regardless of the sequence of construction, Project activities during construction are expected to have low magnitude effects on the GR Herd, mostly because of its large size and broad distribution during winter. Only a small portion of the Herd's winter range overlaps with the Project area, and loss of habitat, potential changes in movement and additional mortality of animals within this area are not predicted to affect its viability. Although the Herd has specialized habitat requirements over different seasons, habitat is not limiting for this KI. The essentially undisturbed winter range of the GR Herd spans about 811,138 km^2 (Schmelzer and Otto 2003).

Similar to that identified in the EIS for S1, S2 or S3 will result in the loss of a small proportion (0.2 percent) of the local GR home range, so the residual environmental effect remains as predicted in the EIS, and is considered **not significant** (Table 6-7).

Table 6-7 S2 or S3 - Residual Environmental Effects Assessment for the George River Caribou Herd

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 of the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.1.2 Operation and Maintenance

Similar to that identified in the EIS for S1, S2 or S3 Project activities during operation and maintenance are expected to have low magnitude effects on the GR Herd (Table 6-7), mostly because of its large size and broad

distribution during winter. Only a small portion of the GR winter range overlaps with the Project area. The residual environmental effect of this phase is also considered **not significant** regardless of sequence.

6.10.2 Change in Residual Environmental Effects - Red Wine Mountains Caribou Herd

6.10.2.1 Construction

Based on the analysis with respect to changes in habitat, associated movements and mortality of the RWM Herd during construction, the Project, regardless of sequencing of Project phases, will have an adverse environmental effect of moderate magnitude that should not be of concern for management. The geographic extent is confined to the Assessment Area (i.e., local), and will occur throughout construction at regular intervals. The environmental effects, however, are reversible within this area, which is presently considered relatively undisturbed by human activity. Habitat is not limiting for this KI over this phase of the Project. Therefore, the residual environmental effect during construction is **not significant** for either Project sequence (Table 6-8). The main threats to the Herd will likely continue to be predation caused by increasing regional Moose numbers, poaching and periodic incursion of, and possible emigration to, the GR Herd. Construction of the Project is not expected to affect the risk posed by these threats. This conclusion is the same as was identified for S1 in the EIS.

Table 6-8 S2 or S3 - Residual Environmental Effects Assessment for the Red Wine Mountains Caribou Herd

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Moderate	Moderate
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.2.2 Operation and Maintenance

During operation and maintenance, no further direct habitat loss or alteration is anticipated with either Project sequence. Therefore, for S2 and S3, there is no change in predicted environmental effects of Project operation and maintenance on changes to habitat, associated movements and mortality of the RWM Herd. The residual environmental effect from activities during operation and maintenance is determined to be **not significant** for S2 or S3 (Table 6-8). The main threats to the Herd will continue to be predation caused by increasing regional Moose numbers (IR# JRP.93) and periodic incursion of the GR Herd, as well as emigration to the GR Herd and poaching unless management can intervene effectively. This conclusion is the same as was identified in the EIS.

6.10.3 Change in Residual Environmental Effects - Moose

6.10.3.1 Construction

For S2 and S3, there is no change to the predicted permanent loss of Moose habitat within the Assessment Area compared to S1. This is mainly because the size and location of the reservoirs have not changed. Therefore, the

residual environmental effect during construction is considered **not significant** regardless of sequence with S2 or S3 (Table 6-9). This conclusion is the same as was identified for S1 in the EIS.

Table 6-9 S2 or S3 - Residual Environmental Effects Assessment for Moose

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	**Adverse**	**Adverse**
Magnitude	Moderate	Moderate
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.3.2 Operation and Maintenance

During operation and maintenance, no habitat loss or alteration will occur in undisturbed areas with either Project sequence. Vegetation management along the wider transmission line (in S2 or S3) will cause some temporary disturbance on an irregular basis, especially where individuals pass through wetland habitat. However, this will be a function of length of corridor (which does not change) rather than width. So the disturbance will not likely be different from that for S1. Therefore, the environmental effect of the Project on Moose during this phase is considered to be **not significant** (Table 6-9). This conclusion is the same as was identified for S1 in the EIS.

6.10.4 Change in Residual Environmental Effects - Black Bear

6.10.4.1 Construction

For S2 and S3, there is no change to the predicted permanent alteration or loss of primary, secondary and tertiary Black Bear habitat within the Assessment Area. This is primarily because reservoir preparation activity and inundation strategy is the same as for S1.

Black Bear are generalists with a broad array of habitat and food types that make it less susceptible to habitat fragmentation (Swihart et al. 2003). Collectively, the residual environmental effects of the Project on Black Bear during construction will not jeopardize the sustainability of the population and therefore are considered **not significant** regardless of sequence in S2 or S3 (Table 6-10). This conclusion is the same as was identified for S1 in the EIS.

Table 6-10 S2 or S3 - Residual Environmental Effects Assessment for Black Bear

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable

Table 6-10 S2 or S3 - Residual Environmental Effects Assessment for Black Bear (continued)

Criteria	Construction Phase	Operation and Maintenance Phase
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.4.2 Operation and Maintenance

During operation and maintenance, no further habitat loss or alteration will occur in undisturbed areas. The residual environmental effects of the Project on Black Bear during operation and maintenance are of low magnitude, remain as predicted in the EIS and are considered **not significant** regardless of sequence (Table 6-10). This conclusion is the same as was identified for S1 in the EIS.

6.10.5 Change in Residual Environmental Effects - Beaver

6.10.5.1 Construction

For S2 and S3, there is no change in predicted loss of habitat for Beaver compared to S1. This is mainly because the reservoirs have not changed nor has the impoundment strategy. Changes in sequencing of Project phases associated with S2 and S3 also does not affect heath or mortality compared to S1. Therefore, the residual environmental effect is considered **not significant** regardless of sequence in S2 or S3 (Table 6-11) as it will be local, and unlikely to influence overall population abundance or its sustainability. This conclusion is the same as was identified for S1 in the EIS.

Table 6-11 S2 or S3 - Residual Environmental Effects Assessment for Beaver

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.5.2 Operation and Maintenance

Based on the limited geographic extent of disturbances during operation and maintenance and the relatively low number of individuals to be affected, the environmental effect of the Project on Beaver during this phase is considered **not significant** regardless of sequence in S2 or S3 (Table 6-11). This conclusion is the same as was identified for S1 in the EIS.

6.10.6 Change in Residual Environmental Effects - Marten

6.10.6.1 Construction

For S2 or S3, there is no change in the predicted loss of habitat for Marten compared to S1. This is primarily because the reservoir preparation activity is the same as for S1. The residual environmental effects of the

Project on Marten during construction are not expected to jeopardize the sustainability of the population and are therefore considered **not significant** regardless of the sequence in S2 or S3 (Table 6-12). This conclusion is the same as was identified for S1 in the EIS.

Table 6-12 S2 or S3 - Residual Environmental Effects Assessment for Marten

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Moderate	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.6.2 Operation and Maintenance

Vegetation management along the widened transmission line will continue over the life of the Project, but this is tertiary habitat and is unlikely to cause further displacement of Marten. As there are no changes due to sequencing of the Project phases in the environmental effect of the Project on Marten during operation and maintenance, the residual effects remain **not significant** regardless of the sequence in S2 or S3 (Table 6-12). This conclusion is the same as was identified for S1 in the EIS.

6.10.7 Change in Residual Environmental Effects - Porcupine

6.10.7.1 Construction

There is no change in residual effects for S2 and S3 compared to S1. Based on planned mitigation and the abundance of primary (and even secondary) habitat for Porcupine throughout the Assessment Area, the sustainability of the population will not be compromised by the Project. Therefore, the residual environmental effect during construction is considered **not significant** for Porcupine regardless of sequence in S2 or S3 (Table 6-13). This conclusion is the same as was identified for S1 in the EIS.

Table 6-13 S2 or S3 - Residual Environmental Effects Assessment for Porcupine

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.7.2 Operation and Maintenance

During the operation and maintenance phase, there will be no further surficial disturbance beyond the Project area in either Project sequence. Due to the local extent, low magnitude, and permanence of facilities (yet temporary nature of any human disturbance and displacement of Porcupine), the residual environmental effect during operation and maintenance is considered **not significant** regardless of sequence in S2 or S3 (Table 6-13). This conclusion is the same as was identified for S1 in the EIS.

6.10.8 Change in Residual Environmental Effects - Canada Goose

6.10.8.1 Construction

For S2 and S3, the overall magnitude of the environmental effect of construction on Canada Geese is expected to be the same as for S1: low in local geographic extent, and permanent in duration. Because the Project is not expected to affect the sustainability of the population, the environmental effect on Canada Geese during construction is considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-14). This conclusion is the same as was identified for S1 in the EIS.

Table 6-14 S2 or S3 - Residual Environmental Effects Assessment for Canada Goose

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Low	Moderate
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.8.2 Operation and Maintenance

There will be no further surface disturbance during operation and maintenance. As the operating regime is the same for S2 and S3, there is no change in residual effects compared to S1. Therefore, the overall magnitude of the environmental effect of operation and maintenance on Canada Goose is considered to be the same as for S1: moderate and irreversible, local in geographic extent, and continuous for the life of the Project. The environmental effect during operation and maintenance is considered **not significant** regardless of sequence in S2 or S3 (Table 6-14). This conclusion is the same as was identified for S1 in the EIS.

6.10.9 Change in Residual Environmental Effects - Surf Scoter

6.10.9.1 Construction

For S2 and S3, the impoundment strategy of the two reservoirs is the same as for S1 – although in reverse order. Therefore, there is no change in the permanent alteration or loss of Surf Scoter habitat within the Assessment Area for either Project sequence. Overall, the magnitude of construction effects on Surf Scoter will be the same as for S1 remaining moderate, at a local geographic extent and permanent in duration. Because the construction phase will be primarily on land, environmental effects on Surf Scoter are limited to those Project activities that directly overlap with staging or breeding habitat, or influence this habitat through sensory disturbance. Due to

the relatively low breeding density of Surf Scoter and the limited extent of disturbance by the Project in upland areas, only a small proportion of breeding pairs in the Assessment Area will be affected. The residual environmental effect during construction is therefore considered **not significant** regardless of the sequence in S2 or S3 (Table 6-15). This conclusion is the same as was identified for S1 in the EIS.

Table 6-15 S2 or S3 - Residual Environmental Effects Assessment for Surf Scoter

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Moderate	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.9.2 Operation and Maintenance

During the operation and maintenance phase, there will be no further terrestrial surface disturbance beyond the Project footprint. The residual environmental effect on Surf Scoter during operation and maintenance is therefore considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-15). This conclusion is the same as was identified for S1 in the EIS.

6.10.10 Change in Residual Environmental Effects - Ruffed Grouse

6.10.10.1 Construction

The primary effects on Ruffed Grouse habitat are the creation of the two reservoirs. As these reservoirs and impoundment strategy are the same regardless of sequencing of Project phases, there is no change in the extent of this effect. Thus, there is no change to primary habitat losses due to impoundment, which will be at most 2.5 percent of the Assessment Area or of a low magnitude, and the residual environmental effect will be considered **not significant** regardless of sequence in S2 or S3 (Table 6-16). This conclusion is the same as was identified for S1 in the EIS.

Table 6-16 S2 or S3 - Residual Environmental Effects Assessment for Ruffed Grouse

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.10.2 Operation and Maintenance

During operation and maintenance, no further irreversible habitat loss or alteration is anticipated in undisturbed areas. The residual environmental effect on Ruffed Grouse will be of low magnitude and is considered **not significant** regardless of sequence in S2 or S3 (Table 6-16). This conclusion is the same as was identified for S1 in the EIS.

6.10.11 Change in Residual Environmental Effects - Osprey

6.10.11.1 Construction

For S2 and S3, there is no change in the aerial extent of the reservoirs or related construction activities. Based on these Project activities and mitigation described in the EIS, approximately 11 existing nest sites within the reservoirs will be replaced by artificial platforms (established on the same territories) with either S2 or S3, the same as for S1. No nests are known within 800 m of the transmission line, therefore the wider corridor is of no consequence. The residual environmental effect is positive for Osprey during construction, and is therefore considered as **not significant** regardless of sequence in S2 or S3 (Table 6-17). This conclusion is the same as was identified for S1 in the EIS.

Table 6-17 S2 or S3 - Residual Environmental Effects Assessment for Osprey

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	High	High
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.11.2 Operation and Maintenance

During operation and maintenance, no further nest or habitat loss or alteration is anticipated in undisturbed areas and the operating regime is the same regardless of sequencing of Project phases. As it is likely that some individuals will occupy transmission line structures, the reconfiguration of the tower structures is not expected to be more or less attractive to Osprey. The magnitude of residual environmental effects of operation and maintenance will be high but are of a positive nature. The residual environmental effects are considered **not significant** regardless of sequence in S2 or S3 (Table 6-17). This conclusion is the same as was identified for S1 in the EIS.

6.10.12 Change in Residual Environmental Effects - Wetland Sparrows

6.10.12.1 Construction

The main environmental effect will be the loss of Wetland Sparrow breeding habitat within the Terrestrial Environment Assessment Area due to the creation of reservoirs. As there is no change is aerial extent of the reservoirs for S2 and S3 compared to S1, effects on habitat are the same. Wetland Sparrows will continue to

breed in unaffected habitat in the Assessment Area, including in the anticipated new wetland areas. The residual environmental effect of Project activities during construction is therefore considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-18). This conclusion is the same as was identified for S1 in the EIS.

Table 6-18 S2 or S3 - Residual Environmental Effects Assessment for Wetland Sparrows

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	High	High
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.12.2 Operation and Maintenance

There will be no further surface disturbance beyond the Project area in any sequence of construction phases. And because Wetland Sparrows will persist, despite disturbance, in remaining and newly created wetland habitat, the environmental effect during operation and maintenance is considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-18). This conclusion is the same as was identified for S1 in the EIS.

6.10.13 Change in Residual Environmental Effects - Harlequin Duck

6.10.13.1 Construction

For S2 and S3, there is no change in the aerial extent of the reservoirs and therefore no change in encroachment up tributaries, the preferred breeding habitat for Harlequin Duck. All known regularly occupied territories will remain farther upstream and above the operating level of the reservoirs. Therefore, the environmental effect on Harlequin Duck during construction is considered **not significant** regardless of sequence in S2 or S3 (Table 6-19). This conclusion is the same as was identified for S1 in the EIS.

Table 6-19 S2 or S3 - Residual Environmental Effects Assessment for Harlequin Duck

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.13.2 Operation and Maintenance

There will be no further surface disturbance beyond the Project area in any sequence of construction phases. The environmental effect during operation and maintenance is considered **not significant** regardless of sequence in S2 or S3 (Table 6-19). This conclusion is the same as was identified for S1 in the EIS.

6.10.14 Change in Residual Environmental Effects - Other Species of Concern

6.10.14.1 Construction

The surface disturbances created during construction of S2 and S3 are the same as for S1. The Project will cause the alteration or loss of between 11.6 and 76.4 km^2 of primary habitat for birds at risk for either Project sequence. Based on the mitigation and the abundance of primary and secondary habitat for birds at risk throughout the Assessment Area, the sustainability of their populations will not be compromised by the Project, and the environmental effect during construction is considered **not significant** regardless of the sequence in S2 or S3 (Table 6-20). This conclusion is the same as was identified for S1 in the EIS.

Table 6-20 S2 or S3 - Residual Environmental Effects Assessment for Other Species of Concern

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	**Adverse**	**Adverse**
Magnitude	Low	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.14.2 Operation and Maintenance

No further habitat loss or alteration is anticipated in undisturbed areas associated with any of the contemplated sequencing of Project phases. During operation and maintenance, the magnitude of environmental effects is low to medium at a regional geographic extent and occurs continuously for the life of the Project on previously disturbed areas. Overall, the environmental effect is considered **not significant** regardless of sequence in S2 or S3 (Table 6-20). This conclusion is the same as was identified for S1 in the EIS.

6.10.15 Change in Residual Environmental Effects - Herpetiles

6.10.15.1 Construction

The main environmental effect will be the loss of amphibian breeding habitat within the Terrestrial Environment Assessment Area due to the creation of reservoirs. As the reservoirs are the same for S2 and S3 compared to S1, there is no change in effects on habitat for herpetiles. All other potential effects are related to a change in habitat, and therefore, there is no change expected for S2 and S3 relative to S1. The residual environmental effect of Project activities during construction is therefore considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-21). This conclusion is the same as was identified for S1 in the EIS.

Table 6-21 S2 or S3 - Residual Environmental Effects Assessment for Herpetiles

Criteria	Construction Phase	Operation and Maintenance Phase
Nature	Adverse	Adverse
Magnitude	High	Low
Geographic Extent	Local	Local
Duration / Frequency	Permanent, Regular Basis	Permanent, Regular Basis
Reversibility	Reversible	Irreversible
Ecological Context	Undisturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: As the residual adverse environmental effect is not significant, there will be no change in species richness, and therefore no change in biodiversity Methods explained in Volume IA, Chapter 9 in the EIS; IR# JRP.116 Criteria defined in Section 5.5 of Volume IIB of the EIS		

6.10.15.2 Operation and Maintenance

There will be no further surface disturbance beyond the Project footprint with any of the contemplated sequencing of Project phases. And, because amphibians will persist, despite disturbance, in remaining and newly created habitats, the environmental effect during operation and maintenance is considered to be **not significant** regardless of sequence in S2 or S3 (Table 6-21). This conclusion is the same as was identified in the EIS.

6.11 Cumulative Environmental Effects

Ongoing and likely future projects and activities that could act in combination with the Project to result in cumulative environmental effects to the terrestrial environment remain the same as those identified in Volume IIB, Section 5 of the EIS. Although the timing of when cumulative effects may occur for S2 and S3 could shift as compared to S1, the results of the cumulative environmental effects analysis as presented in Volume IIB, Section 5 of the EIS and in the responses to IR# JRP.97, IR# JRP.97S, and IR# JRP.163 will not likely change because of a change in sequencing of Project phases. This is because the same Project activities and interactions will occur, albeit in a reversed order and for S3, at a later time not overlapping with construction at Muskrat Falls.

The ongoing and reasonably foreseeable future projects and activities that could act in combination with S2 or S3 of the Project are the same as those evaluated in the EIS. An update of their status is presented in Table 6-22.

Table 6-22 Potential Interactions of Future Projects and Activities with Terrestrial Key Indicators in the Terrestrial Environment Assessment Area

Other Project or Activity	Spatial Overlap	Temporal Overlap
NATO Special Forces Training	Almost all of the Assessment Area is within the Military Training Area	Most military training usually occurs during April-October, but ground exercises may occur throughout the year
Commercial Forestry	Large portion of Forest Management District (FMD) 19A Management Plan overlaps and would alter large sections of terrestrial habitat, increased logging will provide increased access for hunting. Note that this plan is not initiated at this time	Logging in Labrador could occur essentially year-round, with exception of late spring period. The current five-year operating plan would cover the years from 2008 to 2012 overlapping with planned Project construction. Commercial demand is unknown and the plan would be subject to renewal if markets are available
Cultural and Recreational Land Use	Current Trans Labrador Trail and other routes enhance access for hunting and increase risk of disturbance. Hunting and trapping occur in areas that are accessible	Seasonal access enhanced during December through April. Hunting and trapping primarily occurs between October and April

Table 6-23 Potential Interactions of Future Projects and Activities with Terrestrial Key Indicators in the Terrestrial Environment Assessment Area (continued)

Other Project or Activity	Spatial Overlap	Temporal Overlap
TLH	Both Phase I and Phase III are within the Assessment Area and provide increased access for various activities	Construction of Phase III was completed in 2009 although upgrading is ongoing with this and other sections of the TLH. Will operate year-round; access to the south side of the Churchill River now available year-round
Additional Transmission	Power distribution will originate within the Assessment Area, routing will depend on end user and power purchase agreements	The construction of the additional transmission (e.g., Labrador-Island Transmission Link) would overlap the construction of this Project, thereafter it will operate year-round with occasional maintenance activities

The same effects and effects management strategies as evaluated in S1, apply to S2 or S3. However, associated clearing with the completion of the Phase III of the TLH is no longer required with its completion in November 2009. Upgrades to the TLH will result in a relatively small amount of vegetation clearing, but some habitat will be affected. Resulting shifts in wildlife distribution will be mostly inconsequential unless fragmentation creates substantial barriers to movement.

6.12 Accidents and Malfunctions

Regardless of the sequencing of Project phases, the significance of the residual environmental effects on Terrestrial KIs resulting from an accident or malfunction is likely not to change from those assessed in Volume IIB, Chapter 6 of the EIS or in the response to IR# JRP.145. This is because there will not be an increase in magnitude, geographic extent, duration or frequency of the effect. Therefore, in the unlikely event of a dam failure, the adverse residual environmental effect would be **significant**. In the unlikely event of a forest fire or other fire, accidental release of solid or liquid waste, or a hazardous material spill, the adverse environmental effects would be **not significant** for S1, S2, or S3.

6.13 Monitoring and Follow-up

The same EEM programs proposed around the KIs for the Terrestrial Environment in the EIS (i.e., S1) and IR# JRP.112, would apply for either S2 or S3. As outlined in the CEAA, these EEM programs are designed to verify the environmental effect predictions and determine the effectiveness of mitigation measures. The monitoring program will also allow, during construction and during operation and maintenance, for refining and optimizing of mitigation and monitoring through adaptive management measures. The precautionary approach requires Nalcor to *identify, follow-up and monitor its activities, particularly in areas where scientific uncertainty exists in the prediction of effects*. Although there is a high level of certainty associated with the biophysical assessment, this factor will be considered when follow-up programs are developed.

7.0 ECONOMY, EMPLOYMENT AND BUSINESS

7.1 Introduction

The analysis presented in this chapter is based on the EIS Volume III, Socio-Economic Assessment, Chapter 3, responses to relevant IRs, the description of S2 and S3, and updated capital and operating costs for S1, S2 and S3. Details on the Economy, Employment and Business VEC, in terms of its relevance to the overall environmental assessment as well as the methodological approach, are found in the EIS Volume III, Section 3.1.

7.2 Key Indicators

The selection of key indicators (KIs) for the Economy, Employment and Business VEC remain the same as used for S1, as provided in Volume III, Section 3.3 of the EIS, and include the following:

- Economy: assessed at the Provincial, Labrador and the Upper Lake Melville area scales for incomes and revenue from taxes and related sources;
- Employment: assessed at the Provincial, Labrador and the Upper Lake Melville area scales for direct, indirect and induced effects; and
- Business: assessed at the Labrador and the Upper Lake Melville area scales for the potential capability of firms to provide the services or goods required.

7.3 Measurable Parameters

7.3.1 Economy

The parameters used for measuring change in sequencing of the Project phases relative to the Economy are the same as those used for S1 (Table 7-1), as described in the EIS Volume III, Section 3.5.1.

Table 7-1 Measurable Parameters for Economy (reproduced from Volume III, Table 3-3 of the EIS)

Key Indicator	Measurable Parameter
Economy	• Direct, indirect and induced income generated in Newfoundland and Labrador from Project construction and operation and maintenance
	• Direct, indirect and induced corporate taxes, personal taxes and other revenues, including payroll taxes and Worker's Compensation premiums, to Newfoundland and Labrador

7.3.2 Employment

The parameters used for measuring change in sequencing of the Project phases relative to Employment are the same as those used for S1 (Table 7-2), as described in the EIS Volume III, Section 3.6.1.

Table 7-2 Measurable Parameters for Employment (reproduced from Volume III, Table 3-5 of the EIS)

Key Indicator	Measurable Parameter
Employment	• Direct, indirect and induced employment levels in Newfoundland and Labrador, Labrador and its regions from Project construction and operation and maintenance • Employment by gender and Aboriginal status • Labour Force participation rate • Employment rate

7.3.3 Business

The parameters used for measuring change in sequencing of the Project phases relative to Business are the same as those used for S1 (Table 7-3), as described in the EIS Volume III, Section 3.7.1.

Table 7-3 Measurable Parameters for Business (reproduced from Volume III, Table 3-9 of the EIS)

Key Indicator	Measurable Parameter
Business	• Number of businesses in the construction and related trades sectors in Labrador • Value of contracts obtained by Labrador and Newfoundland businesses

7.4 Criteria for Describing Socio-economic Effects – Economy, Employment and Business

The criteria for describing the socio-economic effects of S2 and S3 on Economy, Employment and Business are the same as those used for S1 (EIS Volume III, Sections 3.5.2, 3.6.2 and 3.7.2):

- nature: the long term socio-economic effects of the Project on Economy, Employment and Business.
  - adverse
  - positive
  - neutral
- magnitude: the change in the KI from existing levels that are attributed to the Project.
  - reduction: reduces existing levels
  - neutral: adds nothing to existing levels
  - increase: adds to existing levels
- geographic extent: the area affected by the Project.
  - Upper Lake Melville area
  - Labrador
  - Province
- frequency: the number of times a socio-economic effect will occur.
  - not likely to occur
  - occurs once
  - occurs sporadically at irregular intervals
  - occurs on a regular basis and at regular intervals
  - continuous
- duration: the period of time over which the socio-economic effect will occur.
  - construction phase
  - operation and maintenance phase
- level and degree of certainty of knowledge.
  - low: low level of certainty
  - high: high level of certainty

- likelihood.
  - unlikely: significant adverse socio-economic effect not likely to occur
  - likely: significant adverse socio-economic effect likely to occur

7.5 Determination of Significance

The determination of significance for impacts on Economy, Employment and Business remain the same as those presented for S1 in Volume III, Section 3.6 of the EIS, and are as follows:

7.5.1 Economy

A significant adverse residual socio-economic effect of the Project on Economy will result if the Project causes substantial decreases in the measurable parameters (i.e., income levels and revenues from taxes) over the life of the Project.

A significant positive socio-economic effect of the Project on Economy will result if Project expenditures cause substantial increases in the measurable parameters (i.e., income levels and revenue from taxes) over the life of the Project.

7.5.2 Employment

A significant adverse residual socio-economic effect on Employment from the Project will result from changes in expenditures that produce substantial decreases in employment levels and employment rates from current levels over the life of the Project.

A significant positive residual socio-economic effect on Employment from the Project will result if expenditures cause substantial increases in employment levels and employment rates from current levels over the life of the Project.

7.5.3 Business

A significant adverse residual socio-economic effect from the Project on Business is one resulting in substantial decreases in the number of businesses in construction and related trades in Labrador and value of contracts obtained by Newfoundland and Labrador businesses as compared to current levels over the life of the Project.

A significant positive residual socio-economic effect from the Project on Business is one resulting in substantial increases over the life of the Project in the number of businesses in construction and related trades in Labrador and value of contracts obtained by Newfoundland and Labrador businesses as compared to current levels.

7.6 Potential Interactions

The changes in sequencing of the Project phases, with or without an overlap in construction, would not change the Project activities or the potential interactions of these activities with Economy, Employment and Business, which remain as presented for S1 in Section 3.4 of Volume III of the EIS (Table 7-4).

Table 7-4 Interaction of the Project with the Key Indicators for the Economy, Employment and Business (reproduced from Volume III, Table 3-2 of the EIS)

Project Activities	Key Indicators		
	Economy	Employment	Business
Construction			
Expenditures	2	2	2
Employment	2	2	2
Operation and Maintenance			
Expenditures	2	2	2
Employment	2	2	2
Accidents and Malfunctions[A]			
Dam Failure	2	2	2
Forest Fire	2	2	2

Key:

0 No measurable interaction will occur. Assessment of socio-economic effects is not required

1 Identified interactions that are well understood, are subject to prescribed environmental protection measures or normal regulatory processes, and/or which can be mitigated / optimized through the application of standard socio-economic management measures and practices. Based on past experience and professional judgement, the potential socio-economic effects resulting from these interactions are rated not significant

2 Identified interactions that may result in more substantive socio-economic effects and/or public or regulatory concern. These interactions require more detailed analysis and consideration in the environmental assessment, in order to predict, mitigate and evaluate potential socio-economic effects

[A] Accidents and Malfunctions are addressed in Chapter 7

7.7 Existing Knowledge

Existing knowledge about the socio-economic effects of hydroelectric projects on Economy, Employment and Business is presented for S1 in Volume III, Section 3.2 of the EIS. No material published since these reports were written contributes any substantial new understanding or insights that would result in changes to the assessment of Project effects or their management.

7.8 Socio-economic Effects Assessment of the Change Sequencing of Project Phases – Economy

Following a detailed review of Project Components (Table 2-1), the changes associated with the construction of S2 or S3, in comparison to S1 in the EIS, that are relevant to Economy, Employment and Business are employment and expenditures. This section assesses the socio-economic effects of S2 and S3 on the Economy, as reflected in changes in income and taxes. The differences in overall effects of S2 and S3 on the Economy from those for S1, as described in the EIS Volume III, Section 3.5 and IR# JRP.11 and IR# JRP.161, are small.

7.8.1 Potential Socio-economic Effects of the Change in Sequencing of Project Phases

As was the case with S1, Project expenditures and their associated multiplier effects, particularly during the construction phase, have the potential to increase earned income levels. In addition, provincial government revenues will increase considerably from individual income taxes, corporate taxes and other revenues such as payroll taxes and Worker's Compensation premiums. Potential socio-economic effects on the Economy are changes in incomes and government revenues. The Project activities that have been ranked as 2, contributing to this socio-economic effect, are expenditures and employment during the construction and operation and maintenance phases. The scope of potential effects has not changed with the change in Project sequence (Table 7-4).

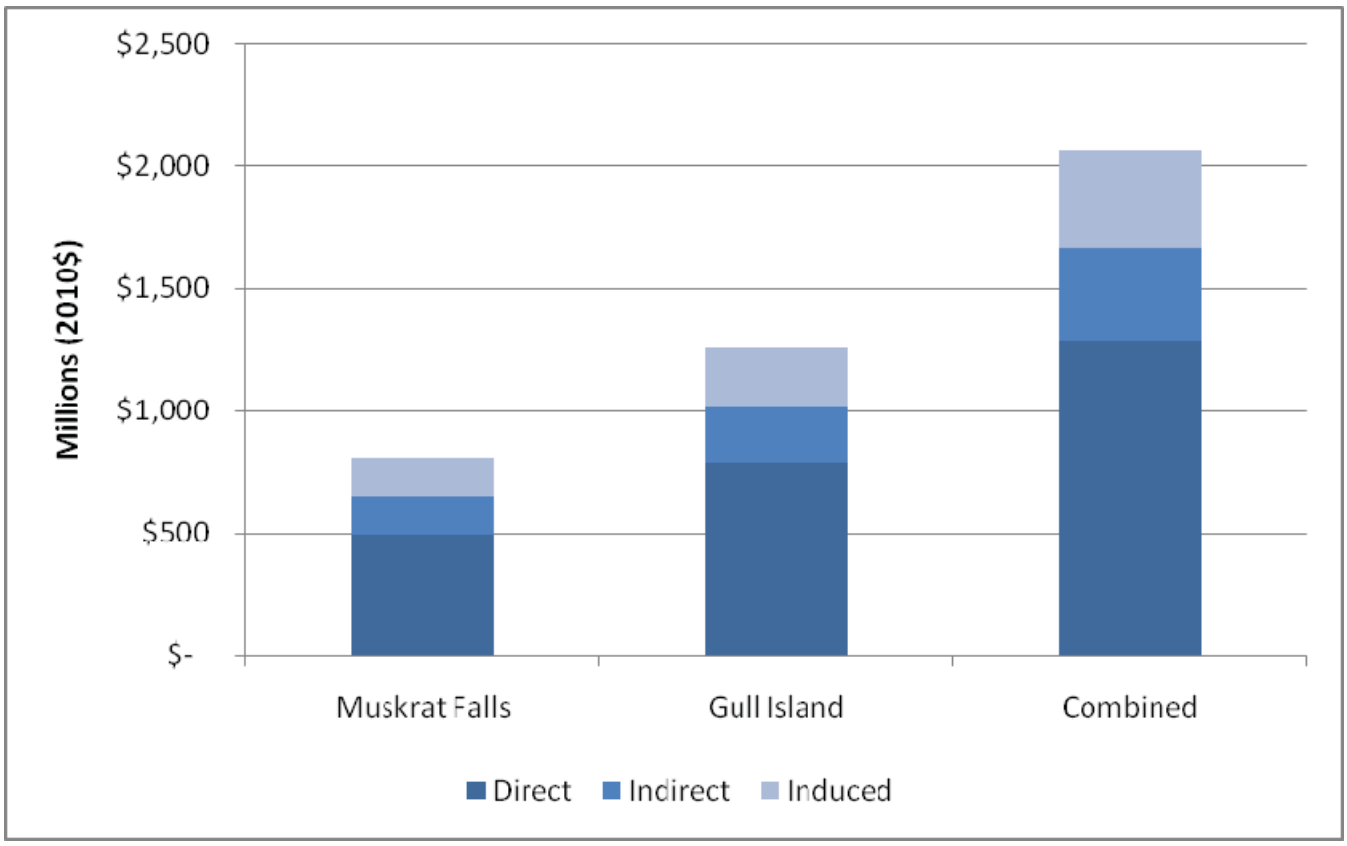
7.8.2 Change in Project Effects - Economy

Income will be generated from the Project through both direct and spin-off (i.e., indirect and induced) employment and through incomes generated by companies that supply goods and services to the Project. All income estimates are based on the Strategic Concepts, Inc. (SCI) model described in Volume III, Section 3.1, of the EIS.

7.8.2.1 Income

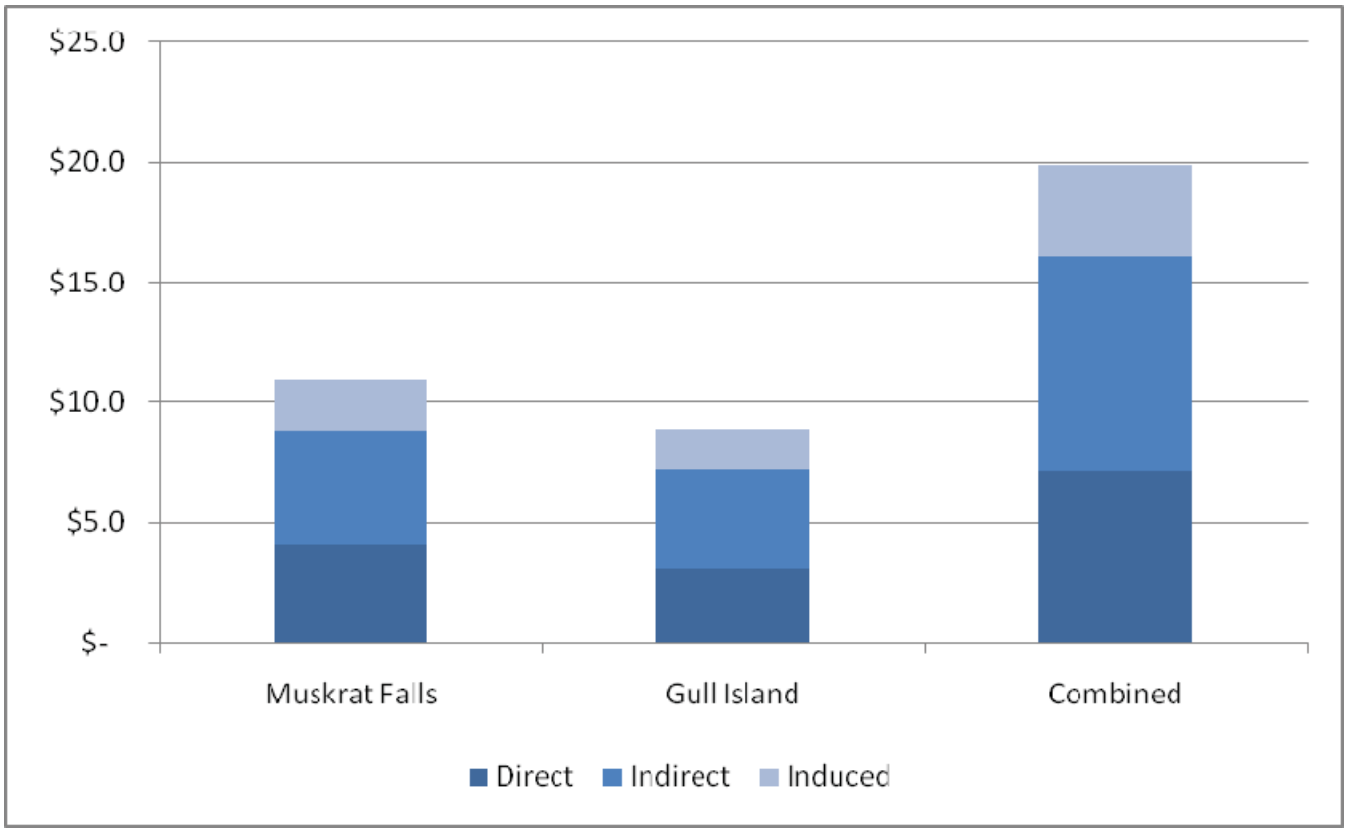
The estimated income effects associated with the construction and operation of S2 and S3 for the Province are shown in Figures 7-1 and 7-2. The first year of operations for each phase of the Project (Muskrat Falls and Gull Island) was used to illustrate the economic effects during operation and maintenance. The income effects for S2 and S3 are virtually identical to those that were forecast for S1 in IR# JRP.11.

Figure 7-1 Composition of Provincial Income (Construction), S2 and S3



Incomes generated by individuals employed directly by S2 or S3 would total $1,285 million, while the overall income effect would be $2,067 million. The purchase of goods and services from businesses in the Province (indirect income) during the construction phase would contribute $382 million to the provincial economy. The induced incomes that flow through the economy from successive rounds of spending by workers and businesses would add an additional $400 million. These income effects are again virtually identical to those forecast for S1 in IR# JRP.11. During a typical year of operations, total income effects on Newfoundland and Labrador labour and business are expected to be $20 million from the Project, including $11 million from Muskrat Falls and an additional $9 million when Gull Island becomes operational.

Figure 7-2 Composition of Provincial Income (Operation and Maintenance), S2 and S3



7.8.2.2 Government Revenues

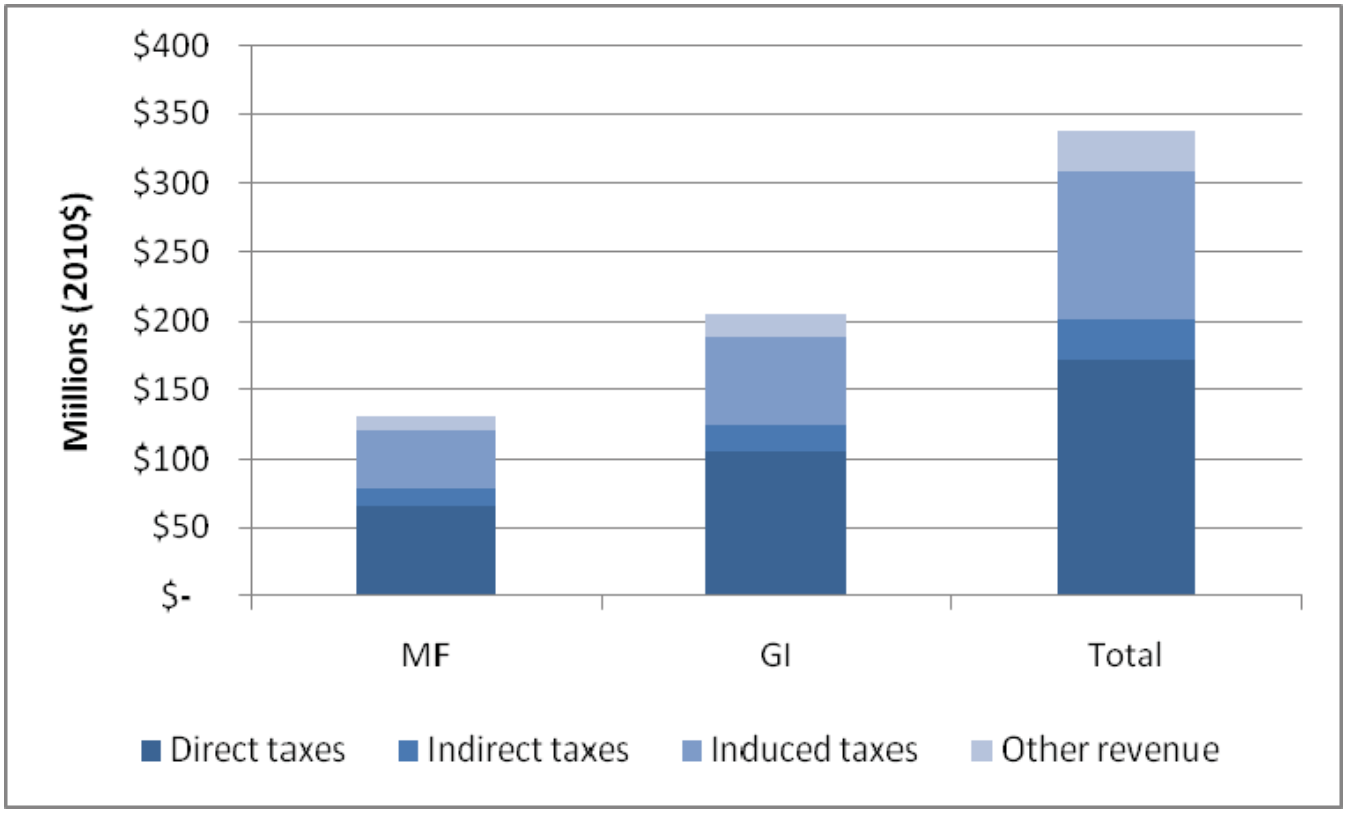
As was the case for S1, government revenue effects of S2 and S3 have been estimated for construction activity only. Over the life of the S2 or S3 construction activity, the Government of Newfoundland and Labrador can expect to receive approximately $337 million in revenue, compared with an estimated $315 million in the case of S1, as presented in IR# JRP.11. These figures are considered comparable within the range of model accuracy. More than half (52 percent) of taxes are derived from direct tax sources, specifically personal income taxes (Figure 7-3).

7.8.2.3 Effects Management

To enhance these potential benefits to Newfoundland and Labrador labour and business, irrespective of sequencing of Project phases, Nalcor has adopted an industrial benefits planning strategy as part of its corporate philosophy, and will be a party to other benefits mechanisms required as part of any IBA with Innu Nation. Nalcor has also implemented the Lower Churchill Construction Projects Benefits Strategy with the Government of Newfoundland and Labrador[2]. These and other potential strategies are discussed with regard to enhancing potential employment and business benefits in Sections 3. 5 (for Employment) and 3.6 (for Business) in Volume III of the EIS.

[2] http://www.nr.gov.nl.ca/nr/energy/lcp_benefits_strategy.pdf

Figure 7-3 Composition of Project-related Tax Revenues (Construction)



7.8.3 Cumulative Socio-economic Effects

There is a potential for cumulative socio-economic effects to occur where other past, present and reasonably foreseeable future projects or activities occur in the same timeframe as the Project. Other projects that may spatially and temporally overlap the Project are those indicated for S1 in the EIS Volume III, Section 3.5.6, and in the response to IR# JRP.97 (Table 7-5).

Table 7-5 Potential Interactions of Future Projects and Activities with the Economy (adapted from Volume III, Table 3-4 of the EIS)

Project or Activity	Spatial Overlap	Temporal Overlap
Voisey's Bay Mine/Mill	Economic, Employment and Business effects overlap in Labrador generally and Happy Valley-Goose Bay specifically	Production at Voisey's Bay will be ongoing throughout Project construction and the early years of the operations and maintenance phase.
Labrador West Mining Developments	Economic, Employment and Business effects overlap in Labrador generally	Production in Labrador West will be ongoing throughout Project construction and during the operations and maintenance phase.
NATO Special Forces Training	Much of the activity will occur in the Upper Lake Melville area, including the community of Happy Valley-Goose Bay	Activity is expected to continue on an ongoing annual basis. Most aviation training occurs during April to October, but ground exercises may occur throughout the year
General Economic and Infrastructural Development in the Upper Lake Melville Area	Infrastructure improvements will benefit the economy of the Upper Lake Melville area	Occurs annually, typically beginning in the spring of each year and concluding before snowfall

Table 7-5 Potential Interactions of Future Projects and Activities with the Economy (continued)

Project or Activity	Spatial Overlap	Temporal Overlap
Commercial Forestry	A large portion of the FMD 19A Management Plan overlaps the Upper Lake Melville area. Forestry operations will affect the economy of this area specifically and that of Labrador and the Province generally	Commercial forestry activities will be ongoing during operation and maintenance phase of the Project
TLH	Highway construction in the Upper Lake Melville area and west will affect the economy of these areas	Activities expected to overlap with Project construction
Additional Transmission	Power distribution will originate within the Upper Lake Melville area. Final routing will depend on the market and delivery strategy (e.g., Labrador-Island link originating from either Gull Island or Muskrat Falls)	Activity expected through the construction phase of the Project and throughout the operations and maintenance phase of the Project

As was the case with S1 (see Volume III, Section 3.5.6), the cumulative socio-economic effects on the Economy for S2 or S3 in combination with other ongoing and future projects would have a positive effect on both Labrador and the Province. While the scale of the expenditures on all other individual projects are unknown and uncertain, expenditures would result in increased incomes to workers and revenues for businesses and increased government revenues through increased taxes and other payments. The additive effect from several projects would increase the overall economic health of Labrador and the Province.

Most of the cumulative socio-economic effects would be experienced during the construction phase, but Project operation and maintenance would continue to add to government incomes and revenues over and above pre-Project levels.

7.9 Socio-economic Effects Assessment of the Change in Sequencing of Project Phases – Employment

Following a detailed review of Project components (Table 2-1), the changes associated with the construction of S2 or S3, in comparison to S1 in the EIS, that are relevant to Economy, Employment and Business are employment and expenditures. This section assesses the socio-economic effects of S2 and S3 on Employment. The differences in overall effects of S2 and S3 on Employment from those for S1, as described in the EIS Volume III, Section 3.6, are small.

7.9.1 Potential Socio-economic Effects of the Change in Construction Sequence

S2 and S3 both have the potential to provide substantial employment opportunities for workers in the Province, Labrador generally and the Upper Lake Melville area specifically associated with both the construction and the operation and maintenance phases. The potential socio-economic effects on Employment are changes in employment levels and rates. S2 and S3 activities that have been ranked as 2, contributing to this socio-economic effect, are expenditures and employment during the construction and operation and maintenance phases (Table 7-4).

7.9.2 Change in Project Effects - Employment

Employment will be generated from Project expenditures directly, indirectly (expenditures on inputs of goods and services required by the Project), or through induced impacts which result from further rounds of income expenditures by individuals and firms. All employment estimates are based on inputs to the SCI model, and are subject to the considerations and constraints discussed in the EIS Volume III, Section 3.6.5.1.

Based on the SCI modelling undertaken for this assessment, the total direct construction-related employment for S2 or S3 would be approximately 15,629 person-years, which is very close to the IR# JRP.11 forecast of 15,532 person-years for S1. The total Project and Project-related (i.e. direct, indirect and induced) employment of Newfoundland and Labrador workers is expected to be approximately 23,474 person-years (Table 7-6), as compared to 22,310 person-years for S1. Total S2 and S3 employment is illustrated in Figures 7-4 and 7-5 respectively.

Table 7-6 Project Employment Effects (Construction Phase), S2 and S3

Category	Muskrat Falls (person-years)	Gull Island (person-years)	Total Lower Churchill (person-years)
Direct Project employment	5,638	9,991	15,629
Direct NL employment	3,676	6,514	10,190
Indirect NL employment	2,177	3,068	5,244
Induced NL employment	3,142	4,898	8,040
Total NL employment	8,995	14,480	23,474

NL = Newfoundland and Labrador
Notes:
Columns and rows may not balance because of rounding errors
Based on total capital expenditures during the construction phase
In comparing these results to those presented in Table 3-10 in IR# JRP.11, the reader should note that transmission infrastructure is associated with the first development, so there is a redistribution of labour effort among S1, S2 and S3. As noted above, however, the total is virtually the same

Figure 7-4 Total Direct Project Employment (Construction), S2

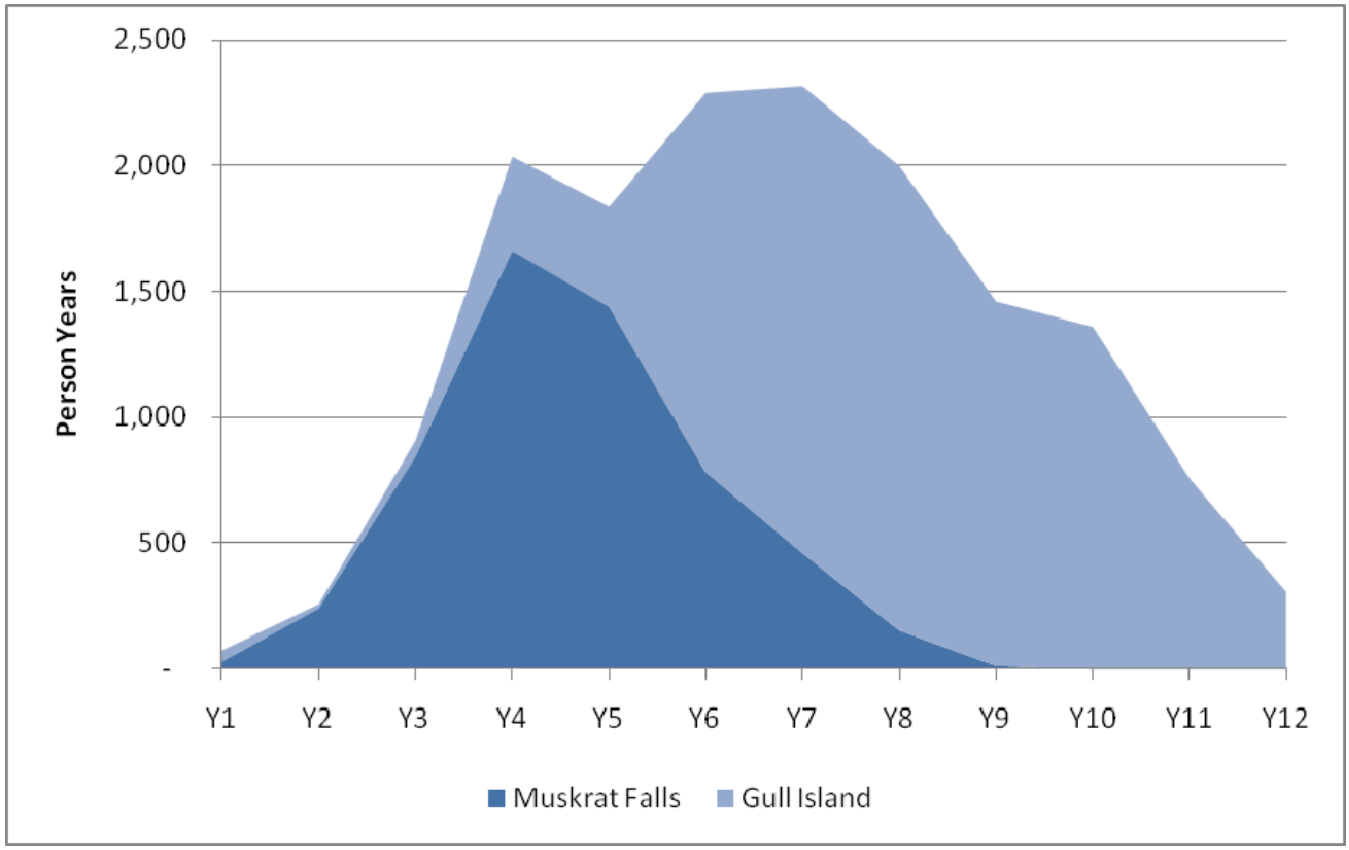
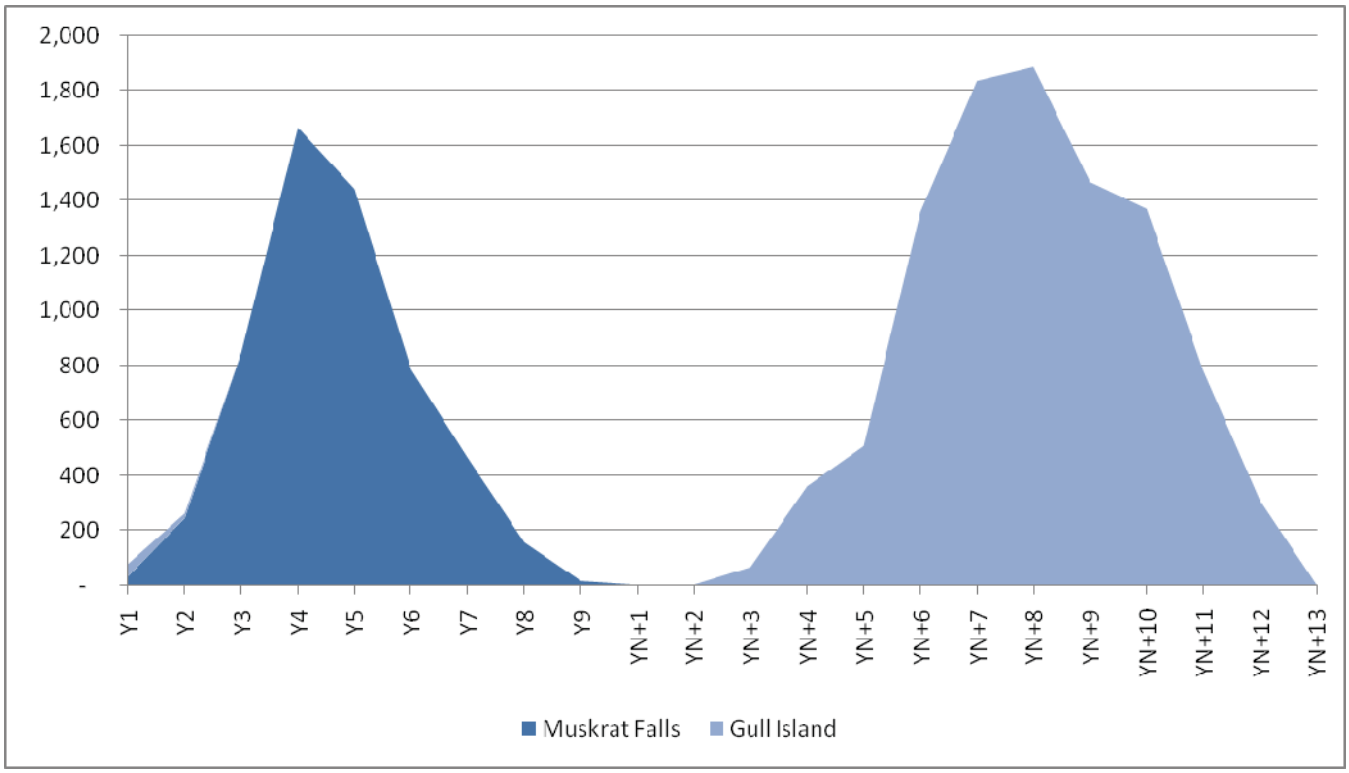


Figure 7-5 Total Direct Project Employment (Construction), S3



For S1, S2 and S3, the operation and maintenance activities would require a much smaller workforce than that required during the construction phase to operate and maintain the generation facilities and associated transmission infrastructure. For both S2 and S3, typical employment during the operation and maintenance phase would be 280 person-years (Table 7-7), more than the 192 person-years estimated for S1. This increase in operation employment reflects an evolution of Nalcor's operating cost estimates, rather than the result of a sequencing change.

Table 7-7 Total Newfoundland and Labrador Employment by Category during Operation and Maintenance, S2 and S3 - Typical Year

Category	Person-Years Employment Project When Muskrat Falls Operational	Person-Years Employment Incremental When Gull Island Operational	Total Person-Years Employment Project Fully Operational
Direct NL employment	46	34	80
Indirect NL employment	66	57	123
Induced NL employment	43	35	77
Total NL employment	154	126	280
NL = Newfoundland and Labrador Note: Based on annual Project expenditures during the operation and maintenance phase			

7.9.3 Cumulative Socio-economic Effects

As was the case with S1 (see Volume III, Section 3.6.6), the cumulative socio-economic effects on Employment for S2 or S3 in combination with other ongoing and future projects would have a positive effect on both Labrador and the Province. While the scale of the labour requirements for all other individual projects are

unknown and uncertain, they would result in increased direct, indirect and induced employment. The additive effect from several projects would increase the overall economic health of Labrador and the Province as a whole. Most of the cumulative socio-economic effects would be experienced during construction activity, but Project operation and maintenance would continue to provide employment over and above pre-Project levels.

7.10 Socio-economic Effects Assessment of the Change in Sequencing of Project Phases – Business

Following a detailed review of Project Components (Table 2-1), the changes associated with the construction of S2 or S3, in comparison to S1 in the EIS, that are relevant to Economy, Employment and Business are employment and expenditures. The differences in overall effects of S2 and S3 on Business from those for S1, as described in the EIS Volume III, Section 3.7 and IR# JRP.132, are small.

7.10.1 Potential Socio-economic Effects of the Change in Construction Sequence

The potential socio-economic effect on Business is change in business activity levels. The Project activities that have been ranked as 2 are expenditures and employment during the construction and operation and maintenance phases.

7.10.2 Change in Project Effects - Business

The type and magnitude of effects on Business will be a function of the degree to which businesses secure contracts to provide materials, equipment, labour and services to the Project. The construction of S2 or S3 would have a total cost of almost $6.4 billion (in 2010 dollars), of which over $2.5 billion would be spent on labour, $2.9 billion on materials and $960 million on equipment.

There would also be business effects during operation and maintenance, where total operating costs (including labour costs) for a typical year are expected to be in the order of $31 million ($17 million for Muskrat Falls and an additional $14 million when Gull Island begins production) in 2010 dollars. During the operation and maintenance phase, business opportunities would be fewer than during construction, but they would continue throughout the life of the Project.

Because the S2 and S3 expenditures are not materially different from those of S1, and the effects management initiatives have not changed, the discussion and analysis of Business opportunities is largely as presented in Volume III, Section 3.7.5. Initially, there could be reduced local impacts because of the reduced economies of scale that would result from the delay in the start of Gull Island as compared to S1. For S3 with an indeterminate temporal gap between the construction of facilities at Muskrat Falls and Gull Island, there may not be significant enough economies of scale for local companies to invest the required capital in establishing supply businesses, which would make them less capable of providing the required goods and services for the Project.

7.10.3 Cumulative Socio-economic Effects

As was the case with S1 (see Volume III, Section 3.7.6), the cumulative socio-economic effects on Business for S2 and S3, in combination with other ongoing and future projects, would be positive. While the scale of the expenditures on all other individual projects is unknown and uncertain, and the timing of the Gull Island expenditures unknown (under S3), expenditures would result in increased revenues for businesses through contract awards and employee expenditures. The additive effect from several projects would increase the overall economic health of Labrador and the Province as a whole. Most of the cumulative socio-economic effects

would be experienced during construction activity, but operation and maintenance activity would continue to provide business over and above pre-Project levels.

7.11 Summary of Change in Residual Socio-economic Effects and Evaluation of Significance

Regardless of the construction sequence, S1, S2 or S3 are projected to have large economic effects on Labrador and the Province as a whole that are consistent with the effects expected under S1. As with S1, there is a high level of certainty associated with the prediction that there would be positive residual socio-economic effects on each of the KIs, given the extent of baseline information and Project information and the understanding of interactions, resulting socio-economic effects, and various effects management measures being taken by Nalcor to optimize positive socio-economic effects.

7.11.1 Economy

Total income effects of S2 or S3 on the Newfoundland and Labrador economy would be almost $2.1 billion, or approximately $172 million annually over the construction phase. They would generate an estimated $337 million in net revenues to the provincial treasury over the life of the Project from the capital expenditures. Compared to S1, the total income would be slightly greater under S2 and S3, while the taxes to the Government of Newfoundland and Labrador would be more pronounced under S2 and S3 than under S1.

The residual socio-economic effects of S2 and S3 during construction on Economy are rated, as was the case for S1 in the EIS, **positive and significant**.

During a typical year of operation and maintenance, the total annual income effects generated in the Province are estimated at $20 million.

Similar to S1 in the EIS, for S2 and S3 the residual socio-economic effects of the Project during the construction, and operation and maintenance phase on Economy are rated **positive and significant**, and the residual adverse socio-economic effects of S2 and S3 on the Economy during construction and operation and maintenance are rated **not significant**. These effects are summarized in Table 7-8.

Table 7-8 Summary of Residual Socio-economic Effects Assessment for Economy (reproduced from Volume III, Table 3-13 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic Extent	Labrador/Province	Labrador/Province
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in Section 3.5.2 Methods explained in Volume IA, Chapter 9		

Any and all cumulative socio-economic effects of S2 or S3 on the Economy are considered **positive and significant** because the current levels of the measurable parameters (incomes and government revenues) would increase as a result of Project activities. Any such increases would be beneficial to the overall economic health of

Labrador and the Province and would be enhanced by the benefits strategies adopted by Nalcor, proponents of other projects and stakeholders. The cumulative socio-economic effects of S2 and S3, in combination with other Projects and activities, on Economy would be **positive and significant**.

The adverse cumulative socio-economic effects of S2 and S3 in combination with other projects and activities on Economy would be **not significant**. These effects are summarized in Table 7-9.

Table 7-9 Summary of Residual Cumulative Socio-economic Effects for Economy (reproduced from Volume III, Table 3-14 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic Extent	Labrador/Province	Labrador/Province
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions of criteria are provided in Section 3.5.2 Methods explained in Volume IA, Chapter 9		

7.11.2 Employment

S2 and S3 would create very similar amounts of employment to that forecast for S1 in the response to IR# JRP.11: 23,474 person-years of employment in Newfoundland and Labrador from construction for an average of 1,956 direct, indirect and induced person-years of employment annually over the construction phase. Construction would require an estimated 15,629 person-years of direct employment of which 65 percent (10,190) would involve workers from Newfoundland and Labrador. Employment opportunities to the Province generally and Labrador specifically would be optimized through use of the employment and training strategies described for S1 in Volume III, Section 3.6.5, of the EIS.

The employment effects of S2 and S3 have the potential to substantially increase overall provincial employment levels, and especially those in Labrador and its regions. In addition, the Project would result in an increase in the number of apprentices, journeypersons and other trained persons in the provincial workforce and increased experience levels for all of those employed. These changes would contribute to improvements in the overall economic health of the Province and to the health and well-being of individuals in the provincial labour force and their families. Therefore, the residual socio-economic effects of S2 and S3 during construction on Employment are rated, as was the case for S1 in the EIS, **positive and significant**.

During a typical year of operation and maintenance, total employment would be 280 person-years. As was the case for S1 in the EIS, the residual socio-economic effects of S2 and S3 during the operation and maintenance phase on Employment are rated **positive and significant**.

The residual adverse socio-economic effects of S2 and S3 on Employment during construction and operation and maintenance are rated, as for S1 in the EIS, **not significant**.

These effects are summarized in Table 7-10.

Table 7-10 Summary of Residual Socio-economic Effects Assessment for Employment (reproduced from Volume III, Table 3-15 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic Extent	Labrador/Province	Labrador/Province
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions of criteria are provided in Section 3.6.2 Methods explained in Volume IA, Chapter 9		

The cumulative socio-economic effects on Employment are considered significant because the current levels of the measurable parameters (employment levels, participation rates) would increase as a result of Project activities. Any such increases would be potentially beneficial to the health and well-being of the individuals employed, and the overall economic health of Labrador and the Province would be enhanced.

The cumulative socio-economic effects from S2 and S3, in combination with other projects and activities, on Employment are, as was the case for S1 in the EIS, **positive and significant** (Table 7-11). The adverse cumulative socio-economic effects of S2 and S3, in combination with other projects and activities, on Employment are, as for S1 in the EIS, **not significant**.

Table 7-11 Summary of Residual Cumulative Socio-economic Effects for Employment (reproduced from Volume III, Table 3-16 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic Extent	Labrador/Province	Labrador/Province
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions of criteria are provided in Section 3.6.2 Methods explained in Volume IA, Chapter 9		

7.11.3 Business

S2 and S3 would both involve capital expenditures of approximately $6.4 billion (2010 dollars). These expenditures are effectively the same as those presented in IR# JRP.11 for S1, and would generate substantial opportunities for the business community within the Province. With the implementation of strategies to enable Labrador and Innu companies in particular to take advantage of these opportunities, many of the potential benefits should accrue to Labrador.

The Business effects of the Project would substantially increase business revenues, capacities and capabilities in the Province. Through business development strategies developed and implemented by Nalcor, Innu Nation and

other Labrador and Newfoundland groups and businesses would have the opportunity to participate in and benefit from the Project. These effects would contribute to improvements in the overall economic health of the Province and to the health and well-being of those individuals involved in the Business sector and their families.

The residual socio-economic effects of S2 and S3 during the construction phase on Business are rated, as was the case for S1 in the EIS, **positive and significant**.

Total operation and maintenance costs for a typical year are approximately $31 million. Therefore, the residual socio-economic effects of S2 and S3 during the operation and maintenance phase are rated, as for S1 in the EIS, **positive and significant**.

The residual adverse socio-economic effects of S2 and S3 on Business during the construction and operation and maintenance phases are rated, as for S1 in the EIS, **not significant.** These residual socio-economic effects are summarized in Table 7-12.

Table 7-12 Summary of Residual Socio-economic Effects on Business (reproduced from Volume III, Table 3-17 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic Extent	Labrador/Province	Labrador/Province
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions of criteria are provided in Section 3.7.2 Methods explained in Volume IA, Chapter 9		

The cumulative socio-economic effects of S2 and S3 on Business are considered significant because the current levels of the measurable parameters (e.g., number of businesses, value of contracts secured) will increase as a result of Project activities. Any such increases are beneficial to the health of the individual businesses involved and the overall economic health of Labrador and the Province as a whole would be enhanced. These effects are summarized in Table 7-13.

Table 7-13 Summary of Residual Cumulative Socio-economic Effects for Business (reproduced from Volume III, Table 3-18 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Increase	Increase
Geographic extent	Labrador/Province	Labrador/Province
Duration/frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and significant	Positive and significant
Likelihood	Not applicable	Not applicable
Notes: Definitions of criteria are provided in Section 3.7.2 Methods explained in Volume IA, Chapter 9		

The cumulative socio-economic effects of S2 and S3 during the construction, and operation and maintenance phases, in combination with other projects and activities, on Business are **positive and significant**.

The adverse cumulative socio-economic effects of S2 and S3, in combination with other projects and activities, on Business are **not significant**.

7.11.4 Effects Management Measures

To enhance economic opportunities in Labrador specifically, and the Province generally, Nalcor will implement an industrial benefits planning approach that will use a variety of employment and business strategies. These, together with elements of the IBA now being negotiated between Nalcor and Innu Nation, will help the Project have a significant and positive socio-economic effect on Economy, Employment and Business in Labrador specifically, and for the Province generally. These measures are planned for the Project as a whole and are not related to sequencing of Project phases.

7.12 Accidents and Malfunctions

The likely environmental effects resulting from an accident or malfunction for S2 and S3 would remain the same as those assessed for S1 in Volume III, Section 7.4 and IR# JRP.145. The same Project infrastructure would be in place, and therefore the potential for dam failure, forest fire, other fires, accidents related to waste management and disposal and hazardous material spill is still present. Nalcor would have the same response measures in place, regardless of the sequencing of Project phases.

7.13 Monitoring and Follow-up

Monitoring and follow-up (Table 7-14) will be as discussed in the EIS Volume III, Section 3.9. The change in Project sequencing would have no effect on the monitoring and follow-up of Project socio-economic effects.

Table 7-14 Proposed Monitoring and Follow-up Programs – Economy, Employment and Business (reproduced from Volume III, Table 8-3, of the EIS)

Objectives	Characteristic to be Monitored	Monitoring Program
Economy		
Measure proportion of Project expenditures made within the Province and Labrador	Project expenditures by amount, type, location and type of contractor (e.g., Aboriginal/non-Aboriginal)	Data collected and compiled by Nalcor and reported to government on a quarterly basis
Employment		
Measure proportion of Project employment involving residents of Newfoundland and Labrador	Project employment by number employed, location of primary residence, occupational category, gender, Aboriginal status	Data collected and compiled by Nalcor and reported to government on a quarterly basis through exit interviews
Business		
Measure proportion of Project expenditures to Newfoundland and Labrador businesses	Project expenditures to businesses by amount, location and type (e.g., sector; Aboriginal/non-Aboriginal)	Data collected and compiled by Nalcor and reported to government on a quarterly basis

8.0 COMMUNITIES

8.1 Introduction

The analysis presented in this chapter is based on the Environmental Impact Statement (EIS), Volume III, Socio-Economic Assessment, Chapter 4.0, responses to relevant IRs, and the description of S2 and S3. The socio-economic effects on Communities, both adverse and positive will derive largely from the Project's economic effects through employment, demands on business, services and social and physical infrastructure. As such the VEC is particularly closely linked to the Economy, Employment and Business (Volume III, Chapter 3 of the EIS and Section 2 of this report) and Land and Resource Use (Volume III, Chapter 5 of the EIS and Chapter 9 of this report) VECs.

8.2 Key Indicators

The KIs selected for assessing the changes in sequencing of Project phases relative to the Communities VEC are the same as for S1 and as outlined in Volume III, Section 4.3 of the EIS, i.e.:

- Physical Infrastructure and Services, including:
  - transportation, power, communications;
  - water, sewer and waste;
  - industrial and commercial real estate; and
  - municipal planning and services.
- Social Infrastructure and Services, including:
  - security (policing and fire protection);
  - education; and
  - housing and accommodation.
- Community Health, including:
  - income, employment and social status;
  - health services;
  - personal health practices and coping skills;
  - healthy child development;
  - social environment and social support networks; and
  - physical environments.

8.3 Measurable Parameters

The main drivers of change in communities affected by the Project during both construction and operation and maintenance continue to be expenditures on goods and services, labour and transportation. This is the case for S1 and any changes in sequencing of Project phases (S2 and S3). While in some cases these factors will affect Communities directly, some changes to infrastructure and services will occur indirectly through the pathway of demographic change and specifically through in-migration to the Upper Lake Melville area.

8.3.1 Physical Infrastructure and Services

The parameters used as the basis for measuring effects of the changes in the sequencing of Project phases relative to system capacities for Physical Infrastructure and Services are the same as those for S1, as described in the EIS Volume III, Section 4.5.1 (Table 8-1).

Table 8-1 Measurable Parameters for Physical Infrastructure and Services (reproduced from Volume III, Table 4-2 of the EIS)

Key Indicator	Measurable Parameter
Physical Infrastructure and Services	Roads-design capacity (i.e., number of vehicles per hour)
	Port – maximum load that can be transferred from vessel to dock (i.e., carrying capacity in tonnes)
	Airport – Passenger terminal design capacity (i.e., number of passengers per annum)
	Water/Sewer– design capacity (i.e., capability of servicing normal demands of a given population)
	Power – design capacity (i.e., load (MW))
	Communications – design capacity (i.e., number of persons capable of being served)
	Waste – design capacity of landfill site (i.e., life expectancy in years based on current use levels)
	Industrial and commercial real estate – available industrial and commercial real estate (hectares)

8.3.2 Social Infrastructure and Services

The measurable parameters selected for measuring effects of the changes in the sequencing of Project phases relative to Social Infrastructure and Services are the same as those for S1, as described in the EIS Volume III, Section 4.6.1 (Table 8-2).

Table 8-2 Measurable Parameters for Social Infrastructure and Services (reproduced from Volume III, Table 4-4 of the EIS)

Key Indicators	Measurable Parameter
Social Infrastructure and Services	Security – Police Officer/population ratio – Fire, Number of calls requiring a response
	Education – Teacher/student ratio – Design capacity (i.e., students/school)
	Housing and Accommodations – Building lot availability

8.3.3 Community Health

The measurable parameters selected for measuring the effects of the changes in the sequencing of Project phases relative to the Community Health KI are also the same as those adopted for S1, as described in the EIS Volume III, Section 4.7.1 (Table 8-3).

Table 8-3 Measurable Parameters for Community Health (reproduced from Volume III, Table 4-6 of the EIS)

Key Indicators	Measurable Parameter
Community Health	Health Services - capacity (e.g., doctor/population ratio; nurse/population ratio; beds available per 1,000 population)
	Physical Environments - level of methylmercury in humans

8.4 Criteria for Describing Socio-economic Effects - Communities

For S2 and S3, the same criteria for describing the socio-economic effects of the Project on Physical Infrastructure and Services, Social Infrastructure and Services and Community Health are used as in the EIS Volume III, Sections 4.5.2, 4.6.2 and 4.7.2. For both Physical and Social Infrastructure and Services these are:

- nature: the ultimate long-term socio-economic effects of the Project on the Physical Infrastructure and Services.
  - positive
  - neutral
  - adverse
- magnitude: the Project-related pressures (level of demand) on the physical infrastructure, social service, or heath systems.
  - low: within the capacity of system
  - moderate: exceeds capacity of system, but can be mitigated through normal planning procedures
  - high: exceeds system capacity, requires major investment to meet demands
- geographic extent: the physical area affected by the Project.
  - Assessment Area
  - regional: central and western Labrador
  - Labrador
- frequency: the number of times a socio-economic effect will occur.
  - not likely to occur
  - occurs once
  - occurs sporadically at irregular intervals
  - occurs on a regular basis and at regular intervals
  - continuous
- duration: the period of time over which the socio-economic effect will occur.
  - construction phase
  - operation and maintenance phase
- level and degree of certainty of knowledge.
  - low: low level of certainty
  - moderate: moderate level of certainty
  - high: high level of certainty
- likelihood.
  - unlikely: significant adverse socio-economic effect not likely to occur
  - likely: significant adverse socio-economic effect likely to occur

The criteria for Community Health, as used in the EIS, differ from the above in respect to magnitude and duration. For this KI these two criteria are defined as follows:

- magnitude: the Project-related pressures (level of demand) on the physical infrastructure, social service, or heath systems.

  - low: status of determinants remain at or near existing levels
  - moderate: status of determinants change from existing levels over the short to medium term
  - high: status of determinants change from existing levels for the long term or permanently
- duration: the period of time over which the socio-economic effect will occur.
  - short term: 0 to 2 years
  - medium term: 3 to 25 years
  - long term: 26 to 40 years
  - permanent

8.5 Determination of Significance

As in the EIS (Volume III, Sections 4.5.3 and 4.6.3), a significant adverse residual socio-economic effect from the Project to both the Physical and Social Infrastructure and Services KIs is one when demands from the Project exceed the existing capacity of the system on an ongoing and consistent basis during the life of the Project. A significant positive residual socio-economic effect from the Project occurs when system changes result in long-term improvement in the capacity of the infrastructure component or the quality of the associated service.

In the case of Community Health (EIS Volume III, Section 4.7.3) a significant adverse residual socio-economic effect on Community Health is likely to result when the socio-economic effects of the Project lead to a deterioration of the determinants of health on an ongoing and consistent basis during the life of the Project such that Community Health or delivery of health services cannot be effectively managed on a regular basis. A significant positive residual socio-economic effect will result when there are improvements to Community Health determinants such that Community Health or delivery of health services is more effectively managed.

8.6 Potential Interactions

The changes in sequencing of Project phases would not change the scope of Project activities or the potential interactions of these activities with Physical or Social Infrastructure and Services or Community Health, as presented for S1 in Section 4.4 of Volume III of the EIS (Table 8-4).

Table 8-4 Interactions of the Project with the Key Indicators for Communities (reproduced from Volume III, Table 4-1 of the EIS)

Project Activities/ Physical Works	Key Indicator		
	Physical Infrastructure and Services	Social Infrastructure and Services	Community Health
Construction			
Expenditures	0	2	2
Employment	2	2	2
Transportation and Road Maintenance	2	2	2
Operation and Maintenance			
Water Management and Operating Regime	0	0	2
Expenditures	0	0	1
Employment	2	1	2
Transportation/Presence and Maintenance of Access Roads	2	0	2
Accidents and Malfunctions[A]			
Dam Failure	2	2	2
Forest Fire	2	2	2

Table 8-4 Interactions of the Project with the Key Indicators for Communities (continued)

Project Activities/ Physical Works	Key Indicator		
	Physical Infrastructure and Services	Social Infrastructure and Services	Community Health
Key:			
0 No measurable interaction will occur. Assessment of socio-economic effects is not required			
1 Identified interactions that are well understood, are subject to prescribed environmental protection measures or normal regulatory processes, and/or which can be mitigated/optimized through the application of standard socio-economic management measures and practices. Based on past experience and professional judgement, the potential socio-economic effects resulting from these interactions are rated not significant			
2 Identified interactions that may result in more substantive socio-economic effects and/or public or regulatory concern. These interactions require more detailed analysis and consideration in the environmental assessment, in order to predict, mitigate and evaluate potential socio-economic effects			
[A] Accidents and malfunctions are assessed in Chapter 7			

8.7 Existing Knowledge

The literature on hydroelectric projects and communities, construction projects and communities, commute work and communities, the in-migration of construction workers, methylmercury in the environment and approaches to socio-economic effects management are summarized for S1 in the EIS in Volume III, Section 4.2. No material published since these reports were written contributes any substantial new understanding or insights that would result in changes to the assessment of Project effects or their management.

8.8 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases - Physical Infrastructure and Services

8.8.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases

The Project activities ranked as 2 (see Table 8-4 above) in the EIS contributing to this socio-economic effect are expenditures, employment and transportation and road maintenance during construction, and transportation / presence and maintenance of access roads during operation and maintenance. The potential socio-economic effect on Physical Infrastructure and Services is change in ability to deliver physical infrastructure and services.

Following a detailed review of Project Components (Table 2-1), there are no changes associated with the construction of S2 or S3, in comparison to S1 in the EIS. Therefore, there are no expected changes to the demands to deliver physical infrastructure and services compared to S1

While the schedule changes associated with S2 and S3 may change the temporal characteristics of the effects, overall the effects are expected to be the same in terms of their nature, geographic extent, frequency, duration, certainty and likelihood.

8.8.2 Change in Project Effects – Physical Infrastructure and Services

Under both S2 and S3, Happy Valley-Goose Bay would still be the hub through which personnel and most of the materials and equipment required for the Project would move during the construction phase. While activity sequencing and timing may affect patterns of use of Physical Infrastructure and Services during this phase, no substantial differences in Project effects are expected under S2 and S3.

Under all sequencing of Project phases, the number of people directly involved during operation and maintenance is relatively small compared with those involved in construction. Few demands would be placed on

local Physical Infrastructure and Services during the operation and maintenance phase. Given that any required improvements to the infrastructure in question would have been made to accommodate construction, any socio-economic effects experienced during operation and maintenance would be well within the capacity of the systems affected.

The effects on individual physical infrastructure components during construction under S2 and S3 are briefly reviewed below.

Airport

Non-local workers would arrive and leave through Happy Valley-Goose Bay by air; S2 and S3 may modify the timing of peak demand, but not the level or total duration of demand. In the case of S3, this would include a temporal gap of indeterminate length during which there would be no such construction-related demand. For all contemplated sequences of Project phases, the Project would measurably increase demand on infrastructure and services at the Goose Bay Airport. While the runway and other airport infrastructure are adequate to meet any anticipated increased needs, the passenger terminal at Goose Bay Airport is currently operating at three times its original design capacity. To meet potential demands from new projects in Labrador, work has started on an expansion and upgrading that will allow the terminal to accommodate an annual flow of over 100,000 passengers by the end of 2011, with further expansion capabilities incorporated into the design.

Port

S2 and S3 would not place any different demands on the Port of Goose Bay and hence the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS. The existing dock would still require upgrading to handle the heavy loads associated with the Project, and Nalcor will liaise with the planning authorities and be involved to the extent necessary to upgrade the dock.

Roads

Workers would arrive at Goose Bay Airport on regularly scheduled flights or chartered aircraft. Buses would meet flights and transport workers to the construction sites. Under S2 and S3, bus movements transporting workers from Goose Bay Airport to the site through Happy Valley-Goose Bay and along the TLH would still involve about five trips per day and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

S2 and S3 would result in a change in the schedule of requirements for materials and equipment moving between the Port of Goose Bay and the construction sites. In the case of S3, this would include a temporal gap of indeterminate length during which there would be no such activity. However over the life of the construction activity the estimated peak requirements are not expected to change, and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

S2 and S3 would not result in any additional demands on the TLH, Black Rock Bridge or the Quebec North Shore and Labrador Railway, and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

Water Supply

S2 and S3 would not place any different demands on the water supply system, other than a lull / lag in requirements in the case of S3, and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

Sewerage

S2 and S3 would not place any different demands on the sewerage system, other than a lull/lag in requirements in the case of S3, and the effects are as assessed in Section 4.5.5.1 of Volume III of the EIS. In October 2010 the

Town of Happy Valley - Goose Bay registered a proposed new sewage treatment plant with the Environmental Assessment Division of the provincial Department of Environment and Conservation, with a view of starting construction in June 2011 and completing it by the end of 2012. The proposed plant will meet the needs of 18,000 people, approximately twice the population currently served.

Landfill

S2 and S3 would not place any additional demands on the landfill and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

Commercial and Industrial Land

The amount of commercial and industrial land required for the Project in Happy Valley-Goose Bay under S2 is not expected to change, and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS. In the case of S3, the level of interest companies have in establishing or expanding operations in Happy Valley-Goose Bay would depend in part on the duration and certainty of construction-related business. An indeterminate temporal gap between the construction of Muskrat Falls and Gull Island may diminish companies' willingness to invest in Happy Valley-Goose Bay, resulting in reduced demand for commercial and industrial land. The degree to which this is the case would depend on the length of the gap and the perceived certainty of Gull Island construction subsequently proceeding. The longer the gap, and the less certain business-people are that Gull Island will proceed, the smaller the likely amount demand for commercial and industrial land.

Power Supply

S2 and S3 would not alter the potential demand from the Project and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS. Any incremental demand from the Project will be met through the provision of additional equipment and will not affect Nalcor's ability to supply its customers in Upper Lake Melville.

Communications

Communications systems and services in the Upper Lake Melville are provided by the private sector. S2 and S3 would not place any different demands on these systems, other than a lull / lag in requirements in the case of S3, and the effects are as assessed for S1 in Section 4.5.5.1 of Volume III of the EIS.

8.8.2.1 Effects Management

The effects management measures for S2 and S3 remain the same as those described in Section 4.5.5 of Volume III of the EIS. Managing and provision of many of the above infrastructure and service elements is the responsibility of a wide range of government departments and private sector organizations. In the case of all contemplated sequences of Project phasing, Nalcor will consult regularly with the relevant agencies and organizations to provide Project information, and to identify and discuss potential Project-related implications for local infrastructure and services.

S2 and S3 are less demanding from an effects management perspective, relative to S1, because Project-related demands would start with the smaller Muskrat Falls facility before stepping up to the larger Gull Island facility, thereby facilitating the introduction and, as necessary, fine tuning of effects management initiatives.

Nalcor has established a Community Information Centre in Happy Valley-Goose Bay and will continue to provide ongoing information and updates on the Project to local residents, community organizations, businesses and other stakeholders throughout the environmental assessment process and into the Project planning and development. This will further facilitate understanding of the Project and the implications of any Project changes

within the local community and offer an ongoing opportunity for stakeholders to provide feedback on Project plans and activities.

8.8.3 Cumulative Socio-economic Effects

There is a potential for cumulative socio-economic effects to occur where other past, present and reasonably foreseeable future projects or activities use the same community infrastructure and services in the Upper Lake Melville area, and specifically those in Happy Valley-Goose Bay, in the same timeframe as the Project. Other projects that may spatially and temporally overlap the Project are those indicated for S1 in the EIS Volume III, Section 4.5.6, and in the response to IR# JRP.97 (Table 8-5).

Table 8-5 Potential Interactions of Future Projects and Activities on Physical Infrastructure and Services (adapted from Volume III, Table 4-3 of the EIS)

Other Project or Activity	Spatial Overlap	Temporal Overlap
Voisey's Bay Mine/Mill	Mine/Mill workers use the Goose Bay airport	Mine/Mill workers use the Goose Bay airport during the Project construction and operations phases
Labrador West Mining Developments	Use of TLH and QSN&L Railway by Labrador West mining operations	Labrador West operations may result in increased use of transportation infrastructure by the time the Project construction phase commences
NATO Special Forces Training	Military personnel will use many of the same infrastructure and service components in Happy Valley-Goose Bay	Training is presently reduced, but federal implementation of operational activities could overlap with the Project
General Economic and Infrastructural Development in the Upper Lake Melville Area	Infrastructure improvements will occur in the Upper Lake Melville area	Occurs annually, will overlap with construction activity
Commercial Forestry	Large portion of District 19A Management Plan overlaps with the area within which the Project will take place. Main effect will be on traffic on the TLH	Commercial forestry activities will be ongoing during the operations phase of the Project
TLH	Both Phases of the TLH will affect the Upper Lake Melville area and the main Project road transportation corridor to the west	Expected to be complete by the time the Project needs arise
Additional Transmission	Power distribution will originate at the Generation Facilities. Routing will depend on the market and delivery strategy but those involved in construction will require access to the same infrastructure and services as those involved with the Project (e.g., Labrador-Island link, originating from either Gull Island or Muskrat Falls)	Construction time frames are expected to be within the same time frame as the Project

In the EIS, the socio-economic effects of reasonably foreseeable projects and activities were expected to have little to no overlap with the socio-economic effects of S1 on the capacity of roads, the port, or the airport, in consideration of the planned expansions and upgrading (Volume III, Section 4.5.6). In addition, all of the projects and activities under consideration have, or will have, undergone environmental assessment at some level. As such, each has or will have specific measures designed to manage any potential socio-economic effects. The EIS and responses to IR# JRP.97, IR# JRP.97S and IR# JRP.116 concluded that the magnitude of anticipated cumulative socio-economic effects related to S1 was expected to be low and this would not change under S2 or S3.

8.9 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases – Social Infrastructure and Services

8.9.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases

The Project activities that have been ranked 2 (Table 8-4) contributing to this socio-economic effect are employment, expenditures and transportation and road maintenance during construction. The potential socio-economic effect on this KI is change in ability to deliver Social Infrastructure and Services.

Following a detailed review of Project Components (Table 2-1), there are no changes associated with the construction of S2 or S3, in comparison to S1 in the EIS. Therefore, S2 and S3 do not change the nature of the issues or the approaches to managing those issues from the analysis provided in the EIS (Volume III, Section 4.5.4).

The magnitude of any socio-economic effects still depends primarily on the numbers of workers involved and the proportion of workers and their families that choose to relocate to Upper Lake Melville. While the schedule changes associated with S2 may change the temporal characteristics of the effects, overall the effects are expected to be the same in terms of their nature, magnitude, geographic extent, frequency, duration, certainty and likelihood.

S3 has no overlap between the construction of Muskrat Falls and Gull Island. As a consequence, there are separate, non-overlapping (and potentially non-continuous) employment and business opportunities associated with the construction of each of them, and this would likely result in lower levels of in-migration to Upper Lake Melville. The degree to which this is the case would depend on the length of the gap and the perceived certainty of Gull Island construction subsequently proceeding. The longer the gap, and the less certain people are that Gull Island will proceed, in migration becomes more unlikely and hence Project-related demand for Social Infrastructure and Services decreases.

8.9.2 Change in Project Effects – Social Infrastructure and Services

Under both S2 and S3, Happy Valley-Goose Bay would still be the hub through which personnel for the Project would rely during the construction phase. While activity sequencing and timing may affect patterns of use of Social Infrastructure and Services during this phase, no substantial differences in Project effects are expected under S2 and S3.

Under all sequencing of Project phases, the number of people directly involved during operation and maintenance is relatively small compared with those involved in construction. Few demands would be placed on local Social Infrastructure and Services during the operation and maintenance phase.

The effects on individual social infrastructure components during construction under S2 and S3 are briefly reviewed below.

Security

The accommodation of workers in specific accommodation complexes and construction camps would continue to be a key effects management initiative in S2 and S3, preventing many of the problems associated with worker-community interactions (see EIS Volume III, Section 4.6.5.1). S2 would not place any different demands, and S3 would likely place lesser demands, on security infrastructure and services. As such, the effects remain as assessed for S1 in Section 4.6.5.1 of Volume III of the EIS.

Education

The worksite accommodations strategy during construction would also minimize the in-migration of workers and their families to Upper Lake Melville. Nalcor would work with the Labrador School Board to provide Project information to facilitate its planning process and will participate in programs (if available) promoting the completion of a Grade 12 education. S2 would not place any different demands, and S3 would likely place lesser demands, on education infrastructure and services. As such, the effects are as assessed for S1 in Section 4.6.5.2 of Volume III of the EIS.

Housing and Accommodations

The schedule changes under S2 would not affect the overall Project-related demand for housing and accommodations, and S3 would likely result in reduced demand, and hence the effects are as assessed for S1 in Section 4.6.5.3 of Volume III of the EIS.

8.9.3 Effects Management

The adoption of an on-site accommodations strategy remains a key element in the Project effects management strategy to help minimize in-migration to Upper Lake Melville (see EIS Volume III, Section 4.5.5). In addition, Nalcor will continue to evaluate potential Project-related implications on the use of local, regional and provincial infrastructure and services and will consult regularly with the relevant agencies and organizations to provide Project information and to identify and discuss potential Project-related implications for local Social Infrastructure and Services and ways to address those issues (see EIS Volume III, Section 4.5.5, and the response to IR# JRP.139).

S2 and S3 are less demanding from an effects management perspective, relative to S1, because Project-related demands would start with the smaller Muskrat Falls facility before stepping up to the larger Gull Island facility, thereby facilitating the introduction and, as necessary, fine tuning of effects management initiatives.

The Community Information Centre in Happy Valley-Goose Bay will continue to be used as a means of providing current information and updates on the Project and this will continue throughout the environmental assessment process and into the Project planning and development phases.

8.9.4 Cumulative Socio-economic Effects

The projects and activities that may temporally and spatially overlap with S2 or S3 are the same as those discussed for S1 in the Volume III of the EIS, Section 4.6.6 and in the response to IR# JRP.97 (Table 8-6). No differences in outcomes are expected as a result of the scheduling changes proposed under S2 and S3.

Table 8-6 Potential Interactions of Future Projects and Activities with Social Infrastructure and Services (adapted from Volume III, Table 4-5 of the EIS)

Other Project or Activity	Spatial Overlap	Temporal Overlap
Voisey's Bay Mine/Mill	Mine/Mill workers use the Goose Bay airport, and may use some of the same infrastructure and services	Mine/Mill workers use the Goose Bay airport during the Project construction and operations phases
NATO Special Forces Training	Military personnel will use many of the same infrastructure and service components in Happy Valley-Goose Bay	Training is presently reduced, but federal implementation of operational activities could overlap with the Project
General Economic and Infrastructural Development in the Upper Lake Melville area	Infrastructure improvements will occur in the Upper Lake Melville area	Occurs annually, will overlap with construction activity

Table 8-6 Potential Interactions of Future Projects and Activities with Social Infrastructure and Services (continued)

Other Project or Activity	Spatial Overlap	Temporal Overlap
Additional Transmission	Power distribution will originate at the Generation Facilities. Routing will depend on the market and delivery strategy but those involved in construction will require access to the same infrastructure and services as those involved with the Project (e.g., Labrador-Island link, originating from either Gull Island or Muskrat Falls)	Construction timeframes are expected to be within the same timeframe as the Project

8.10 Socio-economic Effects Assessment of the Changes in Sequencing of Project Phases – Community Health

8.10.1 Potential Socio-economic Effects of the Changes in Sequencing of Project Phases

As discussed in Section 4.7 of Volume III of the EIS, the complexity of Project-Communities interactions means that considerable overlap exists between Community Health and the other KIs, particularly Social Infrastructure and Services. There is also some overlap with Economy, Employment and Business insofar as income and employment are determinants of Community Health. Community Health embraces elements of other over-arching themes including those of culture and family life.

The Project activities that have been ranked 2 (see Table 8-4 above) in the EIS contributing to this socio-economic effect, are: expenditures (construction); employment (construction and operation and maintenance phases); transportation and road maintenance (construction phase); water management and operating regime (operation and maintenance phase); and transportation / presence of access roads (operation and maintenance phase). The potential socio-economic effect on Community Health is a change in the status of Community Health determinants.

Following a detailed review of Project Components (Table 2-1), there are no changes associated with the Project activities relevant to Community Health with the construction of S2 or S3, in comparison to S1 in the EIS. Therefore, there are no significant changes expected in the status of Community health determinants relative to changes in sequencing of Project phases.

While the schedule changes associated with S2 and S3 may change the temporal characteristics of the effects, overall the effects are expected to be the same in terms of their nature, magnitude, geographic extent, frequency, duration, certainty and likelihood.

8.10.2 Change in Project Effects – Community Health

Under S2 and S3 any socio-economic effects on Community Health in the Upper Lake Melville area would still occur primarily during the construction phase or phases as a result of: demands on local community health services to support the construction workforce; local Project employment (including how the individual and family choose to spend new employment income) or the failure to secure such employment; and interactions between the commute workforce and local residents.

Potential socio-economic effects as the result of changes to or potential stress on personal health practices and coping skills would be no different under S2, but the timing of such effects may change due to project sequencing. Measurable Project-related in-migration to Sheshatshiu, Mud Lake or North West River, or

measurable community interaction with the Project in-migrants in these communities, remains unlikely under any scenario.

S3 sees an indeterminate temporal gap between the construction of Muskrat Falls and Gull Island. As a consequence, there are separate and potentially discontinuous employment opportunities. As was discussed in Section 8.9.1, this gap will likely result in lower levels of in-migration to Upper Lake Melville, depending on the length of the gap and the perceived certainty of Gull Island construction subsequently proceeding. The smaller the likely amount of in-migration, the lesser the opportunity for adverse effects due to community-worker interaction, and the lesser the Project-related demand for health and social services.

Potential changes in community health determinants under S2 and S3 are briefly reviewed below. Overall, no significant differences in overall Project effects on Community Health are anticipated.

Income, Employment and Social Status

S2 and S3 would not result in any additional Project effects on issues that relate to income, employment and social status. However, the specific nature of potential effects under S3 depend on the length of the temporal gap between the construction of facilities at Muskrat Falls and at Gull Island, the ability of the individual to secure construction-related employment for both Muskrat Falls and Gull Island, and how the individual responds to or copes with interrupted or shorter-term employment.

Personal Health and Well-Being

Project employment in relation to personal health and well-being is discussed in EIS Volume III, Section 4.7.5.1. The magnitude and direction of Project socio-economic effects on personal health and well-being depend on: the opportunity for employment (EIS Volume III, Section 3.6.5); whether individuals choose to be employed on the Project; and for those who are employed, how income earned from new employment is spent.

Peak employment under S2 would occur later in the Project construction phase due to activity sequencing, but no significant difference in employment or income related effects on Community Health is expected. There would continue to be potential for Project employment to generate a substantial positive socio-economic effect on personal health and well-being through increased income and reduced unemployment.

The potential exists under S3 for Project employment to contribute positively to personal health and well-being, but there is an indeterminate temporal gap in construction-related employment. For some, this gap would mean shorter-term or discontinuous employment, and less opportunity to improve personal health and well-being. For others, who are able to secure employment on the construction of both Muskrat Falls and Gull Island, it would simply mean interrupted employment with no less opportunity to improve personal health and well-being.

Self-esteem

Under S2 there would continue to be opportunity to increase individual and family self-esteem through new employment and income. Peak employment opportunities would be slightly delayed under S2, but the opportunity to generate overall positive outcomes would remain unchanged.

There is a possibility that the potential adverse effects of employment and increased social status on community structure, due to increased income gaps between individuals and families, could be reduced under S2. The delay in peak employment might provide an opportunity for community adjustment to changing community structure as Project activities ramp-up.

The opportunity would remain under S3 to increase individual and family self-esteem through new employment and income. The indeterminate temporal gap in construction-related Project employment might further diminish potential income gaps between individuals and families and associated effects on community structure. However, shorter-term or interrupted employment might reduce positive effects on self esteem. The specific nature and magnitude of such effects would depend on the duration of the gap and on the ability of individuals to secure employment during both phases of construction.

Nalcor's effects management strategies to increase the positive socio-economic effect of local employment on Community Health and to reduce the potential adverse effects associated with how new or increased income is spent are discussed in EIS Volume III, Section 4.7.5.1.

Health Services

S2 would not result in any additional Project effects on issues that relate to health services, and S3 might place lesser demands on health services.

Primary Health Care

Workers would continue to have access to basic health care services and first response emergency services at the accommodation complexes and construction camps. S2 would not place any different demands on primary health care, though the timing of peak demand will be delayed. Under S2 there is an opportunity for the responsible agencies to monitor demand early on, and as Project activity increases, to determine if additional resources are required to confirm that Project-induced stress on existing services can be managed during peak demand. The effects are as assessed in EIS Volume III, Section 4.7.5.2.

With project sequencing and an indeterminate temporal gap in construction-related Project employment, S3 would likely place lesser demands on primary health care. The temporal gap would also provide the responsible agencies opportunity to manage adaptively, monitoring demand for services during the Muskrat Falls construction period to better prepare for any demands on the health care system associated with the construction of Gull Island.

Mental Health, Addictions and Counselling Services

Neither S2 nor S3 would place any different demands on mental health, addictions and counselling services. Peak demand would likely be delayed as a result of changes in the timing of peak employment and any Project in-migration.

Under both S2 and S3 there would be an opportunity for the responsible agencies to monitor demand early on, and as Project activity increases, to determine if additional resources are required to confirm that Project-induced stress on existing services can be managed. The effects are as assessed in EIS Volume III, Section 4.7.5.2.

Child, Youth and Family Protection Services

S2 would not place any different demands on child, youth and family protection services. The timing of peak demand would be delayed as a result of changes in the timing of peak employment and any Project in-migration.

Due to project sequencing and an indeterminate temporal gap in construction-related Project employment, S3 would place lesser demands on child, youth and family protection services. Depending on the length of the gap, and the perceived certainty of Gull Island construction subsequently proceeding, lower levels of in-migration to Upper Lake Melville are likely, thus further reducing any demand on child, youth and family protection services.

Under both S2 and S3 there is an opportunity for the responsible agencies to monitor demand early on, and as Project activity increases, to determine if additional resources are required to confirm that Project-induced stress on existing services can be managed during peak demand. The effects are as assessed in EIS Volume III, Section 4.7.5.2.

Service Delivery

The effects on the delivery of health services would be as assessed in EIS Volume III, Section 4.7.5.2. Existing Provincial investments together with Project mitigation measures directed toward avoidance of anti-social behaviour and adoption of personal health and healthy work place practices are sufficient to manage any changes in the timing of demand on health services under S2. In the case of S3, the indeterminate temporal gap would likely result in lesser demands on service delivery. No further effects management strategies for health services delivery are proposed.

Personal Health Practices and Coping Skills

S2 and S3 would not result in any additional Project effects on issues that relate to personal health practices or coping skills.

Gambling

No change is expected under S2 and S3 in terms of project effects on personal health practices and coping skills in relation to gambling, in particular problem gambling. The specific nature of effects under S3 depends in part on how an individual securing employment during the construction of Muskrat Falls might respond, behaviourally, to shorter-term or interrupted employment. S2 and S3 would not place any new or different demands on available counselling and support services in the Upper Lake Melville area. Effects are assessed in EIS Volume III, Section 4.7.5.3.

Alcohol and Substance Abuse

Alcohol and substance abuse are existing problems in the Upper Lake Melville area, and in particular amongst the Innu population of Sheshatshiu. Where an alcohol or substance abuse problem already exists, an increase in disposable income can lead to an increase in alcohol consumption. It is possible that Project-related activities and influences will lead to increased alcohol consumption and substance abuse in the Upper Lake Melville area, but these effects would not be exacerbated under S2. The potential for any additional effects under S3 would depend in part on how an individual securing employment during the construction of Muskrat Falls might respond, behaviourally, to shorter-term or interrupted employment. Effects are assessed in EIS Volume III, Section 4.7.5.3.

Physical Activity

S2 and S3 would not result in any changes in physical activity levels, or place additional demands on physical activity infrastructure. Effects are assessed in EIS Volume III, Section 4.7.5.3.

Work-related Stress

A fixed work schedule and lifestyle changes brought about by commute employment may create short-term stress for some, requiring occasional or ongoing counselling through Employee and Family Assistance Programs. But, no significant difference in work related stress or demand for services would result under S2 or S3.

Some residents of Labrador will experience stress because not all people who would want jobs will be successful in obtaining them. Stress due to the inability to secure employment might increase temporarily under S2, due to Project sequencing and the delay in peak employment opportunities, but would decline as the Project progresses and additional employment opportunities become available.

Stress due to short-term or interrupted employment might increase under S3 due to the indeterminate temporal gap and separate and shorter-term employment opportunities. The specific magnitude of this effect would depend on the length of the gap between construction activities, individual behaviour and response to employment interruption, and on the ability to secure employment during the construction of both Muskrat Falls and Gull Island.

Overall, no significant difference is expected under S2 and S3 in terms of the effects of employment and commute work on work-related stress. Effects are assessed in EIS Volume III, Section 4.7.5.3.

Healthy Child Development

S2 and S3 would not result in any additional or different Project effects on issues that relate to healthy child development.

Teenage Pregnancies and Sexually Transmitted Diseases

Effects on teenage pregnancy rates and sexually transmitted diseases are assessed in EIS Volume III Section 4.7.5.4. However, it is possible that the indeterminate temporal gap under S3 would lessen the opportunity for adverse effects associated with community-worker interaction due to potentially lower levels of in-migration to Upper Lake Melville.

Social Environments and Social Support Networks

S2 and S3 would not result in any additional or different Project effects on issues that relate to social environments and social support networks.

Preservation of Language and Culture

Effects on Innu language would be not expected to be significantly different under S2 or S3, and are assessed in EIS Volume III, Section 4.7.5.5.

Traditional Lifestyle

Increased employment and income might have both positive and adverse socio-economic effects on traditional lifestyle. These effects would not be different under S2 or S3 compared to S1 and are assessed in EIS Volume III, Section 4.7.5.5.

Physical Environments

Methylmercury in Fish as a Result of the Project

Predicted peak methylmercury concentrations have been calculated for seven fish species from the lower Churchill River (see the response to IR# JRP.156 and IR# JRP.166). The change in construction sequencing will not result in changes to modelled peak methylmercury levels in fish because the same area will be inundated. Therefore, there is no anticipated change to the potential need for consumption advisories as a result of change in construction sequence. Consumption advisories will be updated prior to inundation based on the results of the Human Health Risk Assessment (HHRA).

As indicated in Volume III, Section 4.8.3 of the EIS and regardless of the construction sequencing, Nalcor will continue to augment baseline data on the methylmercury exposure of the local human population before the reservoirs are impounded, and monitor mercury levels in fish in the reservoirs and downstream of the reservoirs. The extent of monitoring is discussed in greater detail in IR# JRP.166.

The residual adverse socio-economic effects resulting from elevated mercury levels will still be mitigated through the development and posting of consumption advisories where monitoring data and HHRA deem prudent and precautionary.

8.10.3 Cumulative Socio-economic Effects

Most cumulative effects on Community Health would be experienced in the Upper Lake Melville area. Other projects and activities that could contribute to cumulative effects on Community Health are the same as those summarized in EIS Volume III Section 4.6.6.

No significant differences in cumulative socio-economic effects on issues related to Community Health are expected under S2 or S3.

There are no cumulative socio-economic effects associated with methylmercury because the other projects and activities do not contribute to methylmercury levels.

8.11 Summary of Change in Residual Socio-economic Effects and Evaluation of Significance

S2 and S3 are projected to have effects on Communities that are consistent with the effects expected under S1. As with S1, there is a high level of certainty associated with the prediction for each of the KIs, given the extent of baseline information and Project information and the understanding of interactions, resulting socio-economic effects, and various effects management measures being taken by Nalcor to optimize positive socio-economic effects.

8.11.1 Physical Infrastructure and Services

Potential adverse socio-economic effects on Physical Infrastructure and Services will result primarily from Project employment and transportation of materials, equipment and people. Demands on such infrastructure and services will not be substantially different under S2 and S3 from those described for S1 in Volume III, Section 4.5 of the EIS and in the response to IR# JRP.17. With respect to Project needs and Physical Infrastructure and Services capacities, any constraints anticipated during the construction phase were identified and these have not changed. With timely planning and action by the relevant authorities, these can be addressed such that the residual socio-economic effects will be as indicated for S1 in the EIS and in the response to IR# JRP.116, **positive and significant**. Residual socio-economic effects on Physical Infrastructure and Services during operation and maintenance are expected to be within the capacities of the various infrastructure and service components, and therefore any further improvements are expected to be minor in comparison. As a consequence, they are rated **positive and not significant**.

There is no likely change in the residual adverse socio-economic effects of S2 and S3 on Physical Infrastructure and Services during the construction and operation and maintenance phases, as assessed for S1 in Section 4.8 of Volume III of the EIS. Therefore they are predicted to be **not significant.**

Residual effects on Physical Infrastructure and Services on both S2 and S3 are summarized in Table 8-7.

Table 8-7 Summary of Residual Socio-economic Effects Assessment for Physical Infrastructure and Services (reproduced from Volume III, Table 4-12 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Positive	Positive
Magnitude	Low	Low
Geographic Extent	Regional	Regional
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Positive and Significant	Positive and Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in Section 4.5.2 Methods explained in Volume IA, Chapter 9		

Most cumulative socio-economic effects on Physical Infrastructure and Services will be experienced during the construction phase or phases of the Project and they will be largely limited to Happy Valley-Goose Bay where the main point of spatial overlap will occur. As discussed for S1 in Volume III, Section 4.8 of the EIS and in the response to IR# JRP.116, with the implementation of appropriate effects management strategies, no significant adverse cumulative effects are anticipated (Table 8-8). Where infrastructure improvements are made (e.g., airport, port and TLH), all projects and users generally could benefit. As such the cumulative socio-economic effects of S2 and S3 in combination with other projects and activities on Physical Infrastructure and Services are not likely to change from those assessed for S1 in Volume III, Section 4.5 of the EIS. Therefore, cumulative effects of both S2 and S3 are likely to be both adverse and positive and **not significant.**

Table 8-8 Summary of Residual Cumulative Socio-economic Effects Significance for Physical Infrastructure and Services (reproduced from Volume III, Table 4-13 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Low	Low
Geographic Extent	Regional	Regional
Duration/Frequency	Construction phase/continuous	Operation and maintenance phase/continuous
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in Section 4.5.2 Methods explained in Volume IA, Chapter 9		

8.11.2 Social Infrastructure and Services

Socio-economic effects on Social Infrastructure and Services will result primarily from employment and any associated in-migration of workers and families to Happy Valley-Goose Bay. The effects on the social

infrastructure and services components discussed for S1 in Volume III, Section 4.6 of the EIS and in the response to IR# JRP.17 will not be substantially different under S2, and effects will likely to be even further diminished under S3, especially if there is a long temporal gap between the construction of Muskrat Falls and that of Gull Island. With appropriate effects management strategies as discussed in the EIS in place, there is no likely change in the residual adverse effect on Social Infrastructure and Services during either the construction or operation and maintenance phases of S2 or S3. Therefore it is predicted to be **not significant**.

A summary of residual socio-economic effects of S2 and S3 on Social Infrastructure and Services is provided in Table 8-9.

Table 8-9 Summary of Residual Socio-economic Effects on Social Infrastructure and Services (reproduced from Volume III, Table 4-14 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase[A]
Nature	Adverse and Positive	--
Magnitude	Low	--
Geographic Extent	Assessment Area	--
Duration/Frequency	Construction phase/continuous	--
Certainty	High	--
Significance	Not Significant	Not Significant
Likelihood	Not applicable	--
Notes: Definitions for criteria are provided in Section 4.6.2 Methods explained in Volume IA, Chapter 9 [A] Detailed effects analysis not warranted; see Section 4.4.1		

Any cumulative socio-economic effects will be experienced during the construction phase of the Project and will be limited to Happy Valley-Goose Bay where the main point of spatial and temporal overlap will occur. With the implementation of the effects management strategies presented for S1 in Volume III, Section 4.8 of the EIS and in the responses to IR# JRP.97, IR# JRP.97S and IR# JRP.163, particularly with respect to managing Project-related in-migration and movement, the cumulative adverse socio-economic effects of S2 and S3 in combination with other projects and activities on Social Infrastructure and Services are both not likely to change and both are therefore **not significant**. A summary of cumulative socio-economic effects of S2 and S3 for Social Infrastructure and Services is provided in Table 8-10.

Table 8-10 Summary of Residual Cumulative Socio-economic Effects Significance for Social Infrastructure and Services (reproduced from Volume III, Table 4-15 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase[A]
Nature	Adverse and Positive	--
Magnitude	Low	--
Geographic Extent	Assessment Area	--
Duration/Frequency	Construction phase/continuous	--
Certainty	High	--
Significance	Not Significant	Not Significant

Table 8-11 Summary of Residual Cumulative Socio-economic Effects Significance for Social Infrastructure and Services (continued)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase[A]
Likelihood	Not applicable	--
Notes: Definitions for criteria are provided in Section 4.6.2 Methods explained in Volume IA, Chapter 9 [A] Detailed effects analysis not warranted; see Section 4.4.1		

8.11.3 Community Health

The main Project driver with the potential to affect Community Health in the Upper Lake Melville area is employment, particularly construction employment. The socio-economic effects of the Project on health determinants are in large part dependent on social responses, health practices and coping skills, and the availability of social support networks, particularly that of the family.

Demands on health services due to worker in-migration discussed for S1 in Volume III, Section 4.7.5 of the EIS, will not be substantially different under S2. Any effects will likely be diminished under S3, especially if there is a long temporal gap between the construction of Muskrat Falls and that of Gull Island. The effects on Community Health discussed for S1 in Volume III, Section 4.6 of the EIS and in the response to IR# JRP.17 will not be substantially different under S2 or S3. With appropriate effects management strategies as discussed in the EIS in place, there is no likely change in the residual adverse effect on Community Health during either the construction or operation and maintenance phases of S2 or S3. Therefore it is predicted to be **not significant**.

Regardless of the construction sequence, increased levels of methylmercury in fish will be monitored, as will the existing methylmercury exposure of local residents. Nalcor will work with government authorities to develop consumption advisories, if required. The change in the construction sequencing will not likely change the residual adverse socio-economic effects of the Project on Community Health during construction, and operation and maintenance, and are therefore rated **not significant**.

A summary of residual socio-economic effects of S2 and S3 on Community Health is provided in Table 8-11.

Table 8-12 Summary of Residual Socio-economic Effects on Community Health (reproduced from Volume III, Table 4-16 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Low to Moderate	Low
Geographic Extent	Assessment Area	Regional
Duration/Frequency	Medium-term/continuous	Long-term to Permanent/Continuous
Certainty	Moderate	Moderate
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in EIS Volume III, Section 4.7.2 Methods explained in EIS Volume IA, Chapter 9		

Cumulative socio-economic effects that involve the Project will be the same as those assessed in Volume III, Section 4.7.6 of the EIS. With the implementation of the appropriate management strategies, particularly with respect to the ways in which earned income from the projects is managed, the cumulative socio-economic effects of the Project in combination with other projects and activities on Community Health are both positive and adverse, but **not significant**. When the cumulative socio-economic effects of several projects result in improvements in the status of particular health determinants, the overall effects will be positive. A summary of the cumulative socio-economic effects on Community Health for S2 and S3 is provided in Table 8-12.

Table 8-13 Summary of Residual Cumulative Socio-economic Effects Significance for Community Health (reproduced from Volume III, Table 4-17 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Low to Moderate	Low to Moderate
Geographic Extent	Assessment Area	Assessment Area
Duration/Frequency	Medium-term/continuous	Long-term/Continuous
Certainty	Moderate	Moderate
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in EIS Volume III, Section 4.7.2 Methods explained in EIS Volume IA, Chapter 9		

8.12 Accidents and Malfunctions

The likely environmental effects resulting from an accident or malfunction for S2 and S3 will remain the same as those assessed for S1 in Volume III, Section 7.5 and IR# JRP.145. The same Project infrastructure would be in place, and therefore the potential for dam failure, forest fire, other fires, accidents related to waste management and disposal and hazardous material spill is still present. Nalcor will have the same response measures in place, regardless of the sequence of construction. Therefore, in the unlikely event of a dam failure, the adverse residual effect would be significant. In the unlikely event of a forest fire or other fire, accidental release of solid or liquid waste, or a hazardous material spill, the adverse residual effect would be not significant.

8.13 Monitoring and Follow-up

Monitoring and Follow-up activities will not change under S2 and S3 from those for S1 as discussed in the EIS (Volume III, Section 4.9) and in the responses to IR# JRP.112, IR# JRP.112S and IR# JRP.163.

8.13.1 Physical Infrastructure and Services

As part of its ongoing monitoring for management strategy, Nalcor will continue to evaluate potential Project-related implications of the use of local, regional and provincial infrastructure and services. This will include direct Project requirements as well as indirect and induced increases in use of and demand for infrastructure and services by Project workers and their families.

8.13.2 Social Infrastructure and Services

Follow-up programs to determine actual outcomes and whether any optimization strategies implemented were effective, will be the responsibility of the agencies and organizations that deliver the Social Infrastructure and Services in question. Such follow-up would, in any event, be part of their normal planning practices. To assist in these decisions, Nalcor will liaise with local authorities and provide updates on Project activities and plans on a regular basis.

8.13.3 Community Health

Under both S2 and S3, peak employment and in-migration would be delayed, resulting in a possible delay in both some positive and some negative effects on Community Health, including the level of worker-community interaction, work-related stress and, in particular, demands on health services. For both S2 and S3 there will be additional opportunity to monitor Community Health as Project activities ramp-up from the smaller Muskrat Falls phase to the Gull Island phase to ensure that programs are effective and that capacity in health services is sufficient to manage any additional demand caused by Project-related effects.

Regardless of the construction sequence, Nalcor will establish a methylmercury exposure baseline for local residents prior to Project commencement for monitoring purposes and will monitor methylmercury levels in fish as the Project becomes operational (Table 8-13). Further details are presented in IR# JRP.166.

Table 8-14 Proposed Community Health Monitoring and Follow-up Programs (reproduced from Volume III, Table 4-18 of the EIS)

Objectives	Measurable Parameters for Assessment	Monitoring Program
Establish Baseline Exposure of Humans to Mercury	Methylmercury	Data collected and compiled by Nalcor prior to Project commencement
Verify Mercury Levels in Fish	Methylmercury	Data collected and compiled by Nalcor on an annual basis for the first 10 years following impoundment, frequency thereafter to be determined pending results

9.0 LAND AND RESOURCE USE

9.1 Introduction

The analysis presented in this chapter is based on the EIS, responses to relevant IRs, the Consultation Assessment Report (CAR) (Nalcor 2010), and the description of S2 and S3 (Chapter 2 of this report). Land and Resource Use is intrinsically linked to both the biophysical and socio-economic environments, including Aquatic Environment (Volume IIA, Chapter 4 of the EIS; Chapter 5 of this report), Terrestrial Environment (Volume IIB, Chapter 5 of the EIS; Chapter 6 of this report), and Communities (Volume III, Chapter 4 of the EIS; Chapter 8 of this report).

The change to effects on Land and Resource Use by residents of Labrador for cultural, traditional, commercial, recreational and subsistence purposes, as a result of changes to sequencing of Project phases (S2 and S3), are assessed. The definition of Land and Resource Use remains the same as defined in Volume III, Section 5.1 of the EIS. The rationale for selecting Land and Resource Use as a VEC remains the same as described in Volume III, Section 5.1 of the EIS.

Construction, operation, and maintenance of both S2 and S3, compared to S1, would result in changing the same amount of terrestrial habitat into aquatic habitat and alter the same areas that are used for Project infrastructure, as described in Volume IIA, Chapter 4 and Volume IIB, Chapter 5 of the EIS. The Project, S2 or S3, may still increase access to areas of the river valley and also affect the health and sustainability of plant, fish and wildlife populations. However, the change is restricted to a reversal in sequencing (S2) and to a reversal in sequencing and interrupted period of construction (S3) and there is no likely change in the effects of the Project on Land and Resource Use as a result of either S2 or S3.

9.2 Existing Knowledge

The literature on potential environmental effects of major natural resource developments on Land and Resource Use is summarized in Volume III, Section 5.2 of the EIS and in the responses to IR# JRP.142 and IR# JRP.143. Known land and resource use of ten Aboriginal groups is summarized in the CAR submitted by Nalcor in September 2010. Since the time the CAR was submitted, Innu Nation has submitted a report on land and resource use to Nalcor (Armitage 2010). Mapped information pertaining to land and resource use from that report is provided in Appendix A. Nalcor has continued and will continue to consult with these and other Aboriginal groups and stakeholders as appropriate.

The effects of the changes resulting from S2 and S3 are assessed for:

- Changes in Fish and Wildlife Habitat and Loss of Hunting / Trapping / Fishing Areas;
- Access;
- Wage-related Effects;
- Health of Fish and Wildlife for Consumption;
- Navigation and Winter Travel;
- Cabin Use;
- Forestry;
- Mineral Lands;
- Special Areas;
- Berry Picking and Medicinal Plants;
- Agriculture; and
- Landscape and River Aesthetics.

9.3 Key Indicators and Measureable Parameters

The rationale for why KIs are not required for this VEC remains the same as that provided in Volume III, Section 5.3 of the EIS.

The measurable parameters used to describe Land and Resource Use and to assess the effects of changes of the sequence of construction remain the same as those presented in Volume III, Section 5.5.1 of the EIS (Table 9-1).

Table 9-1 Measurable Parameters for Land and Resource Use (reproduced from Volume III, Table 5-2 of the EIS)

Valued Environmental Component	Measurable Parameter
Land and Resource Use	Hunting/trapping/fishing: measured by changes in access, fish and wildlife habitat, health of fish and wildlife for human consumption, and hunting/trapping areas Navigation and winter travel: measured by changes in access Recreational use: measured by change in number of cabins Forestry: measured by change in land base available for timber cultivation Mineral lands: measured by changes in area of leased or licensed mineral lands Special areas: measured by changes in number of special areas Berry picking and medicinal plants: measured by changes in berry picking areas and areas with medicinal plants Agriculture: measured by change in quantity of lands zoned for agriculture Landscape/river aesthetics: measured by pre- and post-development aesthetic value

9.4 Criteria for Describing Environmental Effects – Land and Resource Use

Environmental effects are characterized and described using the same descriptors presented in Volume III, Section 5.5.2 of the EIS:

- nature: the long term environmental effects of the Project on Land and Resource Use.
  - adverse
  - positive
  - neutral
- magnitude: the extent of change in Land and Resource Use levels from the baseline state.
  - low: affects a small group of land and resource users
  - moderate: affects less than the majority of land and resource users across multiple activities
  - high: affects the majority of land and resource users across multiple activities
- geographic extent: the physical area within which interactions are expected to occur.
  - site-specific: environmental effects limited to Project footprint
  - local: within the Assessment Area
  - regional: beyond the Assessment Area
- duration: the period of time the environmental effect will occur.
  - short term: zero to two years
  - medium term: three to 25 years
  - long term: 26 to 40 years
  - permanent

- frequency: the number of times the Project will have an environmental effect on Land and Resource Use.
  - not likely to occur
  - occurs once
  - occurs sporadically at irregular intervals
  - occurs on a regular basis and at regular intervals
  - continuous
- reversibility: whether the adverse environmental effects are reversible or irreversible.
  - reversible
  - irreversible
- ecological or social context: the general characteristics of the area with respect to existing levels of human activity in the Assessment Area.
  - undisturbed: area relatively or not adversely affected by human activity
  - disturbed: area has been previously disturbed by human development or human development is still present
- level and degree of certainty of knowledge.
  - low: low level of certainty
  - high: high level of certainty
- likelihood.
  - unlikely: significant adverse environmental effect not likely to occur
  - likely: significant adverse environmental effect likely to occur

9.5 Determination of Significance

The definition of a significant adverse effect on Land and Resource Use remains the same as that presented in Volume III, Section 5.5.3 of the EIS:

- A significant adverse residual environmental effect is defined as one where the proposed use of land for the Project is not compatible with adjacent land use activities as designated through a regulatory land use process or the Project creates a change or disruption that widely restricts or degrades land and resource use to a point where activities cannot continue at or near current levels within the Assessment Area over the long term.

9.6 Potential Interactions

The change in sequencing of Project phases would not result in a change to the Project activities or the potential interactions of these activities with Land and Resource Use, as summarized in Table 5-1 of Volume III. Any Project activity resulting in alterations of, or restrictions to, areas can result in environmental effects on Land and Resource Use. Regardless of the construction sequence,, access, vegetation cover, and velocity of the river could be altered. The only change in physical disturbance is an incremental increase of less than 6 km^2 resulting from widening the interconnecting transmission line corridor by 20 m. The Project-VEC interactions are summarized in Volume III, Section 5.4 of the EIS (Table 9-2).

Table 9-2 Interactions of the Reversal in Sequencing of Construction with Land and Resource Use (reproduced from Volume III, Table 5-1 of the EIS)

Project Activities and Physical Works	Land and Resource Use
Construction	
Upgrading/Constructing Site Access Roads	2
Site Preparation and Construction of Site Buildings	2
Excavation and Installation of Generation Components	2
Concrete Production	0
Transmission Line Construction	2
Site Water Management	0
Camp Operations	2
Vehicular Traffic on Site	2
Quarrying and Borrowing	2
Reservoir Preparation	2
Impounding	2
Employment	2
Transportation and Road Maintenance	2
Expenditures	0
Operation and Maintenance	
Water Management and Operating Regime	2
Operation of Generation Facilities	2
Site Waste Management	0
Inspection/Maintenance, Repairs Along Transmission Line	2
Employment	2
Transportation/Presence and Maintenance of Access Roads	2
Expenditures	0
Accidents and Malfunctions[A]	
Dam Failure	2
Forest Fire	2

Key:
0 No measurable interaction will occur. Assessment of environmental effects is not required
1 Identified interactions that are well understood, are subject to prescribed environmental protection measures or normal regulatory processes, and/or which can be mitigated/optimized through the application of standard environmental protection measures and practices. Based on past experience and professional judgement, the potential environmental effects resulting from these interactions are rated not significant
2 Identified interactions that may result in more substantive environmental effects and/or public or regulatory concern. These interactions require more detailed analysis and consideration in the environmental assessment, in order to predict, mitigate and evaluate potential environmental effects
[A] Accidents and Malfunctions are assessed in Chapter 7

As summarized in Table 2-1, the modifications associated with the construction of S2 or S3, in comparison to S1 in the EIS, are:

- site preparation and construction of site buildings;
- excavation and installation of generation components;
- transmission line construction;
- employment;
- transportation and road maintenance; and
- expenditures.

The transmission configuration and tower heights may change compared to S1. The resultant changes to landscape aesthetics are assessed. None of the other modifications have any effect on Land and Resource Use.

9.7 Environmental Effects Assessment

9.7.1 Potential Environmental Effects of the Change in Construction Sequence

The environmental effect associated with this VEC is change in land and resource use.

The following construction activities have been ranked as "0" as there would be no interaction with Land and Resource Use, regardless of the sequence of construction:

- concrete production;
- site water management; and
- expenditures.

The reasons why these interactions were ranked as "0" is described in Volume III, Section 5.4 of the EIS. The change in sequencing of Project phases would not change the ranking of these interactions.

The remaining Project activities and physical works listed in Table 9-2 would result in potential interactions with Land and Resource Use (i.e., ranked as "2"). Neither the reversal of construction sequence, with overlap and without overlap in construction, would change the ranking of these interactions, and therefore they are further assessed.

9.7.2 Change in Potential Effects

9.7.2.1 Construction

The change in sequencing of Project phases would still result in noise, dust, increased human presence, increased access, loss of habitat and a change to the configuration of the shoreline. S2 and S3 would not likely result in effects different from those assessed in the EIS because the limits of inundation and physical disturbance would remain the same, with the exception of an incremental increase of less than 6 km^2 in the width of the interconnecting transmission line right-of-way. As indicated in the response to IR# JRP.124, a precautionary approach was taken in the EIS where it was assumed that up to 200 km^2 of terrestrial habitat would be lost, which accounts for the area that would be lost due to this increased width.

Hunting / Trapping / Fishing

Change in Wildlife and Fish Habitat

The change in sequencing of Project phases would not result in a change in the area of land that would be inundated (126 km^2), in the length of new or upgraded roads (approximately 375 km), or in the length of new roads that would remain at the completion of construction (approximately 15 to 30 km).

The proportionate loss of wildlife habitat resulting from inundation or infrastructure would not likely change from that described in Volume IIB, Chapter 5 of the EIS and in the response to IR# JRP.9, IR# JRP.65, IR# JRP.93, IR# JRP.124, IR# JRP.126, IR# JRP.154 and IR# JRP.157. The magnitude of environmental effects on wildlife and fish habitat remains as low to moderate. The residual environmental effects on game species distribution are likely to remain as not significant. Regardless of the construction sequence, the creation of the Muskrat Falls and Gull Island reservoirs would lead to a net total increase in fish habitat and use for angled species, as described in Volume III, Chapter 4 of the EIS and in the response to IR# JRP.153. For S3, the length of time between the completion of the Muskrat Falls generation facility and the initiation of Gull Island construction would influence the adverse effects on wildlife habitat. The longer this interim period, the longer the recovery period would be

available for local populations (e.g., alternative habitat) that may be displaced from activity associated with Muskrat Falls before construction begins at Gull Island.

Change in Hunting / Trapping Areas

The change in construction sequence (S2) is not anticipated to result in changes in effects to hunting / trapping areas or to hunting and trapping, as assessed in Volume III, Section 5.5.5.1 (i.e., hunting and trapping may shift from areas of current activity to adjacent areas that will be more accessible after the reservoirs are inundated; potential for increased travel time to alternate harvesting areas and subsequent increased harvesting costs). Regardless of the construction sequence, other than intermittent interruptions to access during construction, loss of access to any given area is anticipated to be minimal.

As described in Volume III, Section 5.6.1.1 of the EIS and in the response to IR# JRP.110, if an established trap line is lost due to reservoir impoundment, Nalcor will compensate trappers who can demonstrate continual and successional use. Prior to inundation and regardless of construction sequencing, Nalcor will make community announcements and will post notices in the impoundment area warning of the time and nature of the flooding.

Change in Access

Access requirements for the Project for S2 and S3 are the same as S1.

The effects management measures for changes in access will remain as described in Volume III, Section 5.5.5.1 (Change in Access) and be applied to the Project with the change of construction sequence. For example, a no-harvesting policy for the construction labour force will still be in place. As outlined in Volume III, Section 5.5.5.1 (Change in Access) and in the responses to IR# JRP.72 and IR# JRP.164, increased access may eventually require increased management and enforcement by responsible authorities.

Wage-related Change in Opportunity for Hunting / Fishing / Trapping

There is no change resulting from S2 and S3 construction sequences. The effects management measures for wage-related effects will remain as described in Volume III, Section 5.5.5.1 (Wage-related Change in Opportunity for Hunting / Fishing / Trapping) and be applied to the Project with the reversal in construction sequence.

Health of Fish and Wildlife for Human Consumption

Contamination of fish and wildlife from methylmercury would not occur as a result of Project construction activities, regardless of the construction sequence. In the period of time between inundation of the Muskrat Falls reservoir and completion of Gull Island construction, which will vary for S2 to S3, there could be elevated levels of methylmercury in fish in the Churchill River. However, the magnitude of peak methylmercury is not predicted to change for S2 or S3 compared to S1.

Navigation (Vessel / Boat Traffic) and Winter Travel

For S2 and S3, the effects on navigation and winter travel would remain the same as those assessed in Volume III, Section 5.5.5.1 of the EIS because the area that would be inundated remains the same.

Regardless of the construction sequence, the effects management measures will remain the same as described in Volume III, Section 5.5.5.1 (Navigation and Winter Travel) of the EIS and will be applied to the Project with the reversed sequence. For example, lost boat launch points will be replaced.

Cabin Use

The area that would be inundated would remain the same as that assessed in the EIS. Twelve of the 22 cabins identified along the lower Churchill River would be affected by reservoir preparation and impounding, regardless of construction sequence. The increase in the right-of-way width would not affect cabin use.

Forestry

Both S2 and S3 would still result in the inundation of 126 km^2 of terrestrial habitat – the same as S1. In combination with the increased right-of-way width, this still represents less than one percent of FMD 19A. The effects would not change as a result of the reversal in change in sequencing of Project phases.

Mineral Lands

Both S2 and S3 would not change the predicted effects to mineral lands as assessed in Volume III, Section 5.5.5.1 of the EIS because the area that would be inundated would remain the same. The increase in the right-of-way width would not affect mineral lands.

Special Areas

The limits of reservoir impoundment would not change as a result of the change in sequencing of Project phases, and therefore, the effects predicted to occur on ashkui in Volume III, Section 5.5.5.1 of the EIS and in the response to IR# JRP.48 and IR# JRP.154 would not change. The subsequent effects on wildlife would not likely change from that presented in Volume IIB, Chapter 4 of the EIS because the area of inundation would remain the same. The increase in the right-of-way width would not affect special areas.

Berry Picking and Medicinal Plants

Both S2 and S3 would not change the likely effects on berry picking and medicinal plants as assessed in Volume III, Section 5.5.5.1 of the EIS and in the responses to IR# JRP.70 and IR# JRP.70S because the same areas would be inundated. Although the increased width of the right-of-way would result in the removal of habitat (less than 6 km^2), the increase is incremental only and new areas would not be accessed or disturbed.

As outlined in the EIS and in response to IR# JRP.103, Nalcor will relocate Canada yew plants to suitable sites outside the area that will be inundated for re-establishment.

Agriculture

There are currently no areas designated for Agricultural Crown Reserve, nor are farms operating in the Assessment Area. Therefore, there would be no interaction with the Project and no environmental effect with this land use.

Landscape / River Aesthetics

There would be no likely changes to the effects on landscape / river aesthetics during construction as assessed in Volume III, Section 5.5.5.1 of the EIS, regardless of construction sequence.

9.7.2.2 Operation and Maintenance

Activities associated with the operation and maintenance phase would not change from that described and assessed in Volume III, Section 5.5.5.2 of the EIS. Similarly, inspection and maintenance activities along the

transmission line, including vegetation management activities, would not change from that described in Volume IA, Section 4.5.3 of the EIS.

Hunting / Trapping / Fishing

Change in Fish and Wildlife Habitat

During the operation and maintenance phase, altered flow velocity and water levels resulting from impoundment and water management would remain the same as that assessed for S1. Compared to the construction phase, there would be no further effects to fish and wildlife habitat in the operation and maintenance phase, regardless of the construction.

Hunting / Trapping Areas

There would be no further loss of hunting / trapping areas as a result of the Project, regardless of the construction sequence.

Health of Fish and Wildlife for Human Consumption

The effects on health of country food, particularly fish, for human consumption would likely not change as a result of a change in construction sequencing, because the same area will be inundated. Please refer to the response to IR# JRP.166 for more information on mercury in fish.

The magnitude of the peak, and duration of elevated methylmercury in fish in the Churchill River is not predicted to change for S2 or S3 compared to S1. For S3, depending on the length of time between inundation of the Muskrat Falls reservoir and inundation of the Gull Island reservoir for S3, there could be an increased length of time where elevated levels of methylmercury in fish in the Churchill River will exist. Consumption advisories will be updated prior to inundation and during operation of the reservoirs, based on the results of the HHRA, further baseline augmentation, and a follow-up/monitoring program.

Change in Access

S2 and S3 would not affect the change in access during the operation and maintenance phase, as assessed in Volume III, Section 5.5.5.2 of the EIS. New access roads would be limited to 15 to 30 km in length, representing minimal increased access. Regardless of construction sequence, there is some potential for increased snowmobile traffic, which could increase the opportunity for trapping and hunting between the TLH Phase I and the reservoirs. The issue of increased access and activity in the region would still require enforcement by regulatory and resource management agencies so that any such activity is undertaken responsibly and sustainably and/or that additional areas are designated for conservation and protection. Modified licensing policies may still be necessary.

Wage-related Changes in Opportunities for Hunting / Fishing / Trapping

Due to a decrease in employment during operation and maintenance as compared to the construction phase, the environmental effects of wage-related opportunities would remain very low in magnitude regardless of sequence. Depending on the length of time between completion of Muskrat Falls and initiation of Gull Island construction for S3, there could be increased levels of employment during the operation and maintenance phase of Muskrat Falls where it overlaps with the construction of the Gull Island facilities. However, the increased level of employment would still be associated with construction.

Navigation (Vessel / Boat Traffic) and Winter Travel

The change in sequencing of Project phases would not change the over-all depths of the reservoirs or the velocity of the river as assessed in the EIS (Volume IIA, Chapter 4). The Gull Island and Muskrat Falls reservoirs would still have slower moving water with reduced variation in velocities and a general deepening of water towards each powerhouse, resulting in improved navigability. During operation and maintenance, boating activities within the reservoirs could still increase during ice-free seasons due to improved navigability. Depending on the length of time between completion of Muskrat Falls and initiation of Gull Island construction for S3, there could be a delay in increased navigability on the Gull Island reservoir as compared to S1 and S2.

Regardless of the construction sequence, the effects management measures will remain the same as described in Volume III, Section 5.5.5.2 (Navigation and Winter Travel) of the EIS and will be applied to the Project with the change in sequencing. For example, trees will be removed from the reservoir to reduce hazards to navigation from flooded vegetation.

The change in construction sequence (S2) would result in the same delay in ice freeze-up in the fall and ice break-up in the spring in the area of Mud Lake as was indicated in the response to IR# JRP.71. If Muskrat Falls is operating prior to the construction of the Gull Island generation facility (S3), this predicted delay in ice freeze-up in the fall and ice break-up in the spring would be reduced. Nalcor will establish ice monitors and public advisories regarding the status and safety of the reservoir ice and downstream from Muskrat Falls to Mud Lake.

Landscape / River Aesthetics

For S2, there would be no likely changes to the effects on river aesthetics during operation and maintenance as compared to S1 as assessed in Volume III, Section 5.5.5.2 of the EIS, and illustrated in Figures 5-1 to 5-9. Depending on the length of time between completion of Muskrat Falls and initiation of Gull Island construction for S3, there could be a delay in changes in river aesthetics at Gull Island as compared to S1 and S2. The transmission line re-configuration associated with S2 and S3 would result in a slight change in effects to landscape aesthetics as compared to S1 in the response to IR# JRP.16. There would be two lines for the full length of the corridor. The towers would still be lattice steel-type towers but would be no higher than those described for S1 along the Gull Island to Churchill Falls section. The tower height along the Muskrat Falls to Gull Island section would remain the same as compared to S1.

9.7.3 Cumulative Environmental Effects Analysis of the Change in Sequencing of Project Phases and Effects Management

Although the time when cumulative effects may occur could shift as compared to S1, the results of the cumulative environmental effects analysis as presented in Volume III, Section 5.5.6 of the EIS and in the responses to IR# JRP.97, IR# JRP.97S and IR# JRP.163 would not likely change as a result of the reversal in construction sequence or interruption in construction. The same Project activities and interactions would occur, albeit in a reversed order and interrupted for S3. The other past, present and reasonably foreseeable future projects or activities that are likely to spatially and temporally overlap with the Project remain the same as those assessed in Volume III, Section 5.5.7 of the EIS.

Ongoing and likely future projects and activities that could act in combination with the Project to result in cumulative environmental effects (i.e., change in use of land and resources) remain the same as those identified in Volume III, Section 5.5.7 of the EIS (Table 9-3).

Table 9-3 Potential Interactions of Future Projects and Activities with Land and Resource Use (adapted from Volume III, Table 5-3 of the EIS)

Project or Activity	Spatial Overlap	Temporal Overlap
NATO Special Forces Training	A large portion of the Assessment Area is within the training area	Expected to continue yearly, but at a low to modest level. Most aviation training occurs during April to October, but ground exercises may occur throughout the year
Labrador West Mining Developments	Increased use of snowmobile trails between Labrador West and HVGB due to increased population	Overlap is from 2010 onwards
Commercial Forestry	A large portion of District 19A Management Plan overlaps with the Assessment Area. Increased logging will provide increased access for hunting. Forestry operations will also result in environmental effects on terrestrial habitat and wildlife populations	Commercial forestry activities will occur while the Project is in operation
TLH	Increased access for land and resource use generally. Construction would also affect habitat for wildlife populations	Scheduled for completion in 2009. Will operate year-round
Additional Transmission	Power distribution will originate within the Assessment Area, and routing will depend on the market and delivery strategy (e.g., Labrador-Island link, originating from either Gull Island or Muskrat Falls)	Will operate year-round

The management and mitigation commitments that Nalcor has made in Volume III, Section 5.5.7 of the EIS will not change as a result of the change in sequencing of Project phases. The temporal overlap for Labrador West Mining Developments has changed from 2010 to the year of Project start-up. The TLH Phase 3 has been completed.

9.8 Summary of Change in Residual Environmental Effects and Evaluation of Significance

9.8.1 Effects Management Measures

The environmental effects management measures presented in Volume III, Section 5.6.1 will not change as a result of changes in sequencing of Project phases.

9.8.2 Change in Residual Environmental Effects Analysis

9.8.2.1 Construction

Regardless of the sequence of construction, the residual adverse environmental effect of the Project on Land and Resource Use during construction of S2 or S3 remains **not significant** (Table 9-4). This conclusion is the same as was identified for S1 in the EIS.

Table 9-4 Summary of Residual Environmental Effects Assessment for Land and Resource Use (reproduced from Volume III, Table 5-4 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Moderate	Low

Table 9-4 Summary of Residual Environmental Effects Assessment for Land and Resource Use (continued)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Geographic Extent	Local	Local
Duration / Frequency	Medium-term to Permanent/Continuous	Permanent/Continuous
Reversibility	Irreversible	Irreversible
Ecological or Social Context	Undisturbed/Disturbed	Disturbed
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in Section 5.5.2 Methods explained in Volume IA, Chapter 9		

9.8.2.2 Operation and Maintenance

Regardless of the construction sequence, most of the Project's environmental effects on Land and Resource Use would occur initially during construction and continue during operation. Therefore, additional changes to land and resources use patterns during operation as compared to construction would still be minimal. Operation would still result in methylmercury accumulation in fish and potentially a recommended consumption advisory. The only change in the criteria is that the duration for consumption advisories may increase for S3, depending on the length of time between the completion of construction at Muskrat Falls and the initiation of operation at Gull Island. Based on this, and the application of effects management measures, the residual adverse environmental effect of the Project on Land and Resource Use during operation and maintenance remains as predicted for S1, regardless of sequence: **not significant** (Table 9-4).

Cumulative Environmental Effects

Although the time when cumulative effects may occur could shift as compared to S1, the results of the cumulative environmental effects analysis as presented in Volume III, Section 5.6 of the EIS and in the responses to IR# JRP.97, IR# JRP.97S and IR# JRP.163 would not likely change as a result of the change in sequencing of Project phases. The same Project activities and interactions would occur, albeit in a reversed order and interrupted for S3. The other past, present and reasonably foreseeable future projects or activities that are likely to spatially and temporally overlap with the Project remain the same as those assessed in Volume III, Section 5.5.7 of the EIS. Therefore the cumulative effects associated with S2 or S3 are **not significant** (Table 9-5).

Table 9-5 Summary of Residual Cumulative Environmental Effects Assessment for Land and Resource Use (reproduced from Volume III, Table 5-5 of the EIS)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Nature	Adverse and Positive	Adverse and Positive
Magnitude	Moderate	Moderate
Geographic Extent	Regional	Regional
Duration / Frequency	Medium-term to Permanent/Continuous	Permanent/Continuous
Ecological or Social Context	Undisturbed/Disturbed	Disturbed
Reversibility	Irreversible	Irreversible

Table 9-5 Summary of Residual Cumulative Environmental Effects Assessment for Land and Resource Use (continued)

Criteria	Timing	
	Construction Phase	Operation and Maintenance Phase
Certainty	High	High
Significance	Not Significant	Not Significant
Likelihood	Not applicable	Not applicable
Notes: Definitions for criteria are provided in Section 5.5.2 Methods explained in Volume IA, Chapter 9		

9.9 Accidents and Malfunctions

The likely residual effects resulting from an accident or malfunction for S2 or S3 would remain the same as those assessed for S1 in Volume III, Chapter 7 of the EIS and in the response to IR# JRP.145. This is because the same Project infrastructure would be in place. Therefore, the potential for dam failure, forest fire and other fire, accidental release of solid or liquid waste, and hazardous material spills would still be present. Nalcor will have the same emergency response and preparedness measures in place, regardless of the sequence of construction. For S2 and S3, there is no change in the significance of the residual environmental effects on Land and Resource Use resulting from an accident or malfunction because there would not be an increase in magnitude, geographic extent, duration or frequency of the effect (change in land and resource use). Therefore, in the unlikely event of a dam failure, the adverse residual environmental effect would be **significant**. In the unlikely event of a forest fire or other fire, accidental release of solid or liquid waste, or a hazardous material spill, the adverse environmental effects would be **not significant**.

9.10 Monitoring and Follow-up

Monitoring and managing changes in the distribution and intensity of Land and Resource Use remains the responsibility of the provincial and federal government departments and agencies that administer and manage land and resource use activities. Nalcor will provide Project-related information on a quarterly basis to government resource management authorities. Nalcor will still monitor and communicate information regarding ice conditions at select locations on the lower Churchill River. As described in the response to IR# JRP.112, IR# JRP.112S and IR# JRP.163, the results of follow-up and monitoring programs will be used to verify environmental effects predictions, and measure the efficacy of effects management measures for fish and wildlife. Accordingly, adaptive management measures will still be undertaken pending the results of these programs, in consideration of land and resource use patterns and will be used to refine and optimize related monitoring and mitigation measures, if needed. The change in sequencing of Project phases will not alter the framework for monitoring and follow-up.

10.0 CULTURAL HERITAGE RESOURCES

Changes to the effects predictions for Historic and Archaeological Resourcesresulting from S2 and S3 as compared to the effects resulting from S1 (Volume III, Chapter 6 of the EIS) would not likely occur because the area of inundation and physical disturbance would remain the same. In all, 46 archaeological sites with assigned Borden numbers, the Canadian registry for historic and archaeological sites, have been identified in the Assessment Area (Volume III, Section 6.5). Two archaeological sites have already been excavated, thus no further mitigation is required for them. The effects management of the remaining 44 archaeological sites and two sites of cultural and spiritual importance to Labrador Innu recorded for the Assessment Area remains the same as presented in Volume III, Section 6.5.

The proposed mitigation measures for the archaeological sites that will be affected as a result of reservoir preparation and impounding, and through construction of Project infrastructure, remain the same as those proposed for S1 and are categorized as:

1. Systematic Data Recovery (SDR) (involves 24 archaeological sites);
2. Additional Field Recording (AFR) (involves six archaeological sites); and
3. Systematic Field Recording and Subsurface Sampling (SFR and SS) (involves 14 archaeological sites).

Although the width of the right-of-way for the interconnecting transmission line would be increased, the corridor within which it occurs has not been altered. The corridor has been subject to a thorough historic and archaeological resources assessment in accordance with provincial guidelines, and mapped for its archaeological potential with three categories identified: High, Moderate and Low. If Project-related ground disturbance occurs in High potential zones within the corridor, a Stage 1 Historic Resources Overview Assessment will be conducted prior to commencement of work.

There is no likely change in the residual adverse environmental effect on Historic and Archaeological Resources as compared to S1 during construction or operation and maintenance because the area of inundation and disturbance from Project infrastructure would remain the same and it is therefore rated **not significant**. In addition to the mitigation measures described above and in the EIS, there will be a Historic and Archaeological Resources Contingency and Response Plan in place so that all Project personnel are aware of the procedures to follow if Historic and Archaeological Resources are discovered inadvertently during Project construction or operation and maintenance (please see the response to IR# JRP.104). The plan will include follow-up to monitor the condition of any new sites or materials discovered. In addition, Nalcor will conduct a pre-construction Stage 1 Historic Resources Overview Assessment of the route of any permanent access roads once the centre line has been surveyed and marked.

Although the time when cumulative effects may occur could shift as compared to S1, the results of the cumulative environmental effects analysis as presented in Volume III, Section 5.5.6 of the EIS and in the responses to IR# JRP.97, IR# JRP.97S and IR# JRP.163 would not likely change as a result of the reversal in construction sequence or non-overlapping construction periods. The same Project activities and interactions would occur, albeit in a reversed order and for S3 non-overlapping construction. The other past, present and reasonably foreseeable future projects or activities that are likely to spatially and temporally overlap with the Project remain the same as those assessed in Volume III, Section 5.5.7 of the EIS. Therefore the cumulative effects associated with S2 or S3 are **not significant**. The likely residual effects resulting from an accident or malfunction for S2 or S3 would remain the same as those assessed for S1 in Volume III, Chapter 7 of the EIS and in the response to IR# JRP.145 because the same Project infrastructure would be in place, and therefore the potential for dam failure, forest fire or other fire, accidental release of liquid or solid waste, or hazardous

material spills would still be present. Nalcor will have the same emergency response and preparedness measures in place, regardless of the sequence of construction. Therefore, in the unlikely event of a dam failure, the adverse residual environmental effect could be **significant**. In the unlikely event of a forest fire or other fire, accidental release of liquid or solid waste, or hazardous material spills, the adverse environmental effects would be **not significant**.

11.0 REFERENCES

Altman, B. and R. Sallabanks. 2000. Olive-sided Flycatcher (*Contopus cooperi),* The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/502.

AMEC-Sikumiut. 2007. Lower Churchill Hydroelectric Generation Project Habitat Quantification (TF6110443). Fish and Fish Habitat Component Study 3 of 11, Nalcor, St. John's, NL.

Armitage, Peter. 2010. Innu of Labrador Contemporary Land Use Study. Report to Innu Nation.

Avery, M.L. 1995. Rusty Blackbird (*Euphagus carolinus)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/200.

Bromley, R.G. and R.L. Jarvis. 1993. The energetics of migration and reproduction of Dusky Canada Geese. *Condor* 95: 193-210.

Cade, B.S. and P.J. Sousa. 1985. Habitat suitability index models: Ruffed grouse. US Fish and Wildlife Service Biological Report 82 (10.86).

Chilibeck, B., G. Chislett and G. Norris. 1993. Land Development Guidelines for the Protection of Aquatic Habitat. Fisheries and Oceans Canada. 129pp.

Chubbs, T.E., L.B. Keith, S.P. Mahoney and M.J. McGrath. 1993. Responses of Woodland Caribou *(Rangifer tarandus caribou)* to clear-cutting in east-central Newfoundland. Canadian Journal of Zoology 71: 487-493.

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

Environment Canada. 2007. Environment Canada background document on the management of incidental take of migratory birds: towards an updated regulatory approach. October 25, 2007. Ottawa, Ontario.

Fisheries and Oceans. 2007. Practitioners Guide to Habitat Compensation. Fisheries and Oceans Canada, website location: http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155/compensation/index-eng.asp

Godfrey, W.E. 1986. *The Birds of Canada*. National Museum of Canada, Ottawa, ON.

Gosse, M.M., A.S. Power, D.E. Hyslop and S.L. Pierce. 1998. Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador. Fisheries and Oceans, St. John's, NF. X + 105pp., 2 appendices.

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

Hatch Ltd. 2008. Salt Water Intrusion 3D Model Study, Final Report. Lower Churchill Hydroelectric Generation Project. H-323087. Hydrology Component Study 2 of 8, Nalcor, St. John's, NL.

Hunter, M.L. Jr. 1993. Natural fire regimes as spatial models for managing boreal forests. *Biological Conservation* 65: 115-120.

Jacques Whitford. 1998. 1997 Raptor Monitoring Program. Jacques Whitford report prepared for Goose Bay Office, National Defence Headquarters, Ottawa, ON. 25 pp. + Appendices.

Jacques Whitford. 2006. Statistical Analysis of Mercury from Churchill Falls (Labrador) Corporation Reservoirs. Report prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Minaskuat Inc. 2008a. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Inventory of Beaver Colonies in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2008b. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Regional Ecological Land Classification. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2008c. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Forest Songbird Survey. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2008d. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Wildlife Habitat Associations in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project.

Minaskuat Inc. 2009a. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Caribou (*Rangifer tarandus caribou*). Prepared for the Lower Churchill Hydroelectric Generation Project. Prepared for Nalcor Energy, St. John's, NL.

Minaskuat Inc. 2009b. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Moose (*Alces alces)*. LCP 535746. Prepared for Nalcor Energy, St. John's, NL.

Minaskuat Inc. 2009c. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Black Bear (*Ursus americanus)* in the Lower Churchill River Watershed. LCP 535747. Prepared for Nalcor Energy, St. John's, NL.

Nalcor Energy. 2010. Consultation Assessment Report. Supplemental Information to IR JRP.151. CEAR #501

Nellemann C., I. Vistnes, P. Jordhøy, O. Strand and A. Newton. 2003. Progressive impact of piecemeal infrastructure development on wild reindeer. *Biological Conservation* 113: 307-317.

Newbury, T.L. 2006. Effect of low-level military aircraft on the behaviour of spring-staging waterfowl at Lac Fourmont ashkui, Labrador, Canada. M.Sc. thesis, McGill University, 85 pp.

Potvin, F., L. Belanger and K. Lowell. 2000. Marten habitat selection in a clearcut boreal landscape. *Conservation Biology* 14: 844-857.

Schmelzer, I. and J. Fenske. No Date. Life at the Limit: An Intraspecific Analysis of Home Range Variation for a Wide-ranging Rodent, the North American Porcupine (*Erethizon dorsatum*) in Central Labrador, Canada.

Schmelzer, I. and R. Otto. 2003. Winter range drift in the George River caribou herd: A response to summer forage limitation? *Rangifer Special Issue* 14: 113-122.

Scruton, D.A. Sooley, D.R., L. Moores, M.A. Barnes, R.A. Buchanan, and R.N. McCubbin. 1997. Forestry Guidelines for the Protection of Fish Habitat in Newfoundland and Labrador. Fisheries and Oceans, St. John's, NF. Iii + 63pp., 5 appendices.

Simon, N.P.P and F.E. Schwab. 2005a. The response of conifer and broad-leaved trees and shrubs to wildfire and clearcut logging in the boreal forests of central Labrador. *Northern Journal of Applied Forestry* 22(1): 35-41.

Simon, N.P.P. and F.E. Schwab. 2005b. Plant community structure after wildfire in the subarctic forests of western Labrador. *Northern Journal of Applied Forestry* 22: 229-235.

Sleep, D.J.H., and Loehle, C. 2010. Validation of a demographic model for woodland caribou. *Journal of Wildlife Management* 74(4): 1508-1512.

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.

Steventon, J.D. and J.T. Major. 1982. Marten use of habitat in a commercially clear-cut forest. *Journal of Wildlife Management* 46: 175-182

Swihart, R.K., T.M. Gehring, M-B. Kolozsvary and T.E. Nupp. 2003. Responses of 'resistant' vertebrates to habitat loss and fragmentation: The importance of niche breadth and range boundaries. *Diversity and Distributions* 9: 1-18.

Thompson, I.D. and A.S. Harestad. 1994. Effects of logging on American martens, and models for habitat management. Pp. 355-367. In: S.W. Buskirk, A.S. Harestad, M.G. Raphael and R.A. Powell (eds.). Marten, *Sables, and Fishers: Biology and Conservation*. Cornell University Press, Ithaca, NY.

Turner, B. and K. Chaulk. 2000. Waterfowl Use of Spring Staging Areas in the Eastern Portion of the Low-level Flight Training Area of Labrador. Unpublished report prepared for Goose Bay Office, Department of National Defence, Ottawa, ON. 46 pp.

Vistnes, I., C. Nelleman, P. Jordhøy and O. Strand. 2004. Effects of infrastructure on migration and range use of wild reindeer. *Journal of Wildlife Management* 68(1): 101-108.

Water Resources Management Division. 1997. Environmental Guidelines for General Construction Practices. Water Resources and Management Division, Water Resources Investigations Section, provincial Department of Environment and Conservation, St. John's, NL. Website location: http://www.env.gov.nl.ca/env/waterres/regulations/appforms/chapter13_2.pdf

Wege, M.L. and D.G. Raveling. 1983. Factors influencing the timing, distance, and path of migrations of Canada Geese. *Wilson Bulletin* 95: 209-221.

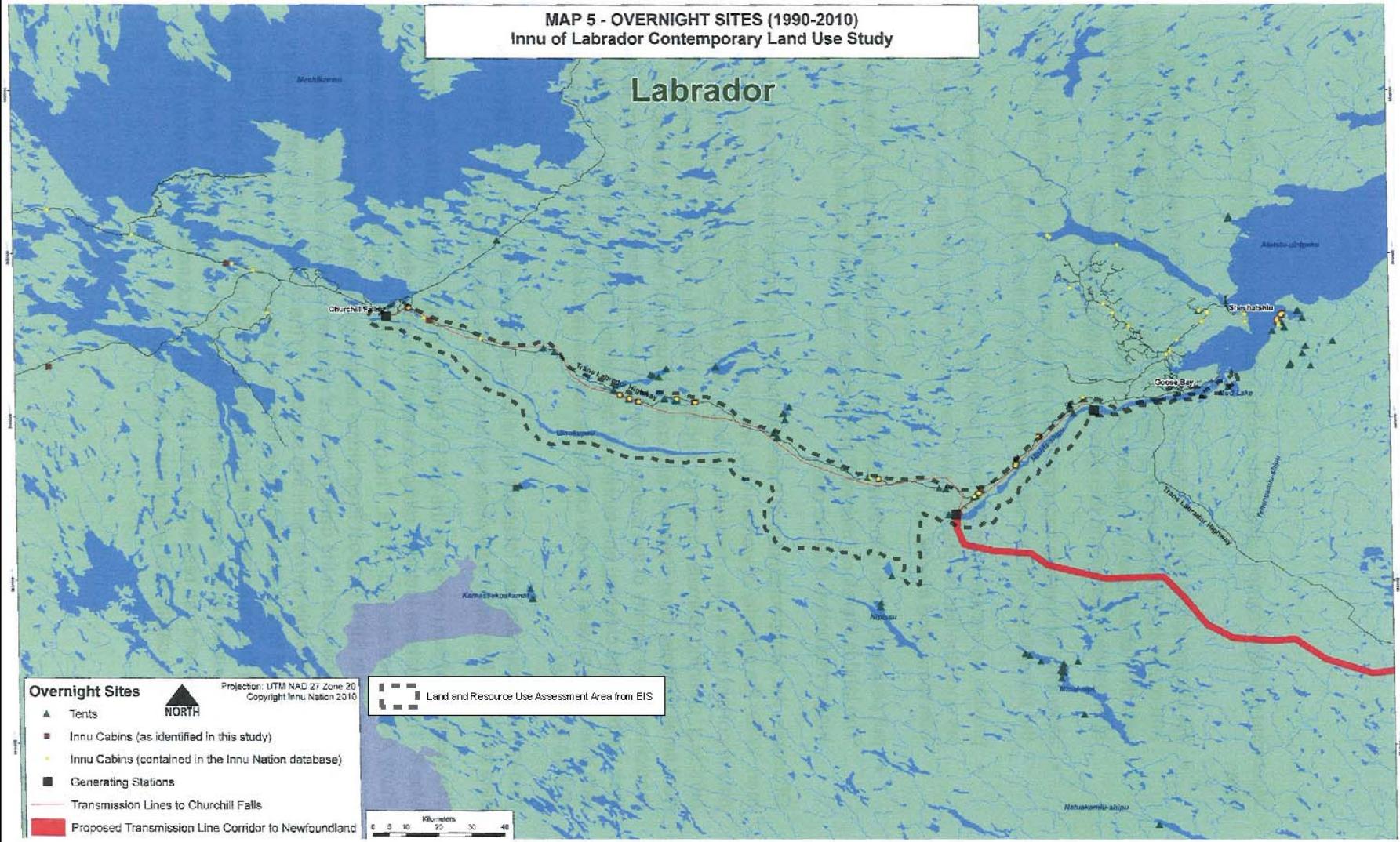
Wright, D.G. and G.E Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. *Canadian Technical Report of Fisheries and Aquatic Science*. 2107: iv + 34p.

PERSONAL COMMUNICATION

Gilliland, S. Canadian Wildlife Service, St. John's, NL.

APPENDIX 1

CONTEMPORARY LAND USE MAPS (LABRADOR INNU)

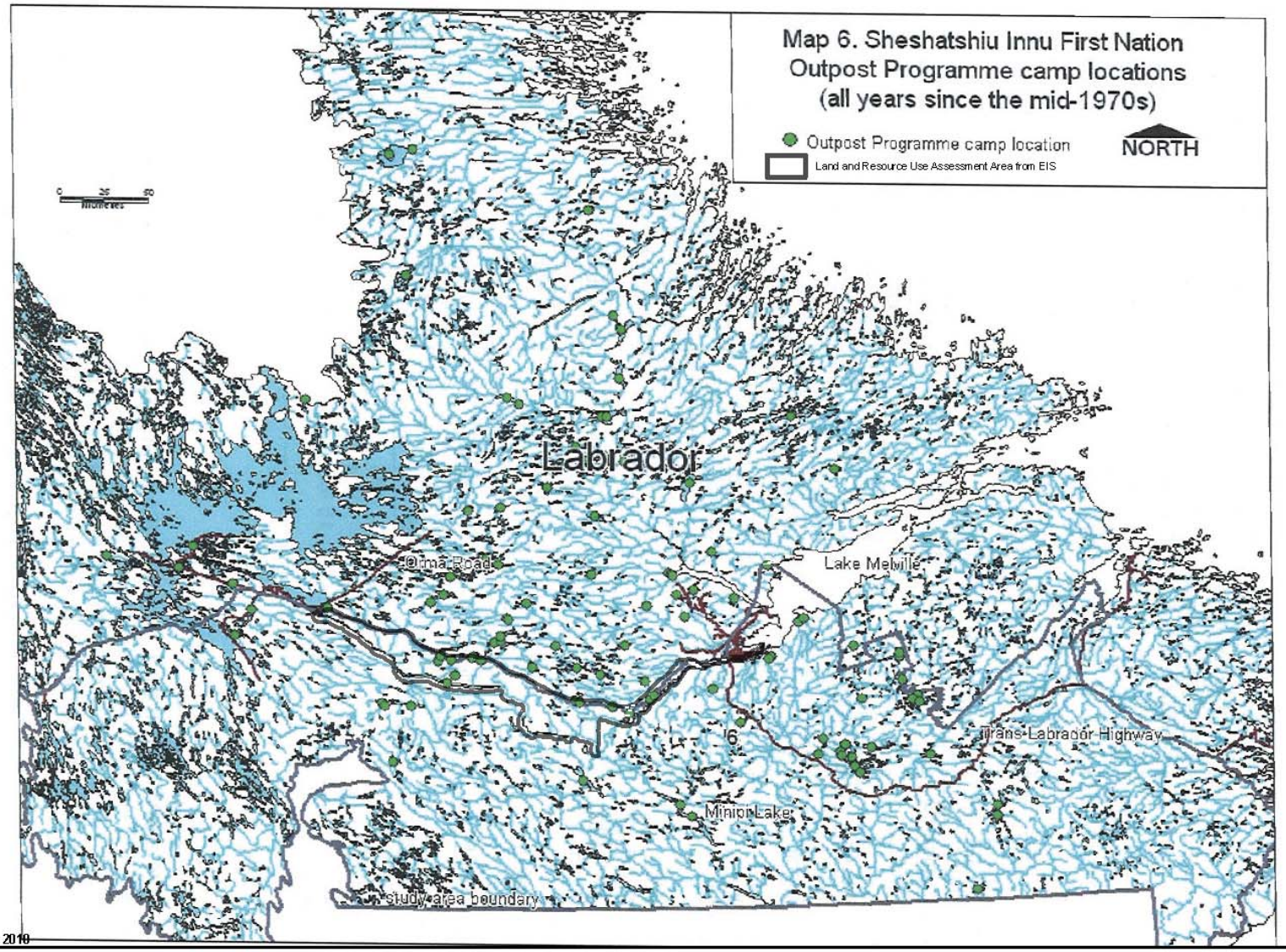


Source: Armitage 2010

nalcor energy

FIGURE 1

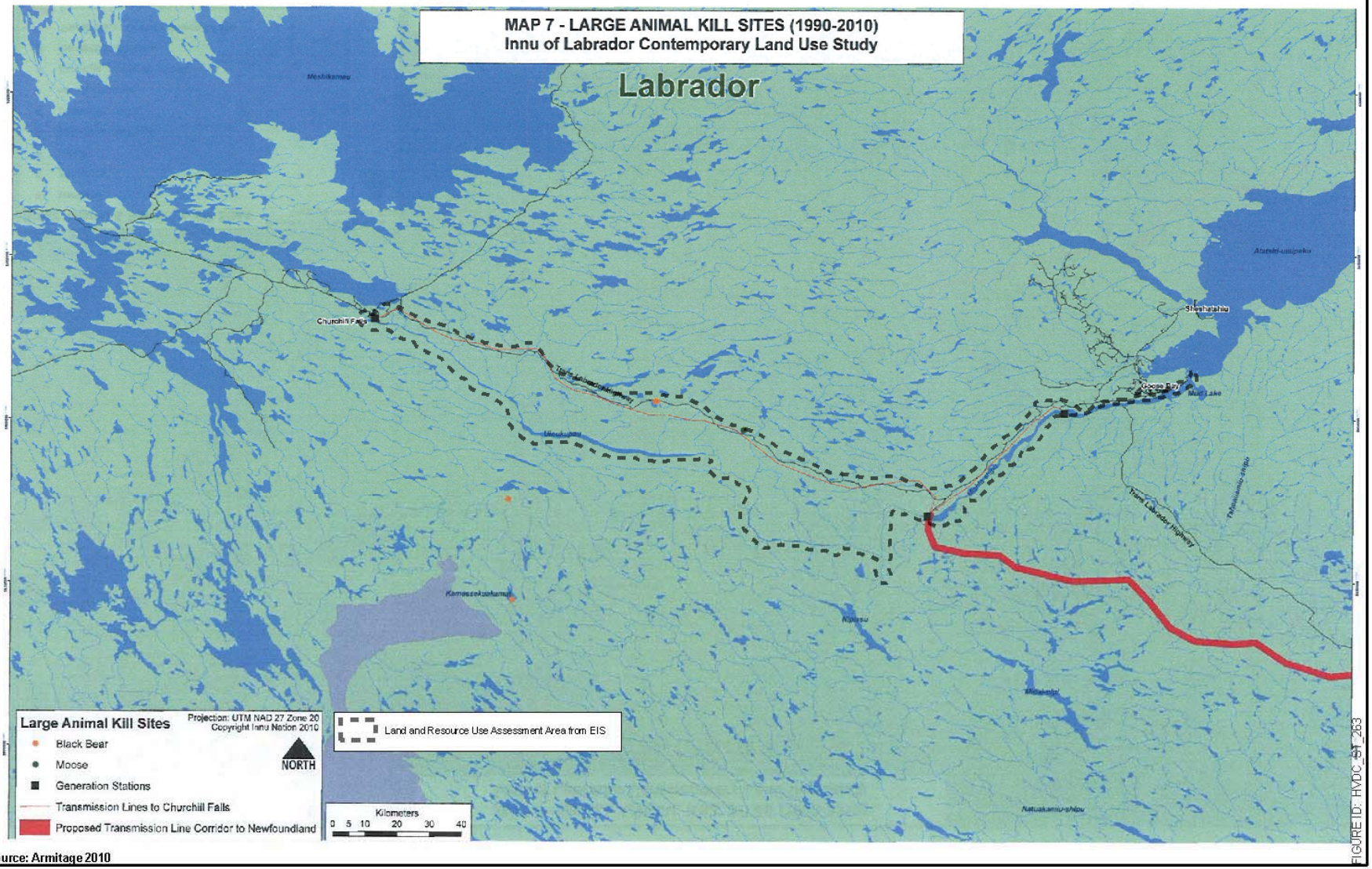
Overnight Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study



Source: Armitage 2010

FIGURE 2

Sheshatshiu Innu First Nation Outpost Programme Camp Locations (all years since the mid 1970s)

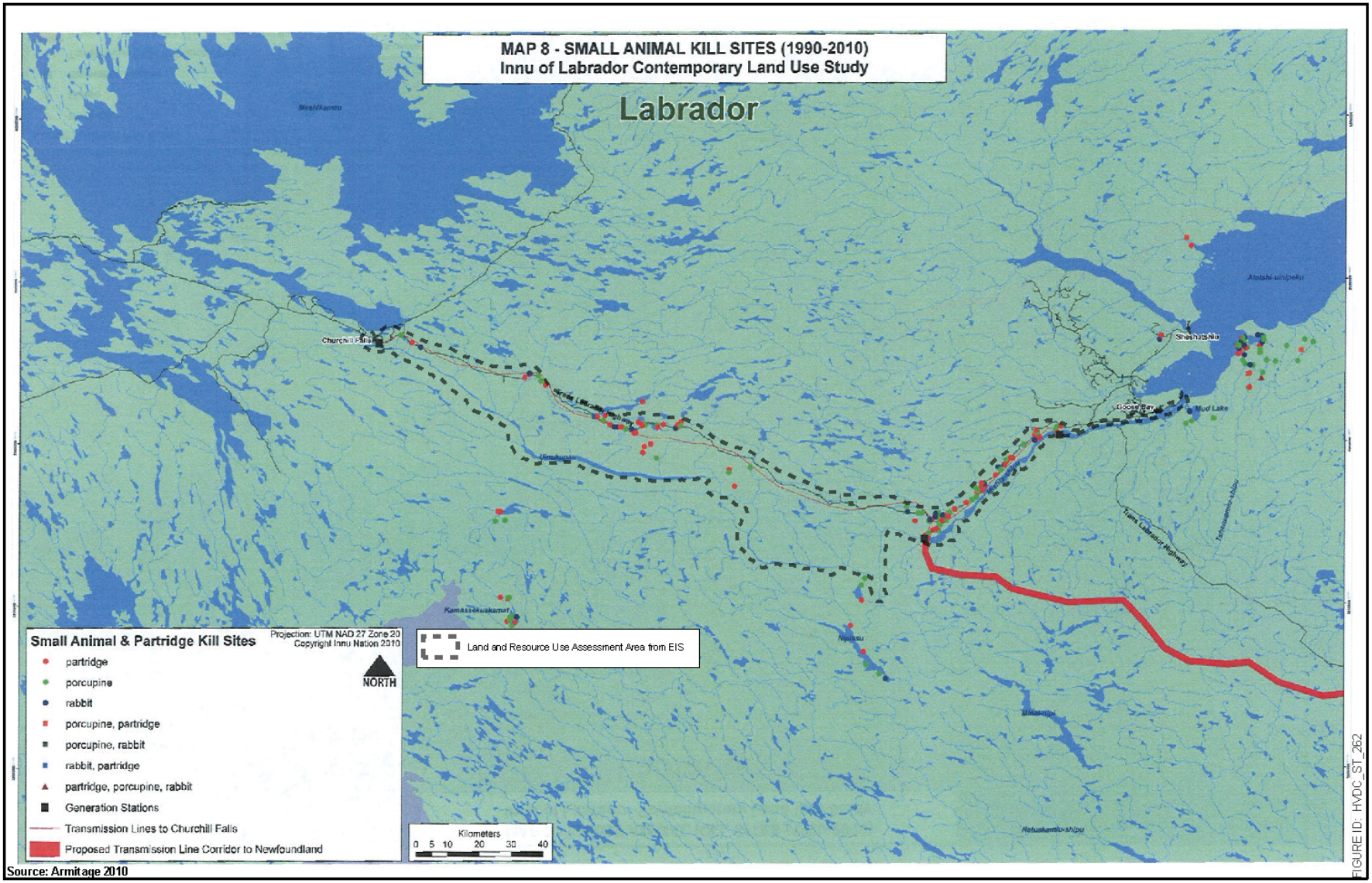


Source: Armitage 2010

nalcor energy

FIGURE 3

Large Animal Kill Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study

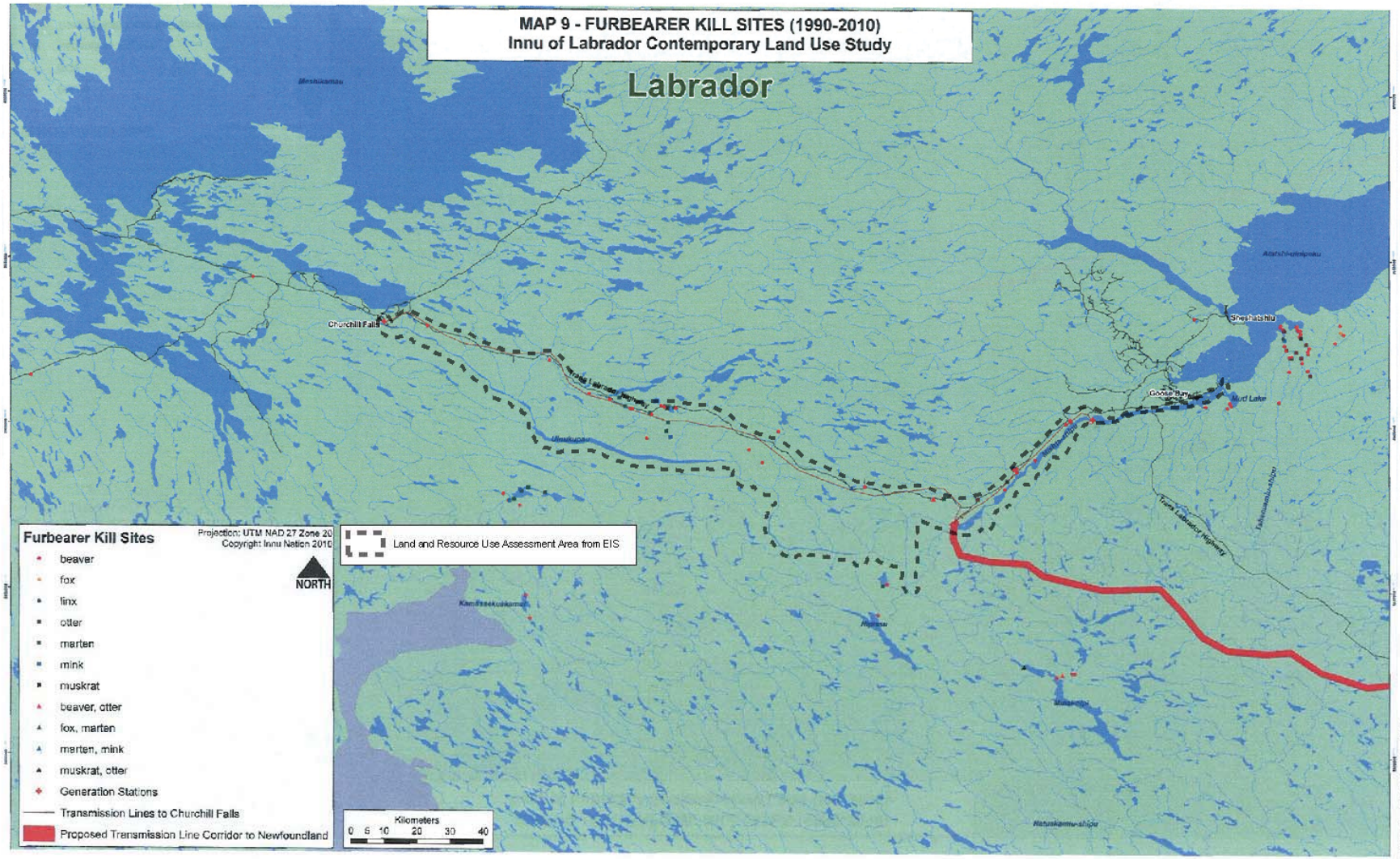


Source: Armitage 2010

nalcor energy

FIGURE 4

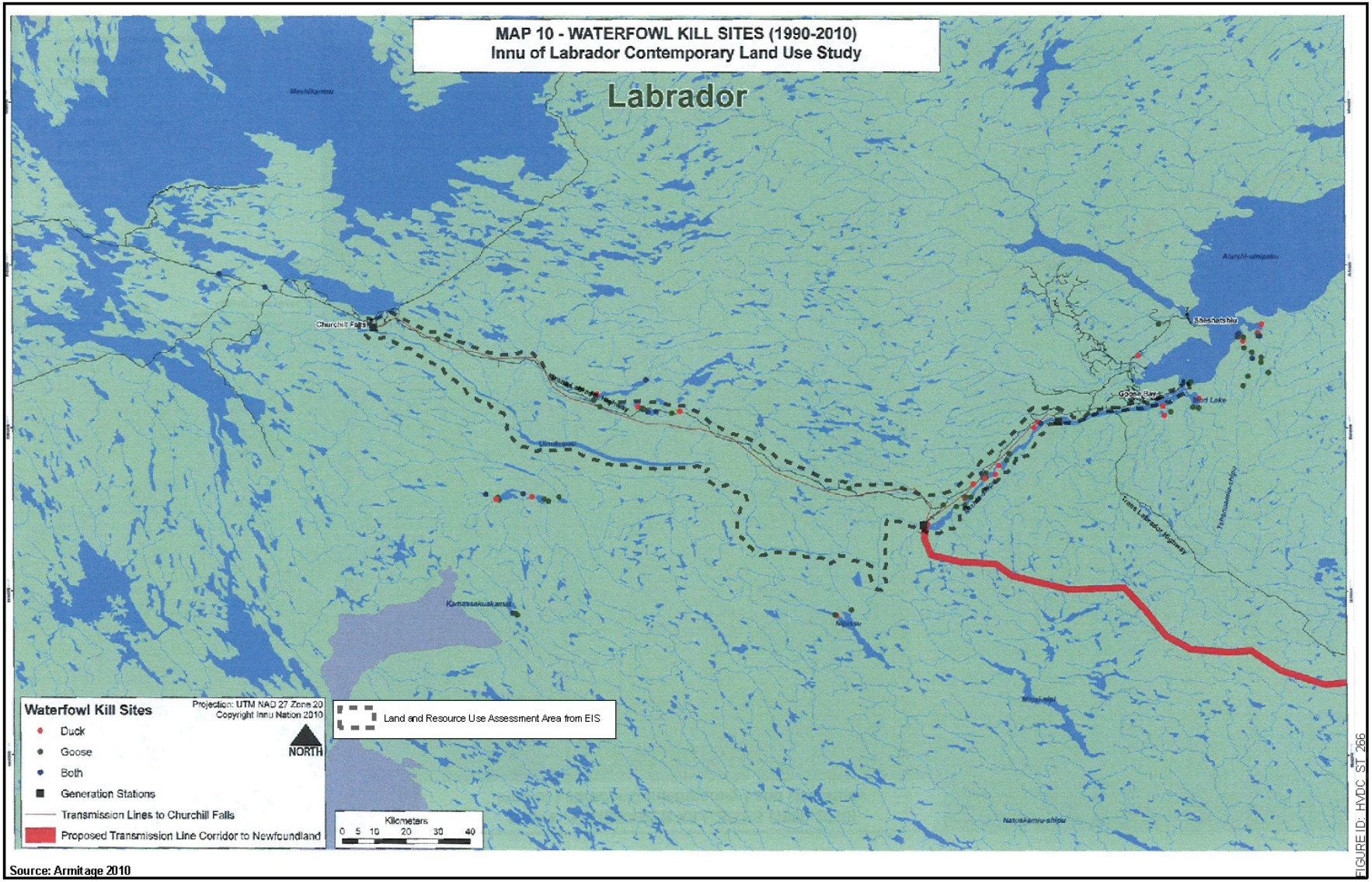
Small Animal Kill Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study



Source: Armitage 2010

FIGURE 5

Furbearer Kill Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study

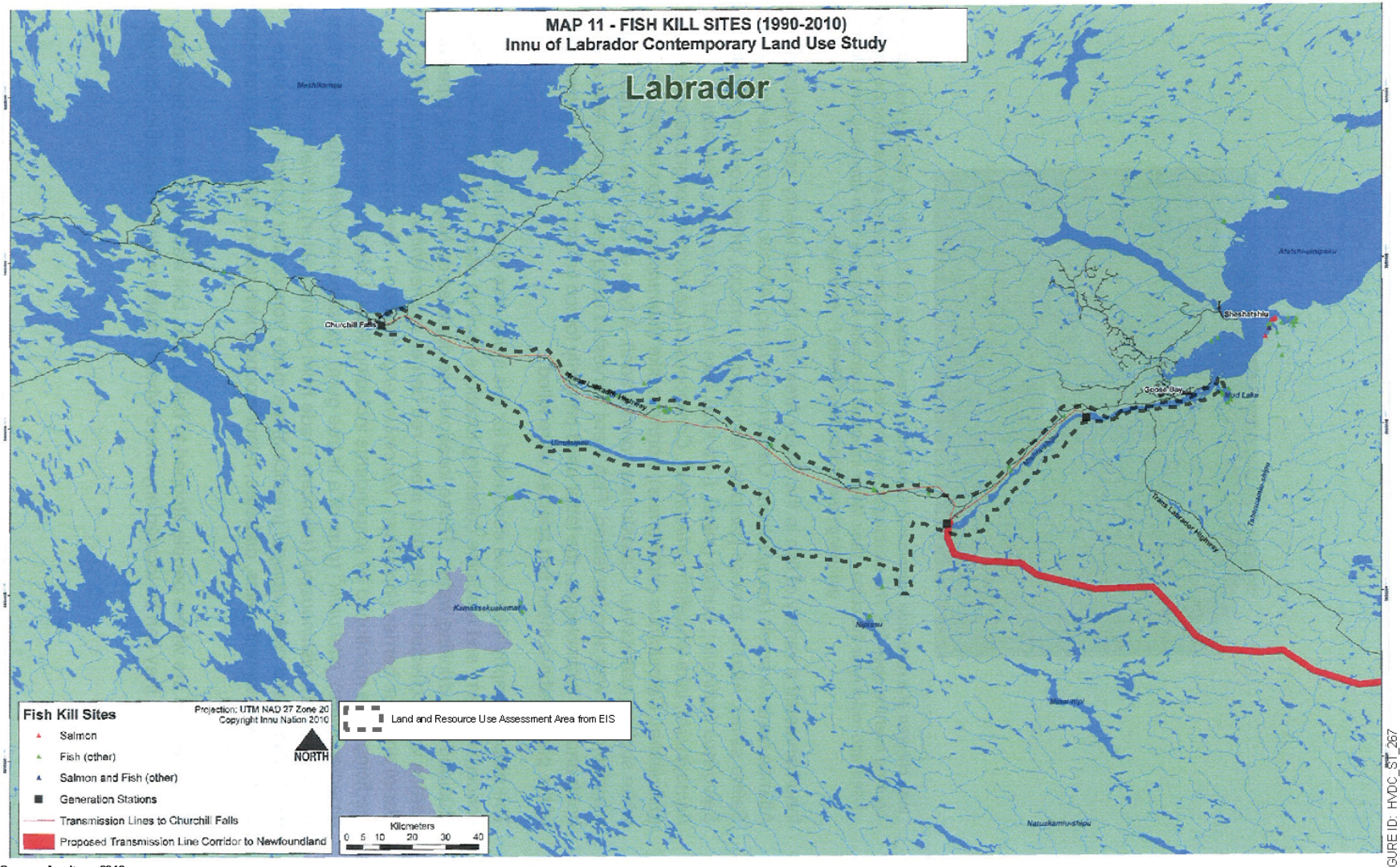


Source: Armitage 2010

nalcor energy

FIGURE 6

Waterfowl Kill Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study

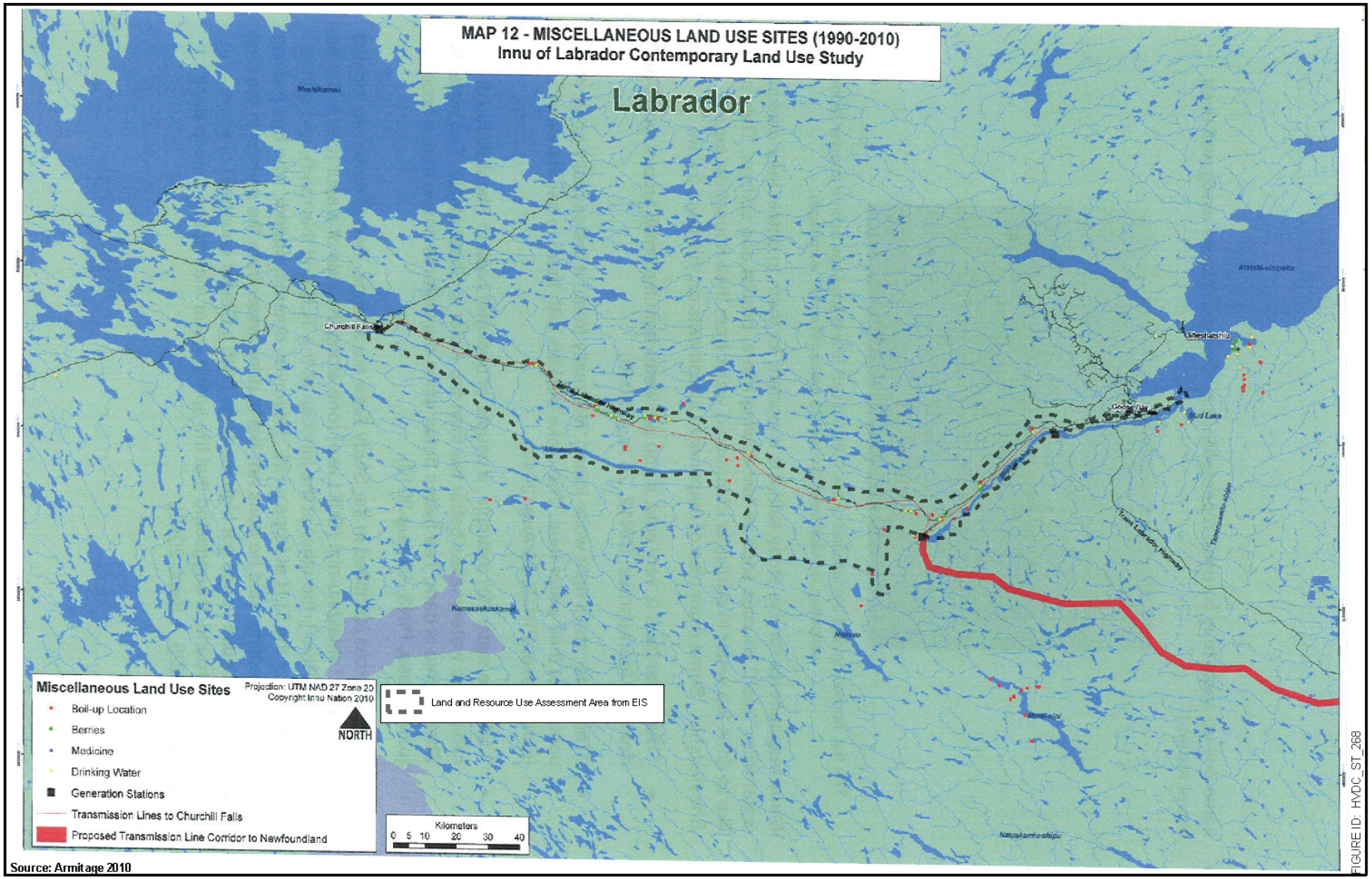


Source: Armitage 2010

nalcor energy

FIGURE 7

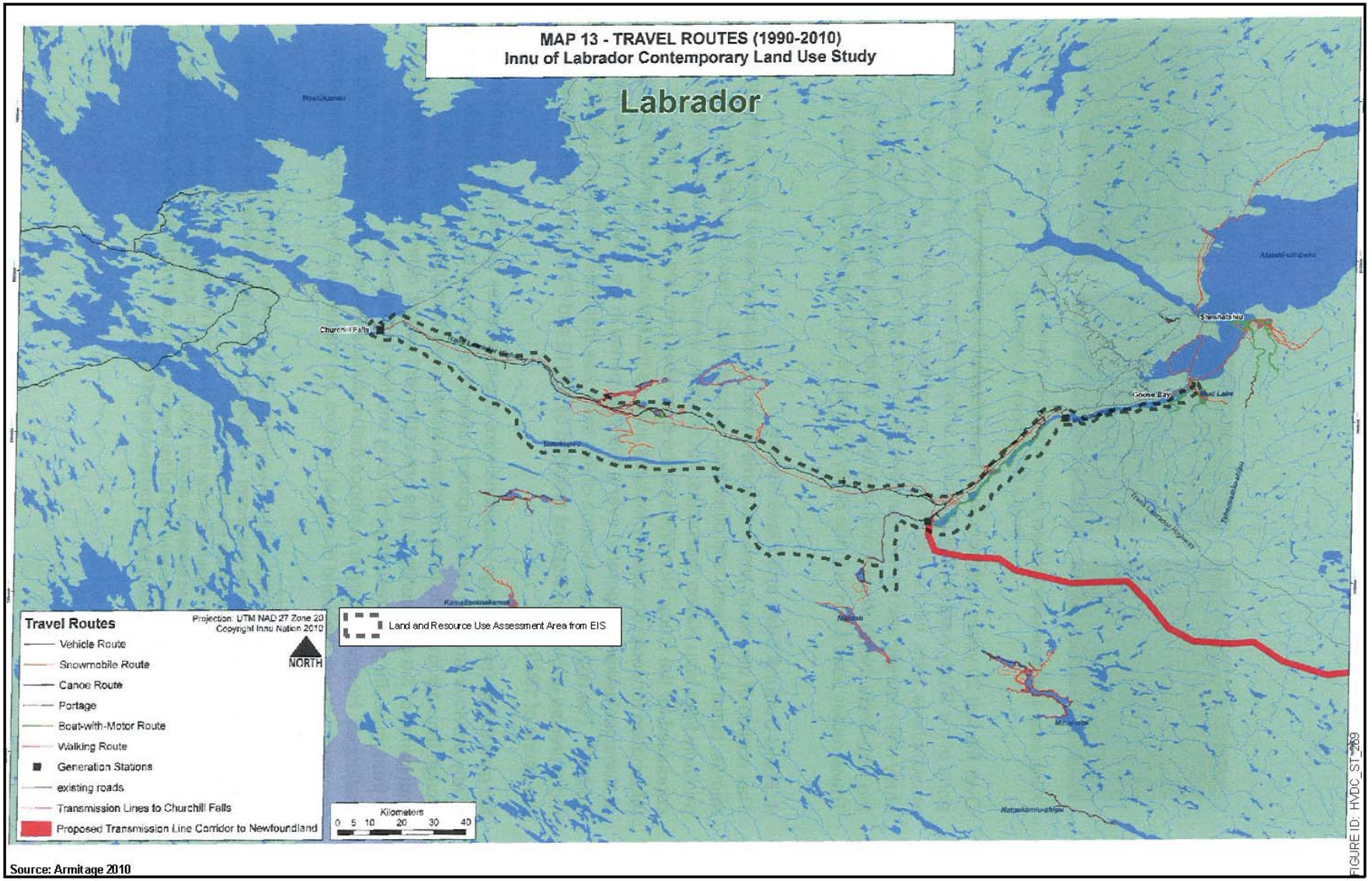
Fish Kill Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study



Source: Armitage 2010

FIGURE 8

Miscellaneous Land Use Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study

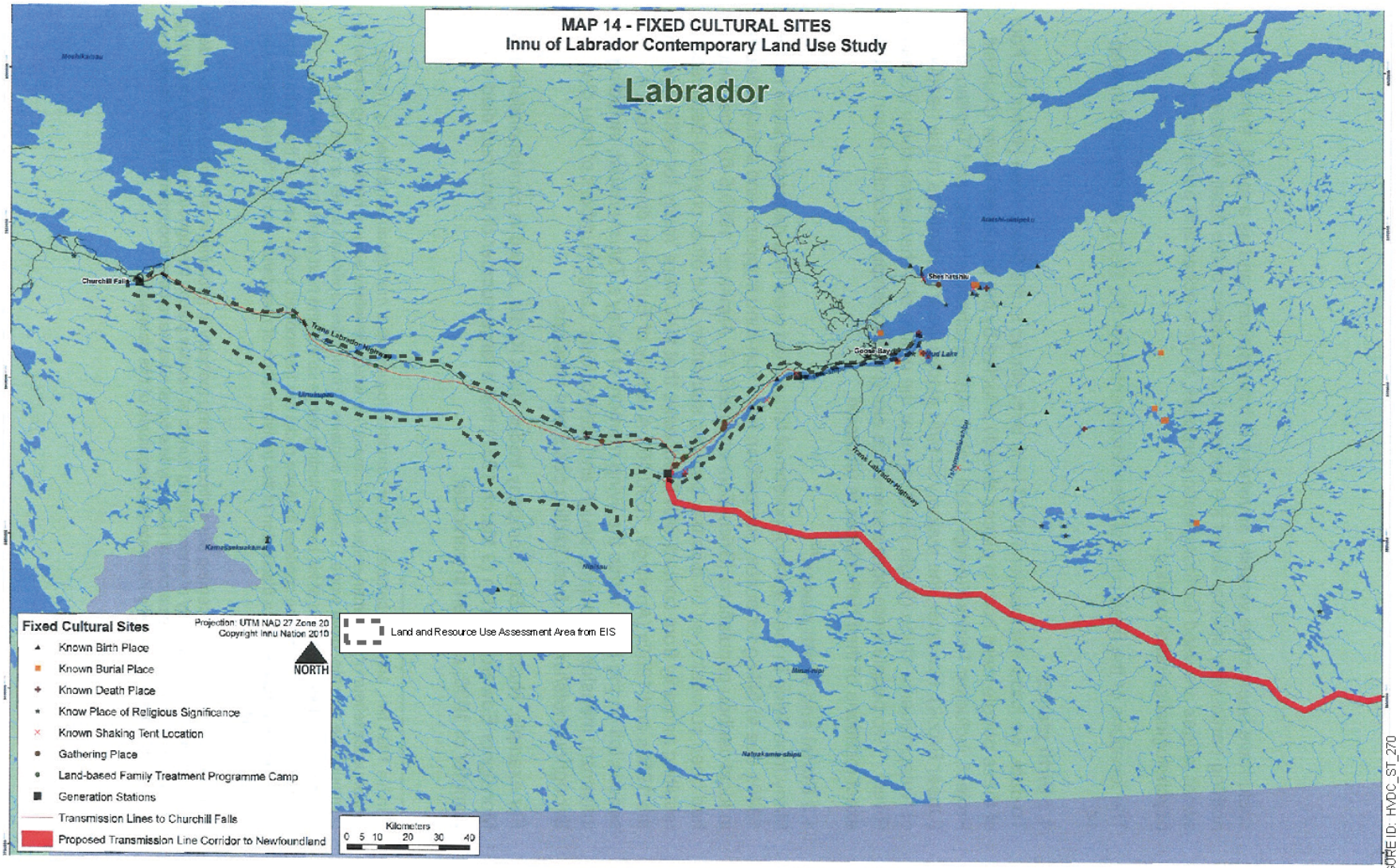


Source: Armitage 2010

nalcor energy

FIGURE 9

Travel Routes (1990-2010)
Innu of Labrador Contemporary Land Use Study

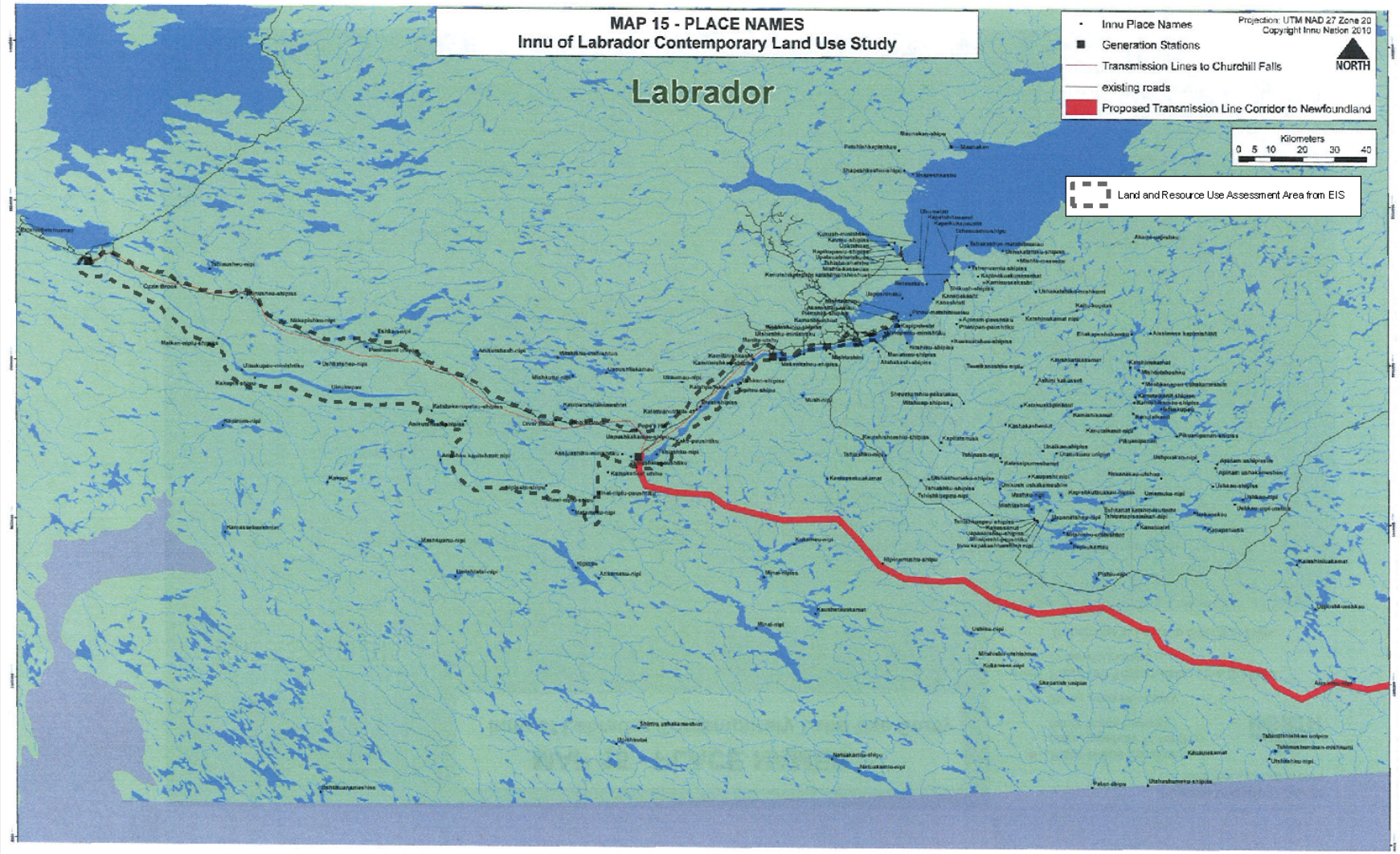


Source: Armitage 2010

nalcor energy

FIGURE 10

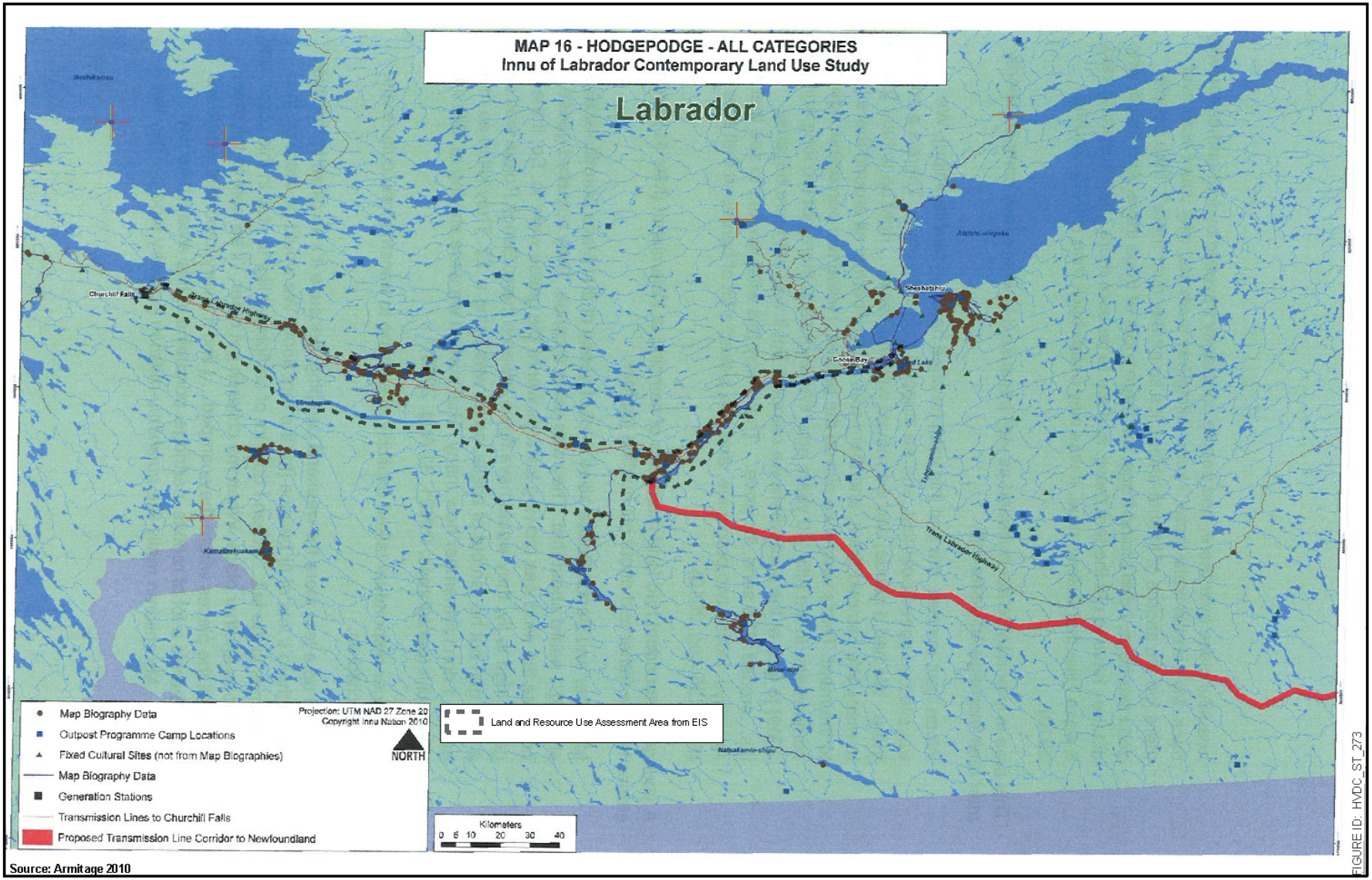
Fixed Cultural Sites (1990-2010)
Innu of Labrador Contemporary Land Use Study



Source: Armitage 2010

FIGURE 11

Place Names
Innu of Labrador Contemporary Land Use Study



Source: Armitage 2010

FIGURE 12

Hodgepodge - All Categories
Innu of Labrador Contemporary Land Use Study