PARTIAL DIVERSION OF THE MANOUANE RIVER

CANADIAN ENVIRONMENTAL ASSESSMENT ACT
COMPREHENSIVE STUDY REPORT

PREPARED BY THE
DEPARTMENT OF FISHERIES AND OCEANS CANADA
QUEBEC REGION

JULY 2002
(AMENDED VERSION, SEPTEMBER 2002)

Pêches et Océans Canada | Fisheries and Oceans Canada

Canada

General Information

Date:	July 2002 (amended version, September 2002)
Proponent:	Hydro-Québec
Project Type:	Partial diversion of a river
Triggers:	*Fisheries Act,* subsection 35(2) *Navigable Waters Protection Act*, subsection 5(1)
Responsible Authority:	Department of Fisheries and Oceans Canada
Study type:	Comprehensive study under the *Comprehensive Study List Regulations*.

Summary

Hydro-Québec plans to divert part of the waters of the Manouane River toward the Pipmuacan reservoir, going through the Hirondelles River, so as to increase the flow to the Pipmuacan reservoir, the main reservoir of the Bersimis complex on the Betsiamites River. A mean annual discharge of approximately 30 m^3/s would be diverted from the Manouane River. Upon completion, the project would provide the Bersimis complex with an average annual net increase in energy production of 318 GWh, accounting for the deduction of electricity to be returned to the Alcan company in compensation for the production losses at its five generating stations.

Rationale for the partial diversion of the Manouane River is based on Hydro-Québec's orientation for sustained growth and profitability, adopted in its 2000-2004 Strategic Plan. The project would involve the construction of a dam, three dikes and two cofferdams on the Manouane River, as well as a regulating structure upstream from Lake Numéro Deux, a flow-measuring weir at the Lake Patrick outlet, and a series of diversion canals between Lake Grand Détour and Hirondelles River. Other work, such as improving or building access roads, culverts, work camps and temporary installations, would also be required.

With a minimum flow rate of 3 m^3/s, the Manouane River's mean annual discharge would drop from the actual 39 m^3/s (approx.) to 9 m^3/s at the cutoff point, and from about 106 m^3/s to 76 m^3/s at the confluence with the Péribonka River. The project would cause the shoreline exposure of 188 ha of the Manouane River. It would also lead to a 0.1 m drop in the water level of the Péribonka River, resulting in the shoreline exposure of 3.8 ha of aquatic area. The project would involve the creation of a reservoir that would span an average 23 km^2 in the spring, flooding an area of 12 km^2. The average level of Lake Patrick would decrease by 1.1 m, resulting in the shoreline exposure of 6.7 ha. On an average annual basis, the flow rate of the Hirondelles River would increase from 1.2 m^3/s to 32 m^3/s, causing the flooding of 2.9 ha along its edges. The Betsiamites River would see its mean annual discharge increase by 47 m^3/s following the diversion of the Portneuf, Sault aux Cochons and Manouane rivers.

The Department of Fisheries and Oceans (DFO) has determined that the project would incur the loss of fish habitat, and therefore requires authorization under subsection 35(2) of the *Fisheries Act* (FA), which triggers the *Canadian Environmental Assessment Act* (CEAA). Several structures to be constructed in navigable waters would also be subject to formal approval under the *Navigable Waters Protection Act* (NWPA), also a trigger of CEAA. DFO has therefore prepared this report in consultation with the federal authorities concerned (Environment Canada, Natural Resources Canada, Health Canada, Indian and Northern Affairs Canada, and Parks Canada).

This report fulfills DFO's obligation as a Responsible Authority established under CEAA, to conduct an assessment of the project's environmental effects, in consultation with other federal authorities who have the appropriate expertise.

Taking into account the proposed mitigation and compensation, the follow-up program, and the proponent's commitments, DFO has determined that the proposed project, as defined in the scope of the assessment, is not likely to have a significant adverse environmental effect.

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1 Introduction

The Department of Fisheries and Oceans (DFO) prepared this comprehensive study report for the partial diversion of the Manouane River proposed by Hydro-Québec, the project proponent. This report fulfills DFO's obligation, as a Responsible Authority under the *Canadian Environmental Assessment Act* (CEAA), to conduct an environmental impact assessment of the project, in consultation with other federal authorities who have the appropriate expertise.

This document includes a summary of the project and the environment in which it would be carried out, the principal results of public consultations, a summary of the main environmental effects, the cumulative effects and the effects caused by accidents or malfunctions that might occur, an outline of the associated mitigation and monitoring measures, determination of the significance of the effects, approval conditions and a conclusion on the environmental acceptability of the project.

The documents listed below are also part of the comprehensive study report and were used in preparing this document. They contain, in more detailed form, the information pertaining to the factors listed above, as well as the proponent's responses to questions raised during the analysis of the completeness of the information provided, as established by the provincial environmental assessment procedure, as well as any additional information needed to meet the requirements of an environmental assessment under the CEAA.

- Hydro-Québec. May 2000. Dérivation partielle de la rivière Manouane. Rapport d'avant-projet. [Partial diversion of the Manouane River. Preliminary project report.] Volume 1, 361 p.
- Hydro-Québec. May 2000. Dérivation partielle de la rivière Manouane. Rapport d'avant-projet. [Partial diversion of the Manouane River. Preliminary project report.] Volume 2, appendices
- Hydro-Québec. December 2000. Dérivation partielle de la rivière Manouane. Résumé du rapport d'avant-projet. [Partial diversion of the Manouane River. Summary of preliminary project report.] 42 p.
- Hydro-Québec. November 2000. Dérivation partielle de la rivière Manouane. Complément du rapport d'avant-projet. Réponses aux questions et aux commentaires du ministère de l'Environnement du Québec. [Partial diversion of the Manouane River. Complement to the preliminary project report. Responses to questions and comments from the Ministère de l'Environnement du Québec.] 138 p. + appendices
- Hydro-Québec. December 2000. Dérivation partielle de la rivière Manouane. Réponses aux questions et aux commentaires des autorités fédérales concernant le rapport d'avant-projet. Première série. [Partial diversion of the Manouane River. Responses to questions and comments from federal authorities on the preliminary project report. First edition.] 114 p. + appendices

- Hydro-Québec. May 2001. Dérivation partielle de la rivière Manouane. Réponses aux questions et aux commentaires des autorités fédérales concernant le rapport d'avant-projet. Deuxième série. [Partial diversion of the Manouane River. Responses to questions and comments from federal authorities on the preliminary project report. Second edition.] 22 p.
- Alliance Environnement inc. June 2000. Dérivation partielle de la rivière Manouane. Étude d'avant-projet. Rapport sectoriel sur les poissons. Hydro-Québec. [Partial diversion of the Manouane River. Preliminary project report. Technical report on fish.] Prepared for Hydro-Québec. 161 p. + appendices
- Belzile, L., Piché, L. and R. Lalumière. May 2000. Évaluation des effets cumulatifs du projet de dérivation partielle de la rivière Manouane. [Assessment of cumulative effects of the partial diversion of the Manouane River.] Prepared by Génivar Consulting Group Inc. for Hydro-Québec's Environment Unit. 55 p. + appendices
- Department of Fisheries and Oceans. May 2002. Programme de compensation de l'habitat du poisson. [Partial diversion of the Manouane River, fish habitat compensation program.] 5 p.

2 Project description

This section presents a summary of the information on the project context and rationale, proposed alternatives and description of the selected facility, which can be found in Chapters 1 and 2 of Volume 1 of the preliminary project report[22] and in the November 2000 complement to the preliminary project report.[25]

2.1 Project context and rationale

The project consists of diverting the water of the Manouane River towards the Pipmuacan reservoir. This project will serve to increase the flow to the Pipmuacan reservoir, the main reservoir of the Bersimis complex on the Betsiamites River.

The water diverted toward the Pipmuacan reservoir will produce more electricity going through the turbines of the two generating stations of the Bersimis complex than it currently produces going through the five generating stations of the Alcan company at the mouth of the Péribonka River and at the outlet of Lake Saint-Jean and the Saguenay River. The average annual production of the Bersimis complex will increase by 318 GWh.

Rationale for the partial diversion of the Manouane River is based on the orientations of Hydro-Québec's 2000-2004 Strategic Plan. According to this plan, an increased demand for electricity in Québec will result in additional sales of 17.4 TWH by 2004, compared to 1999. The energy required for these additional sales will come from new energy supply sources and a reduction in net sales to external markets. The energy generated by the partial diversion of the Manouane River would enable Hydro-Québec to satisfy a part of these additional needs in Québec.

The proponent deems that this project has the potential to meet the three essential conditions set by Hydro-Québec in its 2000-2004 Strategic Plan. These three conditions are cost-effectiveness, environmental acceptability, and favourable reception by the local community.

The proponent has not identified any alternate solution, considering this project to be the most cost-effective option. The proponent is of the opinion that, should this project not be completed, any alternative project carried out in its place would be less economical and would therefore eventually result in an increase in the costs of electricity supply.

2.2 Facility alternatives

The proponent assessed three facility alternatives. The analysis focused on the level of the future reservoir and on the depth level of the diversion canal. According to the proponent, the preferred alternative offers the most advantages, reducing the cost of the project and the size of the Grand Détour reservoir to the minimum.

The proponent also assessed ways to optimize the preferred alternative. This assessment focused on the operating level of the Grand Détour reservoir and on alternatives for water discharge in the Manouane River and the type of design for the retaining structures. With regard to the reservoir's operating level, the proponent selected the most economically advantageous option, which is elevation 418 m. In environmental terms, the proponent estimates that creating the Grand Détour reservoir at elevation 416 m would be slightly more beneficial. However, given that several repercussions could be mitigated by the proposed measures, the difference between creating the reservoir at elevation 416 m and elevation 418 m does not seem significant enough to justify additional costs. With regard to the choice of water discharge method in the Manouane River and the type of design for the retaining structures, the proponent assessed two options.[22] The proponent judges that the two options do not present any significant differences in terms of their effects on the environment.[22] Consequently, the proponent has selected the least expensive of the two solutions.

The proponent also analyzed the possibility of increasing the minimum flow in the river to more than 3 m^3/s during the operating phase so as to diminish the project's effects on the environment. The proponent assessed two ways of increasing the minimum flow rate. The first, of a passive nature, would require increasing the number of conduits for the minimum flow in the dam and raising the crest of the structures. This option would increase project costs considerably. The second, of an active nature, would consist in equipping the dam with a structure allowing for the management of flows restored to the river. The investments required to operate such a structure would be greater than those associated with the passive-type option. In both cases, the increased minimum flow would lead to a decrease in the derivated flow and, consequently, a reduction in the net energy gain. The combined effect of the increased costs associated with the construction and operation of structures allowing for restoration of a greater minimum flow and the reduction in the net energy gain associated with the increase in the minimum flow would compromise the project's cost-effectiveness.

DFO is satisfied with the justification of the proponent regarding the alternative of the project selected.

2.3 Infrastructures

The project consists of constructing a series of diversion canals near the current dike to channel the water of the Manouane River to the Pipmuacan reservoir, going through the

Hirondelles River. This will divert an average annual flow of 30.3 m^3/s from the Manouane River. A minimum flow rate of 3 m^3/s is planned.

Dam

Located at kilometre 97 and built out of concrete, the dam will be 9 m high, 90 m long and 3.75 m wide at the crest. The structure will allow for the discharge of part of the flow when the reservoir level exceeds 418 m. A minimum flow rate of 3 m^3/s will be maintained at all times in the Manouane River by means of two 0.85 m pipes drilled into the part of the dam located on the right shore at elevation 411.2. Construction of the dam in the riverbed will require setting up a cofferdam upstream of the dam. The cofferdam elevation is dictated by the water level attained during 20-year pluvial floods (418 m), with a freeboard of 1.5 m. The cofferdam will therefore have a crest of 419.5 m. This cofferdam will be levelled to elevation 415.0 m once work has been completed.

Dikes

The project requires three dikes. Dike 1, located between kilometre 94.5 and kilometre 95, will be built in concrete and will be 5 m high and 36.5 m long, with a top width of 3.75 m, allowing for water discharge over its crest. To protect against overburden and erosion from floods with a 50-year recurrence interval or more, a 1.5 m gabion wall will be required above the dike's left abutment. Upstream, the excavations will be 136.5 m wide over a distance of 200 m. Downstream, excavations will be carried out from the foot of the dike up to the river, at kilometre 95, and will cover an area 98 m wide and 50 m long. The maximum depth of these excavations will be 8 m. Dike 2 will close the secondary branch of the Manouane River at approximately kilometre 99. The dike will be built entirely of fill and will be 14 m high and 138 m wide, with a crest at elevation 423 m. A cofferdam will be placed upstream of this dike up to elevation 416 m. Finally, Dike 6 would close the oxbow arm of the Manouane River 1.5 kilometres north of the dam, at kilometre 110. It will be 8 m high and 43 m long, with a crest at elevation 423 m. Dikes 2 and 6 will be built out of till, sand and gravel.

Diversion canals

Built over 7 km, the diversion canals will channel the water diverted from the Grand Détour reservoir to the Pipmuacan reservoir. The canals will follow natural depressions and will link three lakes. The excavated sections of the canals will total 5.6 km. Excavation is also planned for two of the lakes located along the diversion route (lakes Numéro Un and Numéro Deux). The first segment of the canal, 12 m long with an invert at elevation 413 m, will extend from the Grand Détour reservoir to Lake Patrick. The second segment, with a 9 m-wide invert, will extend from Lake Patrick to Hirondelles River, which flows into the Pipmuacan reservoir.

Flow-measuring weir

A concrete weir will be built downstream of the Lake Patrick outlet. This structure will allow for precise measurements of the flow diverted by the projected facility. With its crest located at elevation 413 m, this structure will be 1 m high and will occupy the entire 9 metre width of the canal. Gabions will be placed downstream and upstream of the structure. The canal bed downstream of the weir will be covered with a geomembrane and rockfill to protect against erosion.

Regulating structure

The regulating structure, equipped with 4.25 m wide openings, will be built immediately upstream of Lake Numéro Deux, at the edge of the current drainage basins of lakes Grand Détour and Patrick. It will be used to interrupt the flow to the Pipmuacan reservoir when spillage is expected at the Bersimis-1 facility.

Grand Détour reservoir

The Grand Détour reservoir will be created by the elevation of the water level of Lake Grand Détour. This reservoir will have an average basin area of 23 km^2 in the spring, corresponding to a 12.4 km^2 increase in the aquatic area. Its level will vary between an elevation of 413.8 m in low-water season and 419.2 m in flood season. The probable maximum flood would bring the reservoir level to 421.5 m, causing an additional area of 7 km^2 to be flooded.

Impact mitigation structures

Two structures (spurs) will be set up to mitigate the impacts on the environment. The first spur will be built at the Lake Duhamel outlet, at kilometre 50, in order to preserve the lake's current water-level variations between kilometres 50 and 61. It will occupy half the width of the river. This spur will be 50 m long, 2.5 m high, with a crest at elevation 252 m.

To prevent the spur from causing rises in the water level to exceed natural levels during flood periods, an area about 40 m wide will be levelled on the supporting shore, to an elevation of 252 m as well. The second spur will be built at kilometre 83 and will serve to maintain the current water levels between kilometres 83 and 92. This structure will have a crest level of 399 m, a maximum height of 2 m and a length of 65 m.

Access roads, work camps and temporary installations

The structures will be accessed from Saint-Ludger-de-Millot over a distance of 195 km via a road that leads to the Chute-des-Passes power plant. This road will require repairs in certain places. Some forest roads will be extended to the sites of the retaining and diversion canal structures, and it will be necessary to raise two bridges and to install culverts. As well, a temporary camp will be needed during construction of the structures. This camp will be built near the bridge that straddles the Grand Détour River.

2.4 Construction cost and schedule

The cost of the project is estimated at $72 million.[4] The work is scheduled to begin as soon as provincial and federal government authorizations have been obtained, and will take approximately 16 months. The proponent had planned the facility's commissioning for the fall of 2002.

3 Environmental assessment and applicable regulations

The project requires an environmental assessment under the *Canadian Environmental Assessment Act* (CEAA) since it will cause a loss of fish habitat productive capacity, which requires an authorization issued under subsection 35(2) of the *Fisheries Act* (FA). This 35(2) authorization triggers the CEAA under the *Law List Regulations*.

Before such an authorization is issued, the proponent has to propose a compensation plan in compliance with the principle of no net loss in fish habitat productive capacity as set out in the *Policy for the Management of Fish Habitat* of the Department of Fisheries and Oceans (DFO). This plan must be subject to the legal obligations of a compensation agreement between the proponent and the DFO. The compensation plan will be part of the condition of the Fisheries Act 35(2) authorization.

As well, the project is subject to formal approval under subsection 5(1) of the *Navigable Waters Protection Act* (NWPA), which is also a trigger of the CEAA.

As specified by section 9 of the *Comprehensive Study List Regulations*, a proposed construction, decommissioning or abandonment of a structure for the diversion of 10,000,000 m^3 per year or more of water from a natural water body into another natural water body, or an expansion of such a structure that would result in an increase in diversion capacity of more than 35 per cent, requires a comprehensive study-type environmental assessment.

A comprehensive study conducted under the CEAA is based on self-assessment, a principle which the Responsible Federal Authority uses as a basis to examine the environmental effects of a project before making any irrevocable decisions.

Within the meaning of the CEAA, the DFO, through the Fish Habitat Management Direction (FHMD) and Navigable Waters Protection Division (NWP), is the only Responsible Federal Authority for this project. DFO has ensured that the environmental assessment process and the comprehensive study are in compliance with CEAA requirements.

Other federal departments have also been consulted to determine their interest with regard to this project and to obtain their respective comments and requirements concerning the environmental assessment under the CEAA. These are Indian and Northern Affairs Canada (INAC), Environment Canada (EC), Natural Resources Canada (NRCan), Health Canada (HC), and Parks Canada (PC). The Canadian Environmental Assessment Agency (CEAA) has also worked on this file on matters of interpretation of the CEAA and methodology.

4 Scope of the environmental assessment

The scope of the project includes the construction of one dam, three dikes, a series of diversion canals, a regulating structure between lakes Numéro Un and Numéro Deux, a weir at the Lake Patrick outlet, two cofferdams, access roads and the use of waste disposal sites for excavation materials, as well as the partial diversion of water from the Manouane River to the Pipmuacan reservoir via a diversion canal and the Hirondelles River.

The environmental assessment includes study of the project's environmental effects including those caused by potential accidents or malfunctions and the cumulative effects that the project, combined with the existence of other structures or other projects or activities, is likely to cause to the environment.

Environmental impacts as defined by subsection 2(1) of the CEAA are the changes caused by the project to the biophysical environment and the direct effects of these changes on human health, socio-economic conditions, natural and cultural heritage (historical, archaeological,

paleontological and architectural) as well as the current use of lands and natural resources for traditional purposes by Aboriginals.

The study also deals with the following:

- the project rationale;
- the various means of carrying out the project;
- the significance of the environmental effects;
- the effects of the environment on the project;
- public comments;
- mitigation measures;
- the need for a follow-up program and its requirements;
- assessment of the capacity of renewable resources that may be significantly affected by the project to meet the needs of present and future generations.

5 Public consultation program

5.1 Hydro-Québec communications program and provincial public hearings

5.1.1 Hydro-Québec communications program

Hydro-Québec has set up a communications and community relations program in order to provide as much information as possible on the Manouane project, to find out about the concerns and expectations of the public directly affected, and to answer questions and comments from the various stakeholders. This program is described in Chapter 11 of the preliminary project report.[22]

The program was carried out in two steps 1) general information sessions (June to November 1997); and 2) meetings of an information and exchange table, workshops devoted to the project, meetings of a scientific committee, and information and consultation meetings (September 1997 to April 2000).

The first step consisted of eight meetings with 29 different organizations, including county regional municipalities (MRCs) and municipalities, ministries, media, band councils and recreational and tourism groups. The second step consisted of 28 meetings, including five sessions of the information and exchange table.

During the construction phase, the proponent intends to pursue the close collaboration initiated during the preparation of the environmental impact statement.

5.1.2 Public hearings

In accordance with the environmental assessment procedure of the Ministère de l'Environnement du Québec, the project was submitted to the Bureau d'audiences publiques sur l'environnement (BAPE) for investigation and public consultation. The commission's mandate was conducted from May 7 to September 7, 2001. The hearings took place in two parts. An initial round of hearings was held in Alma from May 14 to 17, 2001. The first session of the second round of hearings was held in Betsiamites on June 11, with the following sessions held in Alma on June 12 and 13, 2001. Ten public sessions were held in

all. During the second round of hearings, the commission received 27 briefs and verbal presentations. From May 7 to 10, 2001, in preparation for the public hearings, the commission held five preparatory meetings in Montreal, Québec City, Mashteuiatsh, Lamarche and Betisamites. It also held a meeting with the Secretariat aux affaires autochtones in Québec City on May 11, 2002. The commission also took a helicopter tour on May 15, 2001, of the area of the proposed structures and drainage basins of the Manouane and Péribonka rivers, from Lake Manouane to the Pipmuacan reservoir. The BAPE released its inquiry and public hearings report on October 4, 2001.[4]

5.1.3 Concerns and issues raised by the community

The public consultation carried out by the proponent and the BAPE revealed several issues and concerns held by the various organizations consulted. These pertained to partnership agreements, the impact of the project on the water level of Lake Saint-Jean, recreational and tourism potential, navigability of the Péribonka and Manouane rivers, activities of the Innu communities, landlocked salmon and other fish species, Betsiamites River salmon, beavers and caribou in the Baie aux Hirondelles, and mercury levels in fish flesh. Opinions and concerns were also put forth with regard to the introduction of rainbow smelt in Lake Duhamel by the proponent, the cumulative impacts on the Betsiamites River, the project's impact on timber-floating activities, the participation of organizations in the preliminary project studies and environmental follow-up, the public hearings conducted by the proponent, the timetable for the project, regional economic benefits, project costs and cost-effectiveness, project rationale, compensation of recreational leaseholders, the project's impact on outfitters' activities, the presence of signage during manoeuvres carried out on regulating structures, the history of exploitation of the Manouane and Péribonka rivers, and archaeological remains. Some individuals also raised questions concerning the interpretation of the sustainable development principle. The importance of setting up a classification system for the area's rivers was also underlined. This system would allow to determine the energetic development alternatives that would be beneficial on the economic, environment and social aspects for the next decades.

Of the various issues listed above, the primary subjects of concern during the public hearings held by the BAPE were the project's potential effects on recreational and tourism development, navigation, the project's pertinence, fishing resources and their harvesting (landlocked salmon in particular) as well as the creation of a limited partnership (SOCOM) whose sponsors would be the proponent and five county regional municipalities (MRC).

5.1.4 Position held by groups and organizations

The proponent states that through its communication and community relations program, it has been able to define the respective positions of the groups and organizations affected by the project to partially divert the Manouane River.

Hydro-Québec has reached an agreement providing for the creation of a limited partnership (SOCOM) with the MRCs of Fjord-du-Saguenay, Maria-Chapdelaine, Haute-Côte-Nord and Manicouagan. At the time of writing this report, the Lac-Saint-Jean-Est MRC, to be included in the agreement, had not yet signed. Hydro-Québec came to agreements with the Innu

communities of Mashteuiatsh and Betsiamites. The agreement with the Innus of Mashteuiatsh was signed in June 2001 while the latter was signed in September 1999.

The agreement between Hydro-Québec and the Innu community of Mashteuiatsh deals only with the partial diversion of the Manouane River. Mashteuiatsh would invest a percentage of the cost of the project and assume its share of the costs of harnessing, exploitation and environmental follow-up. Mashteuiatsh would in return receive an amount of money based on energy sales. Included in the agreement are other important monetary amounts which would be dedicated namely to an integrated development program, mitigative measures, garanteed contracts to Innu companies, and a commitment from Hydro-Québec to promote the hiring of Innus of Mashteuiatsh by the contractors.[4]

The agreement between Hydro-Quebec and the community of Betsiamites (Pesamit Agreement 1999) deals with Portneuf, Sault aux cochons, Manouane and Toulnustouc hydroelectric projects. It includes many financial aspects, such as investments from the community and returns from the energy sales, job creation and contract access, payments to the community, the creation of a community based fund and a Betsiamites-Hydro-Québec consortium with a fund for mitigative measures. Hydro-Québec would make available to the consortium amounts, which would be intended, in priority, to support land use and occupation by the Betsiamites community members affected by the project. The Pesamit Agreement 1999 also provides for the development of a project for the rehabilitation of salmon in the Betsiamites River.

It would seem that an agreement has been reached between the Alcan company and Hydro-Québec to compensate the production losses at five of Alcan's generating stations following the diversion of 30 m^3/s of the Manouane River to the Pipmuacan reservoir. This agreement would return to Alcan 360 GWh of the 678 GWh produced by this diversion.[4, 22]

Representatives of the Regroupement des locataires des terres publiques [Association of public-land leaseholders] and the Regroupement régional des gestionnaires de Zones d'exploitation contrôlées (ZEC) [Regional association of managers of controlled zones of exploitation] expressed their satisfaction with the proponent's public consultation process and the meetings with recreational facility owners. They consider the proponent's project acceptable. The Comité de protection de la rivière Péribonka [Committee for the protection of the Péribonka River] participated in the meetings of the information and exchange table. The committee seems satisfied with the discussions and explanations but points out that public hearings also play a role of fostering understanding among the general public. [22]

The public hearings carried out by the BAPE showed that the community is divided over the project. Some are of the opinion that the project would be a significant economic lever for the region, and that the agreements signed with the proponent would assure the regions and local groups the place they are entitled to as users and managers of the territory. However, others—such as the municipality of Lamarche—consider that the diversion project would hinder the development of the community, which aims to develop its local economy by building on the recreational and tourism potential of the Péribonka and Manouane rivers. As well, some participants, including the Fédération québécoise du canot et du kayak (FQCK) [Québec canoeing and kayaking federation], the Centre de plein air de Tchitogama [Lake Tchitogama outdoor centre], the Camp des Écorces de Tchitogama and the Club de canot-

camping L'Aviron [canoe-camping club], fear that the project will harm recreational and tourist uses of the territory, such as pleasure boating and recreational fishing, and will curtail development of its potential in the future. [4]

Mouvement Au Courant, the Conseil régional de l'environnement du Saguenay-Lac-Saint-Jean [regional environment council of Saguenay-Lac-Saint-Jean] and the FQCK voiced reservations about the project's rationale and pertinence in terms of the increased energy demand of Québec citizens. However, the Association de l'industrie éléctrique du Québec [electrical industry association of Québec] and the Association of Consulting Engineers of Quebec are of the opinion that the project is justified because it responds to the province's internal energy needs and would absorb in part the growth in demand. [4]

Managers of the Pourvoirie du Lac Duhamel are concerned with the maintenance of current fishing conditions for landlocked salmon; they fear that the consequences of the variation of hydraulic parameters may be greater than anticipated and that the potential of the segment of river that runs through the outfitter's territory may be affected. Moreover, the Pourvoirie du Lac Duhamel voiced its doubt about the effectiveness of the mitigation measures proposed by the proponent to limit the project's effects on landlocked salmon. In light of these apprehensions, the outfitting operations affected by the project (Pourvoirie Pavillon Boréal and Pourvoirie du Lac Duhamel) —have submitted requests to obtain a guarantee that they will be able to continue their activities and that they will be compensated for the environmental impacts caused by the project. The proponent has agreed to implement mitigation measures in collaboration with the outfitters, and to continue discussions on possible compensation for losses and inconveniences resulting from the project. [22]

5.2 NWPA posting

As required by the *Navigable Waters Protection Act* (NWPA), the proponent places a notice in the Canada Gazette (July 20, 2002) and two local newspapers (July 21, 2002) to apprise the public of its project and invite people to share their concerns about navigation.

5.3 Public consultations under the CEAA

A period for public comment is provided when the comprehensive study report is filed with the Canadian Environmental Assessment Agency (CEAA). During this period the public will be able to review the documents and express their opinions and concerns about the project's environmental effects. In addition, there were eight requests for documents from the public registry from March, 2001 to August, 2002.

5.4 Aboriginal groups consultations

Aboriginal groups affected by the project were consulted and will be again in the future. Indeed, in the course of the implementation of its communications and community relations program, Hydro-Quebec met with the Montagnais Council of Lac Saint-Jean (elected band council of Masteuiatsh) and the Betsiamites Band Council. These groups participated actively to the meetings of the information and exchange table.

A working group composed of representatives from the Montagnais Council of Lac Saint-Jean and the proponent was also formed during the preliminary stages of the project. It met

six times before the environmental impact study was filed (July 1997 to April 2000) to discuss inventories to be conducted, the results of those inventories and foreseen mitigating measures. As well, the Innus from Mashteuiatsh collaborated with Hydro-Québec's consultants in the preparation of studies dealing with land use and archaeology. Also, negotiations were undertaken between Hydro-Québec in 1998 and representatives of Betsiamites and Mashteuiatsh which resulted in the agreements mentioned in section 5.1.4.

The Betsiamites Band Council delegated five representatives during the public hearings held by the BAPE and presented a brief. The Innus of Mashteuiatsh were not represented at the provincial public hearings. However, a summary of the Mashteuiatsh agreement was filed to the BAPE by the Montagnais Council of Lac Saint-Jean. Also, the community has been implicated in the realisation of the preliminary studies prepared by the proponent, they participated at a preparatory meeting for the BAPE public hearings in Mashteuiatsh as well as in the proponent's communications program.

As well, the Department of Indian and Northern Affairs of Canada (INAC), considering that Aboriginal groups are the best judges of the possible effects of the project on their activities, contacted representatives of Mashteuiatsh and Betsiamites. They did not raise any particular preoccupation which would require that they be consulted before the tabling of the comprehensive study.

Also, the present comprehensive study report will be submitted to public consultation, as prescribed by the CEAA. This will provide further possibilities to aboriginals to voice their preoccupations towards the project. Furthermore, public consultation under the NWPA were another opportunity for Aboriginal groups to express their concerns.

As specified previously, the proponent plans to pursue, during the construction and exploitation phases, the close collaboration initiated with Aboriginal groups during the preliminary phase of the project.

6 Current state of the environment

Chapters 5, 6 and 7 of the preliminary project report provide a detailed description of the general components and environmental issues involving natural and human environments.[22] The documents cited in section 1 of the current document may also provide additional information. The following sections present the main points related to the current state of the environment.

The territory under study has been divided into five sectors in order to facilitate the description of the host environments and environmental effects, namely:

- the Péribonka River;
- the Manouane River;
- the Lake Grand Détour;
- the Hirondelles River; and
- the Betsiamites River.

6.1 Physical Environment

6.1.1 Hydrography, hydrodynamics and river features

Péribonka River

The river has its source in the Otish Mountains, nearly 400 km north of Lake Saint-Jean, and drains a watershed of 27,000 km^2. There are three generating stations on the Péribonka River: Chute-à-la-Savane, Chute-du-Diable and Chute-des-Passes. The three plants are located, respectively, 19 km, 39 km, and 195 km upstream of Lake Saint-Jean. The Chute-des-Passes dam is located about 10 km upstream of the generating station of the same name. The Manouane reservoir is located at the headwaters of the Manouane River, the flow of which was diverted toward the Péribonka River by way of the Bonnard canal in the late 1950s. The Chute-du-Diable and Chute-à-la-Savane generating stations are referred to as run-of-river power plants, which means they do not have any active water storage and that their headbay level is relatively constant. The headbay of the Chute-du-Diable generating station reservoir, located about 50 km upstream from the station, at kilometre 95, is characterized by the presence of sand bars that gradually emerge as the flow of the Péribonka River is reduced. Under current conditions, a channel provides the depth necessary for navigation (0.6 m). The section of the Péribonka River located between Route 169 (km 21) and Serpent River (km 158) has been inventoried over an area of approximately 103 km^2. The vast majority of this area, or approximately 101 km^2, is characterized by a slow flow (less than 0.5 m/s), a depth greater than or equal to 1 m, and a substrate composed of silt, clay or organic debris. Elsewhere, there is a rapid flow (greater than 0.5 m/s), a depth less than 1 m, and a substrate composed of materials of various grain sizes, from gravel to blocks.

Manouane River

The Manouane River has its source immediately downstream of the Manouane reservoir, at the east spillway's outlet point. It runs 250 km from its source until flowing into the Péribonka River. It has a difference in elevation of 306 m and drains a watershed of 4,600 km^2. In the projected construction zone, its average flow rate is about 39 m^3/s, reaching approximately 106 m^3/s at its junction with the Péribonka River. The river's route includes lakes, falls and rapids, as well as subcritical flow sections. Aside from Lake Duhamel, located between kilometres 51 and 61, the majority of the lakes are at the headwaters. The falls and rapids are located primarily between kilometres 65 and 93. The subcritical flow reach extends from the confluence of the Manouane and Péribonka rivers to Lake Duhamel. Lake Duhamel has a maximum width of less than 700 m. Its water level generally remains between elevations 250.5 m and 252.3 m, while the depth of the lake ranges from 2 m to 24 m.

The Manouane River has been divided into four segments according to its physical characteristics. The first segment, extending from the river mouth (kilometre 0) to Lake Duhamel (kilometre 51), has very little difference in elevation. It has an entrenched bed, the valley floor is very wide, and the slopes are often very steep. The second segment consists of the lacustrine area of Lake Duhamel. It has steep sides and a relief of hills. The third segment, extending from kilometres 61 to 81, is slightly entrenched. It has a difference in elevation of 145 km, or 7 m per kilometre of river. The fourth segment concerns the section

of the Manouane Rover located upstream of kilometre 81 as well as the tributaries that will be submerged upon the project's completion. This segment has a difference in elevation of 0.5 m per kilometre of river, and only a few rapids break the watercourse slope.

The riverbed substrate of segment 1 is made up primarily of a mix of gravel and pebbles. Segment 2 of Lake Duhamel has a sandy substrate. Segment 3 is composed mostly of outcrops of bedrock, blocks and cobbles. The riverbed of segment 4 is mostly sandy.

Lake Grand Détour

Lake Grand Détour is located in the zone that is to be submerged. The lake has an area of 425 ha and 19.3 km of shoreline. Its maximum depth is 13 m, with an average depth of 2.9 m. The current mean water level of Lake Grand Détour is around elevation 412.8 m. Observations of the sequence of riparian vegetation indicate a drawdown of less than 2 m. The substrate of the Lake Grand Détour sector is predominantly sandy. The rapid flow zones account for 10% of its length. In these spots, the lakebed is composed of coarser materials such as gravel, blocks and cobbles.

Hirondelles River

Lakes Numéro Un and Deux and Lake Patrick are located directly on the path that the diverted water will take to get to the bay of the Pipmuacan reservoir (Baie aux Hirondelles). The maximum depths of these three lakes are approximately11 m, 9 m and 27 m respectively. The watershed of Lake Patrick has an area estimated at approximately 10 km^2. The inflow from this watershed represents approximately 0.6% of the Manouane River's entire inflow at kilometre 97. The current level of Lake Patrick is approximately at elevation 416m. Its area at the mean level of 416 m is estimated at approximately 1 km^2. The average inflow of Lake Patrick is estimated at approximately 0.2 m^3/s, reaching an average of approximately 1.6 m^3/s during spring floods.

The Hirondelles River has an estimated watershed of 52 km^2. The moderate inflow from this watershed represents an average of 3% of the inflow to the Manouane River at kilometre 97. The average inflow is estimated at 1.2 m^3/s, reaching 8.7 m^3/s during spring floods. The lacustrine area and meanders are the principal types of facies encountered. The rapids and riffles represent 6% of the river length. The substrate of the meanders and lakes is sandy with blocks. In the rapids, the substrate is composed of blocks, cobbles and pebbles.

Betsiamites River

The Betsiamites River is characterized by the presence of two reservoirs, Pipmuacan and Bersimis-2, which are managed so as to supply two hydroelectric generating stations, Bersimis 1 and 2. The mean flows of the river are 274 m^3/s at Bersimis-1, 324 m^3/s at Bersimis-2 , and 402 m^3/s at the river mouth where it flows into the Saint Lawrence River. The Bersimis-2 generating station is located 72 km from the river mouth. Due to management for Bersimis-2, the river flow downstream from the station is subject to sudden and frequent variations. On any given day, the flow can vary by 150 m^3/s above or below the average. During normal operating periods, the flow fluctuates between 600 and 130 m^3/s, the latter threshold having been set as a protection criterion for biological and human use. [22]

The probable maximum spring and fall floods for the Betsiamites River basin at Bersimis-2 have been assessed at approximately 2,700 m^3/s and 2,350 m^3/s respectively. As for 10,000-year floods, the spring and autumn peaks are approximately 2,000 m^3/s and 1,600 m^3/s respectively.

In the case of the Betsiamites River estuary, there is no natural weir to slow tide penetration until kilometre 25. During spring tide, the tide is felt up to 10 km. Water level recordings show that the tide does not reach kilometre 23. The limit of tidal influence is therefore located between kilometres 10 and 23.

The proponent plans to undertake a data collection campaign in 2002 in order to better define the reference state concerning salt water intrusion into the Betsiamites River. [26]

6.1.2 Stability of riverbed and banks

The description of the banks' sensitivity to erosion, for the various rivers and bodies of water affected by the project, was realized according to photo interpretation results presented in the preliminary project report.[22] Photo interpretation of the banks was carried out for segment 3 (from km 61 to km 81) and segment 4 (km 81 to km 127) of the Manouane River, for Lake Grand Détour and the tributaries that would be flooded by the project, and for the Hirondelles River. These are the segments that would be most affected by the partial diversion of the Manouane River. Photo interpretation of the banks was not conducted for segment 1 or the Péribonka River, as the drops in water levels and the nature of the materials are not likely to make the new banks sensitive to erosion. Nor was photo interpretation done for segment 2, given that a spur would be built at the Lake Duhamel outlet to preserve the current water level variation between kilometres 50 and 61. The criteria for the banks' sensitivity to erosion are based on the cohesion between particles and the angle of the bank slope.

Péribonka River

Given their granulometric composition, the terraces of the Péribonka River are subject to erosion in the form of gullying, bank caving, and rockslide.

Manouane River

The banks of segment 3 of the Manouane River are composed predominantly of sand and gravel (44%) and sand (16%). This segment has both gentle and steep slopes. Banks of till and till on bedrock are less frequent, accounting for roughly 23% of this river segment. In segment 4, the banks are composed almost exclusively of sand and gravel (90%), and its slopes range, for the most part, from moderate (11 to 25% inclination) to steep (inclination greater than 25%).

About 35% of the banks of segment 3 of the Manouane River (from km 61 to km 81) are highly sensitive to erosion. These banks are composed of sand and sand and gravel, and are located mainly between kilometres 61 and 65, and between kilometres 76 and 81. The sections made up of till and till on bedrock, however, show low sensitivity to erosion. Nearly 90% of the islands show low sensitivity to erosion, due to their low slopes. Segment 4 of the Manouane River (from kilometre 81 to 127) is composed mainly of banks with moderate to high erosion sensitivity, which account for 79.6% of the segment. The banks are made of sand, with moderate to steep slopes. In this segment, 55% of the islands show moderate

erosion sensitivity. The inventory of the banks indicates that about 3.3 km are eroding in segment 3 of the Manouane River, and 2.6 km in segment 4.

Lake Grand Détour

In the Lake Grand Détour sector, nearly 57 km of banks have been studied. Some about 90 % are composed of sand, with low to moderate slopes (from 1 to 10% inclination). About 50 % of the banks of Lake Grand Détour and its tributaries have low erosion sensitivity. Some 4.8 km of the banks in the Lake Grand Détour sector show erosion.

Hirondelles River and diversion canals

A total of 16.6 km of banks have been mapped along the Hirondelles River, Lake Patrick and Lake Numéro Deux. These banks are composed of sand and gravel (51%), till (29%) and till on bedrock (8%). The banks of lakes Numéro Deux and Patrick are mostly made up of till, and have low to moderate slopes. Generally, they show low erosion sensitivity. The banks of the Hirondelles River have average to low slopes, especially downstream, and sandy and sandy-gravelly sediments. No eroding banks have been inventoried along the Hirondelles River.

Betsiamites River

In 1985, the total length of banks affected by erosion was 65 km out of a total length of 144 km. Most of the toes of slopes were composed of relatively cohesive clays.

6.1.3 Thermal regime

Manouane River

The water in the Manouane River reaches its peak temperature at the end of July or beginning of August. It fluctuates by 1 or 2°C from day to night, and usually remains between 16 and 23°C at kilometre 61 and between 15 and 22°C at kilometre 97. Around mid-August the water begins to cool, reaching 0°C in November.

Lake Grand Détour

Under the current conditions, except for during major heat waves without any wind, Lake Grand Détour is hardly stratified, given that it is very shallow. The section of the Manouane River between kilometres 97 and 108.5 as well as the Grand Détour River have a thermal regime very similar to that of the portion of the Manouane River that lies downstream from the projected dam, to be located at kilometre 97.

Hirondelles River

There has been no survey of the water temperature of the Hirondelles River. The river is narrow and flows over a steep rocky bed, punctuated by several rapids. It is therefore likely that, in the summer, the water is colder than in the Manouane River. In the fall, however, its cooling may be slowed in relation to that of the Manouane River, and it may remain ice-free until a later date. In the spring, break-up is likely to come earlier on the Hirondelles River than on the Manouane River.

Betsiamites River

From June 15 to September 1, the water temperature of the Betsiamites River varies between 12 and 17°C. The thermal regime of the Betsiamites River is largely influenced by the water temperature of the Pipmuacan reservoir, which means that the spring heating and fall cooling of this river's waters occurs more slowly. This influence also causes higher winter temperatures. In winter, the river's water temperature remains between 1 and 2°C.

6.1.4 Ice regime

The Manouane River's steepest gradient, located between kilometres 3 and 4.5, encourages frazil ice to evacuate downstream. Part of this frazil ice is evacuated into the Péribonka River. The other part builds up at the mouth of the river (kilometres 1 and 2) and forms a dune. This dune no doubt raises the water level in the downstream portion of the river up to kilometre 4.

In the Manouane River, downstream of kilometre 61, only the Lake Duhamel outlet (kilometre 50) remains free of ice throughout the winter. At the beginning of winter, there is an ice-free clearing between kilometre 8 and kilometre 50, which gradually freezes over as the season progresses. The frazil ice that forms at the beginning of the winter in the clearing between kilometres 61 and 66 appears to be evacuated toward the river mouth in Lake Duhamel. The frazil dune that is thus formed is not large enough to modify the water levels in the spawning areas. The section of rapids further upstream remains partially free of ice throughout the winter. The frazil most likely accumulates in the form of dunes in the slower sections (from kilometre 70 to kilometre 74) or moves underneath the ice until the entrance to Lake Duhamel. Thus, no frazil ice is deposited in any of the river's spawning areas.

6.1.5 Water quality

The physico-chemical characteristics of the waters affected by the project are described in section 5.8 of the preliminary project report.[22] Little data is available on the water quality of the lakes, rivers and reservoirs under study. However, the area studied does not contain any sources of pollutant emissions likely to modify the water quality.

6.2 Biological environment

6.2.1 Ichthyofauna and fish habitat

The information described below was taken primarily from the preliminary project report [22] and the technical report on fish,[1] presented by the proponent.

Manouane and Péribonka rivers

The principal species found in the Manouane and Péribonka rivers are brook trout, lake trout, whitefish, northern pike, landlocked salmon and yellow walleye. There is also some white sucker, longnose sucker, burbot, round whitefish and some species of cyprinids and sculpins. The presence of brook trout is considered marginal, except in the tributaries of the Manouane and Péribonka rivers, where it is abundant.[2] Lake trout is probably present as well in the Manouane and Péribonka rivers, since it is present in some lakes that flow into these rivers. It is absent, however, from lakes Duhamel, Grand Détour and Patrick. Landlocked salmon and

yellow walleye are found in the Péribonka River, Lake Duhamel, and the first 68 kilometres of the Manouane River. Rainbow smelt is abundant in Lake Tchitogama and possibly the Manouane River. As well, threespine stickleback, five-spined stickleback, lake herring and yellow perch can be found in the Péribonka River downstream from Chute-de-la-Savane.

Potential spawning grounds for landlocked salmon are indicated on the map titled "Inventaire des milieux humain et biophysique de la rivière Manouane" [Inventory of the human and biophysical environments of the Manouane River] in Appendix S of the preliminary project report.[23] The characteristics of these spawning grounds are presented in Appendix F of Volume 2 of this same report. In the Manouane River, the only landlocked salmon spawning ground recognized by the Société de la Faune et des Parcs du Québec (FAPAQ) is located upstream of Lake Duhamel, at kilometre 62.5. This spawning ground occupies an area of about 54,000 m^2. Moreover, the results of the photo interpretation of the accessible portion of the Manouane River (from kilometre 0 to kilometre 68), presented in Appendix D of the preliminary project report[23], show that the area containing riffles conducive to landlocked salmon spawning extends approximately 666,000 km^2. In addition to the spawning grounds mentioned above, the FAPAQ points out the presence of a sizeable potential spawning zone for landlocked salmon near the mouth of the Manouane River. The study carried out by the proponent led to the discovery of ten potential spawning grounds in this sector, between kilometres 3 and 19, for a total area of 45,000 m^2. There is also a potential spawning area at the mouth of the Houlière River (kilometre 33; approximately 440 m^2), and another at the mouth of the Petite Manouane River (kilometre 61; approximately 19,000 m^2). In the Manouane River, the more sensitive juvenile-rearing habitats are the shallow sills located near the spawning grounds, between kilometres 3 and 19, as well as between kilometres 61 and 68. In the other sectors, usable juvenile habitats are concentrated mainly close to the shores or inside the tributaries.

Habitats in the Manouane River usable by juvenile landlocked salmon are concentrated mostly close to the banks. In total, taking into account all of the accessible portions of the Manouane, Duhamel and Petite Manouane rivers, habitats favourable to landlocked salmon rearing occupy an area of 467 ha, of which 83% are located along the route of the Manouane River. According to the proponent, the lotic habitats available in the accessible part of the Manouane River are in no way a limiting factor for landlocked salmon, which leads us to believe they are probably under-used by the juveniles. However, it seems that the low availability of lacustrine environments (feeding areas) in the basin of the Péribonka and Manouane rivers constitutes the main limiting factor for the landlocked salmon population living upstream from the Chute-du-Diable dam. In addition to the low availability of lacustrine environments, the landlocked salmon population living in the Péribonka and Manouane basin face several other potentially limiting factors. The main factors are the possible overexploitation of the resource in the free access areas located downstream from the Pourvoirie du Lac Duhamel, the loss of specimens from the downstream migration of fish at the Chute-du-Diable dam, the inaccessibility of the feeding areas in Lake Saint-Jean, the absence of rainbow smelt (the landlocked salmon's preferred prey) in Lake Duhamel and the Manouane River, as well as the presence of several competing species such as yellow walleye, northern pike and burbot.

There are no habitats suitable for landlocked salmon rearing in the portion of the Péribonka River contained between the Chute-du-Diable dam and its confluence with the Manouane River. As for rest places (pools) for landlocked salmon, they seem to be sufficiently abundant and well distributed throughout the accessible portion of the Manouane, Duhamel and Petite Manouane rivers.

An inventory of yellow walleye spawning grounds conducted in spring 2000 on the Manouane River between kilometres 33 and 65.5, as well as on the Petite Manouane River up to its confluence with the Duhamel River, led to the identification of 15 potential spawning grounds for yellow walleye, six of which are in use. Three of the spawning sites confirmed are located upstream from Lake Duhamel: two sites at the confluence of the Petite Manouane and Duhamel rivers, and one at kilometre 63.5 of the Manouane River. The three other confirmed sites are located downstream from Lake Duhamel, at kilometre 35.3, kilometre 49.4, and kilometre 49.6. The average area occupied by each spawning ground (potential or confirmed) is estimated at about 350 m^2. It is also possible that yellow walleye spawn near the outlet of Lake Duhamel, downstream from a small island located at kilometre 51.2. As for the lake itself, an inspection revealed that the littoral slopes are too steep and do not have the characteristics conducive to yellow walleye spawning. According to the inventories conducted, the availability and quality of spawning sites do not truly constitute a limiting factor for yellow walleye productivity in the Manouane River and Lake Duhamel. In addition to the spawning grounds identified above, the mouths of the various tributaries of the Péribonka and Manouane rivers offer potential spawning grounds for yellow walleye.

Inside Lake Duhamel, yellow walleye have a significant rearing and nursery area. In fact, this lake has a wide variety of fish species that can serve as prey fish (sucker, cyprinid, whitefish and round whitefish). However, this body of water has low conductivity and a particularly low morphoedaphic index, causing it to have low productivity; such conditions are not favourable to yellow walleye development. Indeed, yellow walleye populations reach their highest density in rivers and bodies of water that are shallow, turbid, moderately productive (mesotrophic) and have a substantial littoral zone. Lake Duhamel is located on the edge of the northern limit of the species range, which means that the gonad growth and maturation seasons are relatively short and cold. The Manouane River delta upstream from Lake Duhamel (kilometres 61 to 64), the mouth of the Manouane River (kilometres 0 to 3), and the Péribonka River are the other main rearing and food supply sites for yellow walleye.

In the lower reaches of the Manouane River (kilometres 0 to 68), the main habitat constraints confronting the yellow walleye pertain to the availability of rearing and feeding areas, since there are few slow-flowing areas in this section of river. Thus, all factors listed above may contribute to limit yellow walleye production in the system under study.

FAPAQ files do not contain any information on the lower reaches of the Manouane River (kilometres 0 to 68) and the Péribonka in terms of spawning grounds that may be used by other species of interest, such as brook trout, northern pike and whitefish.

Brook trout is rare in the waters affected by the project. This situation can be explained by the presence of numerous predator or competing species. In fact, the flow and habitat conditions of the Manouane River, Grand Détour River, Lake Grand Détour, Lake Patrick and Hirondelles River are distinctly more suitable to northern pike, whitefish and sucker than

to brook trout. Availability of brook trout spawning habitats is probably not a limiting factor since the species is able to spawn in sites similar to those used by landlocked salmon. In the survey conducted by the proponent, only one brook trout spawning ground, less than 100 m^2, was detected, near kilometre 91. However, a spawning ground recognized as one of brook trout is present at the outlet of Lake Paul, which joins the Manouane River at kilometre 75. In the upper reaches of the Manouane River, the best quality habitats for the rearing of young trout are located between kilometres 68 and 82.5. However, trout movement is greatly restrained in this area due to the presence of 12 falls and cascades, four of which are deemed utterly impassable by salmonid fish. Starting at kilometre 82.5, habitats offering lotic-type flow conditions account for less than 20% (410,700 m^2) of the area available to the trout, in both the Manouane River's main watercourse (kilometres 82.5 to 128) and the tributaries that will be submerged. Such conditions appear distinctly more favourable to the development of northern pike, which at the same time restricts brook trout development, given that the northern pike preys on brook trout.

Upon the DFO's request, exploratory electrical fishing was carried out from August 1 to 6, 2001, in the Manouane River between kilometres 68 and 82, as well as in the two main tributaries located in this sector (Naja and Adèle streams) in order to check for the presence of brook trout.[2] During this survey, the presence of brook trout was confirmed in the Naja stream only. The results obtained therefore support the hypothesis that the presence of brook trout in the Manouane River is marginal.

The areas most suitable to northern pike, both in terms of flow and slope conditions and the development of riparian ecotones, are located between the mouth of the Manouane River and kilometre 14, in Lake Duhamel, and in the delta upstream from this lake. In fact, there are numerous aquatic and riparian vegetation zones conducive to northern pike reproduction all along the Manouane River. The largest vegetation zones are located between the river mouth and kilometre 14, in the southern part of Lake Duhamel, in the delta upstream from this lake (kilometres 61 to 64), and from kilometre 78 up to the limit of the future submergence zone.

The principal rearing and feeding areas of the northern pike are between the mouth of the Manouane River and kilometre 14, in Lake Duhamel, and in the delta upstream from this lake (kilometres 61 to 64), as well as upstream from kilometre 82 up to the site of the projected dam. Lake Duhamel contains few bays favourable to the northern pike, as a result of its very uniform shape. Beginning at kilometre 82, lentic habitats become distinctly predominant (more than 88% of the areas), favouring northern pike to the detriment of brook trout, given that the northern pike preys on brook trout. Northern pike therefore appear to be the dominant species in this section of river.

Hydromorphological inventories show a preponderance of rapid flow zones in the lower reaches of the Manouane River, which would indicate that whitefish have a large number of spawning grounds. Relatively cool summer temperatures and the oligotrophic conditions found in Lake Duhamel are conducive to whitefish development. In the summer, the whitefish probably remain within the lake interior. The sectors most suitable to the feeding of northern pike, as listed above, are probably also used for the rearing and feeding of whitefish. However, the whitefish would prefer the deeper areas in the river centre, while the northern pike would tend to gather in the shallow areas, close to the river banks.

Lake Grand Détour

Northern pike have numerous aquatic and riparian vegetation zones conducive to their reproduction on the periphery of Lake Grand Détour, as well as in the adjacent watercourses (Grand Détour and Manouane rivers). Whitefish, meanwhile, can probably reproduce in the Grand Détour River.

Conditions in the Grand Détour River are poorly suited to the rearing of brook trout, as lentic habitats account for more than 90% of the available areas. This habitat is more conducive to the development of northern pike than brook trout.

Lake Grand Détour does not seem favourable to the natural maintenance of lake trout, given its shallow depth (maximum 13 m), its low pH, and the absence of sites conducive to the reproduction of this species.

Hirondelles River

According to available data, Hirondelles River and Lake Patrick can be considered as marginal habitats for brook trout given, on the one hand, the presence of northern pike, whitefish and sucker, and on the other, the limited reproduction and rearing potential.

Several young pikes were seen during inventories conducted in the main tributary and the outlet of Lake Patrick, which suggests that this species can reproduce in this watercourse.

Pipmuacan reservoir and Betsiamites River

The fish species likely to be present in the Baie aux Hirondelles and the Pipmuacan reservoir are whitefish, northern pike, white sucker, longnose sucker, burbot, lake trout and brook trout. Available habitats in this bay are not known, however. [18]

A total of 17 species are present in the Betsiamites River, in the area downstream from the Bersimis-2 generating station. Of these species, the Atlantic salmon, whose population is judged precarious, is one of the most important species harvested by the Aboriginal community of Betsiamites, at the river mouth. Other species found in the river include brook trout, whitefish, northern pike, the American eel and rainbow smelt, as well as Atlantic sturgeon, cod and lamprey. Capelin, plaice, herring and lumpfish are found in the estuary of the Betsiamites River.

In terms of the Atlantic salmon population, an estimated 100 to 500 adult salmon make an upriver run each year.

There are no major obstacles to salmon movement in the section of the Betsiamites River contained between the river mouth and the Bersimis-2 dam. The main tributaries of the Betsiamites River, however, contain several impassable obstacles that make them inaccessible to the salmon. In the Betsiamites River, good-quality salmon-spawning areas account for about 6% of the total area of available habitats. The main spawning grounds used are located at the top of the river at kilometres 67, 65, 52 and 42. The tributaries are more marginally used for spawning (redds were identified in Boucher River only). [1]

In Betsiamites River, the utilization rate of available habitats by young salmon indicates that the density of juveniles in this watercourse is low compared to the other rivers of the Côte-Nord [North Shore] and Québec. [1]

In the main reach of the Betsiamites River, 57.5% of available habitats with a flow of 130 m^3/s offer favourable conditions for juvenile rearing. The proportion of category I (excellent quality) and category II (moderate quality) habitats is approximately 36% and 22% respectively for all available habitats. In the accessible portion of the main tributaries, the combined proportion of excellent or moderate quality habitats is approximately 63%, slightly above the values observed in the Betsiamites River. [18]

Available fry-rearing sites remain stable at flows varying between 60 and 200 m^3/s, whereas the optimum flow for parr is 175 m^3/s. [18]

While conducting studies on salmon, several species of fish were observed downstream from the Bersimis-2 generating station and near the tributaries and the estuary of the river. The list of species present can be found in the document "Dérivation partielle de la rivière Sault aux Cochons, février 2000" [Partial diversion of the Sault aux Cochons River, February 2000].[20] The northern pike can be added to this list. [18]

The species identified in the river mouth and adjacent coastal area are diverse. In the rivers's estuary, capelin enjoy the beaches up to kilometre 5, as well as the beaches at Pointe à Michel and the sand spit of the Betsiamites. Plaice appear to occupy the entire channel up to the route 138 bridge (kilometre 8.5). More to the west, Atlantic sturgeon are reported along the shoreline between Pointe à Michel and the Îlets Jérémie. Atlantic cod and Atlantic halibut can be found further offshore. A seal haulout has also been spotted less than 1 kilometre offshore from Pointe à Michel. [18]

Significant concentrations of soft shell clams are present in the estuarine shoals, on the banks facing the town of Betsiamites, and facing all the beaches from Pointe à Michel to the Îlets Jérémie. Green sea urchins, waved whelk, Stimpson's surfclam and snow crab are also found in the sector. However, there is little data available on the abundance and distribution of these species. [18]

During electrical fishing campaigns carried out for salmon studies, an assessment of eel abundance was done based on incidental catches. According to these inventories, the number of juvenile eel is very low in the Betsiamites River and its main tributaries, with the exception of the Nipi River. [25]

The habitat most beneficial for the feeding and growing of eels (lakes) is completely absent from the easily accessed portion of the Betsiamites basin. The channels along the main reach of the Betsiamites are fairly deep and fast-flowing, making it unlikely that large eels would frequent them. Eel densities in the channels are therefore probably as low as in zones of rapids and riffles. The substrate of the Betsiamites River is made up largely of granular materials (pebbles, cobbles and gravel) plugged by clayey-silty particles, affording little possibility for eels to bury themselves in the substrate during the day. It is possible, however, that eels use the Betsiamites estuary for summer feeding and then swim up the river in the fall to overwinter. [18]

Rainbow smelt is the main species fished at the fishing weir located on the river's estuary left bank. In the Betsiamites, salt water can penetrate the estuary through the bottom up to 10 km from the river mouth. Given the substrate's characteristics, smelt could spawn upstream of the maximal influence area of saltwater penetration as far as the structures of the Bersimis-2

complex. Potential smelt spawning sites therefore appear to be abundant beyond the salt intrusion limit and do not constitute a limiting factor for this species in the Betsiamites River. [18]

Brook trout is found in the portion of the Betsiamites River located downstream from the Bersimis-2 facilities. Roughly 60% of the habitat available in the Betsiamites includes rapids and riffles suitable for the rearing of brook trout. As well, this species has many potential spawning sites all along the river, given the dominance of granular, gravel and pebble substrates. If the only criterion for potential spawning grounds is sites dominated by a gravel and pebble substrate, then the total potential area is approximately 1,350,000 m^2. However, the numbers of juvenile brook trout appear to be very low in the Betsiamites River and its tributaries. [18]

6.2.2 Riparian and aquatic vegetation

Generally speaking, the semi-aquatic ecosystems form a narrow shrub strip dominated by sweet gale and speckled alder.

According to the Centre de données sur le patrimoine naturel du Québec (CDPNQ), no vascular plant species susceptible to be designated as threatened or vulnerable under the *Act respecting threatened or vulnerable species* has been reported along the Manouane River, Lake Grand Détour or the Hirondelles River. However, very few plant inventories have been carried out in the area under study. It is therefore possible that this area may still contain such species. In the Péribonka River sector, the CDPNQ has identified Greene's rush as the only vascular plant species susceptible to be designated as threatened or vulnerable.

In 1990, the Ministère de l'Énergie et des Ressources du Québec conducted an inventory of plant colonies in the Parc de conservation de la Pointe-Taillon [Pointe-Taillon conservation park]. In all, 46 plant colonies or groups of individual plants were found. They were: marram grass, poverty grass, beach pea, prairie cord grass, caudate wormwood and Western sand cherry. At the time of the inventory, all the colonies were considered vulnerable or endangered.

Péribonka River

The length of the Péribonka River, riparian and aquatic vegetation is concentrated inside the Parc de conservation de la Pointe-Taillon, particularly on the south bank. Moreover, of the peat bogs located in the MRCs of Maria-Chapdelaine and Lac-Saint-Jean-Est, only the Pointe Taillon peat bog is currently protected.

Manouane River

Riparian vegetation along the first 14 kilometres of the Manouane River, covering 146 ha, is composed mostly of high scrubland. From kilometre 14 to 51, there is 21 ha of riparian vegetation, 35% of which is found between kilometres 33 and 38. In this section, the high scrubland clearly dominates the riparian strip, with herbaceous species occupying less than 10%. Lake Duhamel is characterized by the presence of a riparian strip that at times is more than 20 m wide. Most of the vegetation is found in the southern part of the lake toward the outlet, totalling 26 ha. This vegetation is made up of a wide expanse of scrubland, bounded by a narrow strip of herbaceous species that occupies nearly 30% of the riparian strip. From

kilometre 61 to kilometre 64, herbaceous vegetation occupies nearly 40% of 14 ha riparian vegetation expanses. The segment between kilometres 64 and 78 is made up of a succession of rapids not very conducive to the development of riparian vegetation. Patches of scrubland occupying close to 7 ha punctuate its 14 kilometres. From kilometre 78 up to the cutoff point at kilometre 97, the riparian vegetation is more abundant due to the presence of meanders and braided channels. The vegetation covers 129 ha as a riparian ecotone made up primarily of low scrubland, followed by high scrubland up to 20 m wide. The herbaceous vegetation appears to be confined to the more humid areas of the abandoned channels, where it occupies about 20% of the riparian strip.

Lake Grand Détour

From kilometre 97 to kilometre 112 (limit of the submergence zone), as well as on the edges of Grand Détour Lake, Grand Détour River and Rond Stream, riparian vegetation takes the shape of scrubland. This scrubland is made up primarily of alder groves, with 20% herbaceous species. In the submergence zone as a whole, the riparian ecotones of Lake Grand Détour cover an area of 486 ha, which represents 58.4% of all riparian and aquatic vegetation in the area encompassing Lake Grand Détour, Hirondelles River and the Manouane River.

Hirondelles River

Hirondelles River has 3 ha of scrubland vegetation. The scrubland is 5 m wide on average, and contains alder, willow and sweet gale.

Betsiamites River

There is little documentation on the habitats of the Betsiamites River. An inventory carried out around the Bersimis-2 reservoir by Hydro-Québec in 1997 revealed that the shrub stratum is poorly developed on about 4% of the river's banks. It is made up mostly of green alder and sweet gale. Only a few grass beds are found on the periphery of this reservoir.

A seagrass bed grows on the left bank of the Betsiamites River estuary, between kilometres 0.5 and 4.5.

6.2.3 Avian fauna

The June 2001 inventory of ground-dwelling birds carried out by the proponent led to the identification of 45 species.[27] Given the presence of balsam fir stands in the study area, we cannot exclude the possibility that the thrush sp. listed in the frequency of occurrence table of the bird species drawn from this inventory[27] might concern Bicknell's thrush individuals, a species classified in the "special concern" category in the May 2001 list of Canadian endangered species. Aside from the potential presence of Bicknell's thrush, no other endangered species was identified during these inventories.[27] However, according to experts at Environment Canada, some of the species appearing in this table require special attention. For instance, due to their declining populations, the rusty blackbird, the white-winged crossbill, and the boreal chickadee should be monitored in their distribution area throughout Québec. As well, although it has a considerable quantity of favourable habitats in the study area, the palm warbler is nonetheless a relatively rare species in its distribution area as a whole. The same can be said of the bay-breasted warbler. Finally, it should be noted that 16 of the species inventoried appear on one or more lists of endangered species for the American

north eastern states. This fact highlights the decrease in the distribution areas of these species toward the north.

Of the 125 bird species characteristic of black spruce forests, only the bald eagle is on the list of species susceptible to be designated as threatened or vulnerable in Québec. There have been no reports of bald eagle nesting in the study area. In addition to the bald eagle, the peregrine falcon, Le Conte's sparrow, Nelson's sharp-tailed sparrow, the grasshopper sparrow, the yellow rail, the clay-coloured sparrow and the rufous-sided towhee are susceptible to be designated as threatened or vulnerable in Saguenay-Lac-St-Jean region by the CDPNQ.

Birds of prey include the red-tailed hawk and the merlin. Although these species are not considered at risk, they are nonetheless relatively rare and more vulnerable to human activity. According to the list of species associated with black spruce bioclimatic regions, nine species of diurnal and fives species of nocturnal birds of prey are likely to frequent the study area.

The Péribonka River sector straddles five bioclimatic regions: the balsam fir-yellow birch sub region, the balsam fir-white birch or red maple community association, the balsam fir-white birch sub region (west), the balsam fir-white birch sub region (east), and the black spruce feather moss association. According to the *Atlas of Breeding Birds of Quebec*,[13] the numbers of breeding bird species in these regions are, respectively, 181, 183, 176, 169 and 150.

Under the *Regulation respecting wildlife habitats*, aquatic birds gathering areas at the mouth of the Péribonka River are protected. No other wildlife habitats relating to avian fauna (heronry, aquatic birds gathering area, bird colony, habitat of a threatened or vulnerable species) have been inventoried in the study area.

The sector of the Manouane River, Lake Grand Détour and Hirondelles River straddle two bioclimatic regions of the coniferous forest zone: the black spruce balsam fir feather moss association and the black spruce feather moss association region. According to the *Atlas of Breeding Birds of Quebec*,[13] the first region, occupying most of the study area, contains 126 species of breeding birds. The second region, located at the western limit of the study area, contains 150. If we subtract species associated with the urban environment, the agricultural environment and the river, as well as those found in western Québec, we are left with 125 bird species that may frequent the study area during breeding season.

Also according to the *Atlas of Breeding Birds of Quebec*, [13]14 species of waterfowl are likely to frequent the study area during breeding season. In the sectors of the Manouane River mouth, the northern part of lakes Grand Détour and Duhamel, and the Hirondelles River basin, several nesting couples were inventoried. The species identified were the American black duck, Canada goose, common goldeneye, surf scoter, ring-necked duck, common merganser, green-winged teal, black scoter, Northern pintail, wood duck, mallard, hooded merganser and red-breasted merganser.

On May 27, 1999, the proponent conducted an inventory of nesting couples on the Manouane River and in the partial diversion zone. Four species were observed and presumed to be breeders. These species are the Canada goose, the American black duck, the common goldeneye and the common merganser. A total of 60 ducks and geese were observed the

length of the 110 kilometres of river inventoried, with an average of three nesting couples per 10 kilometres of river. The inventory conducted in spring 1999 in the area to be flooded and at the future outlet led to the identification of six nesting couples. The Canada goose and the American black duck were the only species identified in the sector of the Grand Détour lake and river. Only Lake Numéro Deux had Anatidae (common goldeneye and American black duck) in the outlet sector. The common loon was also seen at Lake Grand Détour. The most common aquatic bird is the spotted sandpiper.

6.3 Human environment

6.3.1 Socio-economic and socio-demographic profile

The area under study overlaps with the Saguenay-Lac-Saint-Jean administrative region to the west, and the Côte-Nord administrative region to the east, The Manouane River is located entirely in the county regional municipality (MRC) of Fjord-du-Saguenay. The Péribonka River runs through the MRCs of Fjord-du-Saguenay, Maria-Chapdelaine and Lac-Saint-Jean-Est.

The Manouane River runs entirely through public lands under the jurisdiction of the Ministère des Ressources Naturelles du Québec (MRN) [Department of Natural Resources Quebec]. The Péribonka River is located mostly on public lands, the areas of private land corresponding to the urban areas of the Lake Saint-Jean plain. In the north-west part of the study area, however, the Alcan company rents an area stretching from the Chute-des-Passes dam to the generating station. In addition, the Alcan company has rented the public lands bordering the Péribonka River, downstream of the Chute-des-Passes dam up to the river mouth at Lake Saint-Jean.

The Péribonka River is situated entirely within the Roberval beaver reserve frequented by the Innu community of Mashteuiatsh. The northern part of the Manouane River, as well as the sector of Lake Grand Détour, the Baie aux Hirondelles and the Pipmuacan reservoir are situated in the Bersimis beaver reserve frequented by the Betsiamites Innus. Two native communities—those of Mashteuiatsh and of Betsiamites—will therefore be affected by the project.

The Mashteuiatsh Reserve is located on the west shore of Lake Saint-Jean and covers 1,524 ha. In 1996, the resident population of the Mashteuiatsh Reserve was 1,896 people. The population is considered quite young, with more than 46% of residents under 25 years of age. However, of the Aboriginal communities established in reserves, the Mashteuiatsh community is one of the oldest in Québec. In 1997-1998, some 350 people worked for the Band Council, making it the most important employer in Mashteuiatsh. The public service, teaching, healthcare and social service sectors account for just over half the jobs in the community, while other sources of employment are in forestry, manufacturing, construction, transportation, retail sales, and the accommodation and restaurant industries.

Occupying 255 km^2, the Betsiamites community is the largest Aboriginal reserve in southern Québec. The population, which totalled 3,055 people in 1998, is considered young; 48% of residents are under 25 years of age.[21] The Band Council employs close to 200 people full

time, providing more than two-thirds of jobs in the community.[21] Other fields of economic activity are forestry, construction, petty trade and traditional activities.

The regional economy of the Côte-Nord is based primarily on the exploitation and transformation of resources. Mines, forests, hydroelectric power and fishing are the main economic activities. The unemployment rate is fairly high, at 17%.

The economy of the Saguenay-Lac-Saint-Jean region is also based on natural resources. Exploitation of the hydroelectric potential, aluminium production and pulp and paper constitute the region's key sectors. The region has an unemployment rate of 15.5% overall, and 14% in the Fjord-du-Saguenay MRC specifically.

6.3.2 Recreation, navigation and landscape

This section provides a brief presentation of the recreation, leisure and tourism activities relating to the Manouane and Péribonka rivers, as well as the results of a study conducted among lease holders of recreational facilities.

Péribonka River

The area under study includes three Controlled Harvesting Zones (ZEC): ZEC des Passes, ZEC du Lac-de-la-Boiteuse, ZEC Onatchiway. The first is located on the right bank of the Péribonka River, and is completely encompassed in the area of study. The two others are located only partially in the area of study. The limits of these three ZECs do not reach the Péribonka River. There is one outfitter without exclusive rights, the Pourvoirie des Passes, located at the top of the Péribonka River, about 4 km downstream from the Chute-des-Passes generating station.

According to data collected in an inventory conducted in 1998, which was based on available data from the MRN, there are 21 official recreational facility sites along the banks of the Péribonka River, from the river mouth to the Chute-des-Passes generating station. The map of land use drafted by the regional office of the MRN and updated in May 2001 shows 23 cottages along the Péribonka River in the section between Lake Tchitogama and the Chute-des-Passes dam.

Several recreational and tourism activities or infrastructures are directly connected with the Péribonka River inside the municipalized territories. Navigation is practised on the river, both for recreational boating and fishing purposes, in particular by riverside lease holders of recreational facilities and customers of the Péribonka boating centre. Various services are offered to customers. The tourism complex on Repos and Broët islands, as well as on part of Lucien island, is in the same municipality. This complex includes the Île-du-Repos youth hostel and a primitive campground.

Pointe-Taillon park is a provincial conservation park that lies at the mouth of the Péribonka River. In 1998, it received 45,000 visitors. It offers beaches, a bicycle path and primitive campsites. Visitors can also swim and practise water sports. Nature observation and interpretation activities are offered. Several development projects are planned for the park within the scope of the development plan of the Lac-Saint-Jean-Est MRC.

In the Lamarche municipality, Lake Tchitogama is used for several recreational activities, and includes a marina. Visitors can also practise hunting, fishing and ice fishing, and ride all-terrain vehicles and snow mobiles. Accommodation and restaurant services are offered as well.

The Péribonka River is highly frequented by sportfishing enthusiasts all along its course. At Ascension, the Péribonka River offers good recreational and tourism potential for recreational boaters in the summer, and turns into an ice fishing village in winter.

In terms of snowmobile trails, the Trans-Québec Trail No. 93 crosses the Péribonka River at the town of Sainte-Monique. As well, a local trail crosses Lake Tchitogama and then the Péribonka River. Trail No. 93 as well as the local trails in the area under study are connected to regional trail No. 328.

The Fédération québécoise du canot et du kayak (FCKQ) recognizes this river as navigable by canoe starting from Lake Péribonka. In fact, at the top of the river, from the Chute-des-Passes dam, the route includes long portages that enable canoers to reach the Manouane River slightly upstream from the Houlière River. From its confluence with the Manouane River up to Lake Tchitogama, where the route ends, Péribonka River stretches some 75 km. A trailmarking project is currently underway along the Péribonka River.

Manouane River and Lake Grand Détour

The outfitters and recreational facilities on public lands are the leading tourist attractions of the portion of the study area that stretches to either side of the Manouane River.

There are two outfitters with exclusive rights on the shores of the Manouane River: the Pourvoirie du Lac Duhamel and the Pourvoirie Pavillon Boréal. The territory of the two outfitters is concentrated mainly on the river's left bank. The Pourvoirie du Lac Duhamel extends from kilometre 46 to kilometre 75 of the Manouane River, while the Pourvoirie Pavillon Boréal covers the section extending from kilometre 75 to 86. The Pourvoirie du Lac Duhamel occupies an area of 166 km^2, while the Pourvoirie Pavillon Boréal occupies an area of 98 km^2.

In 1998, there were at least 15 cottages on the immediate shores of the Manouane River, which has very steep banks. A group of seven cottages was located at kilometre 40 of the Manouane River; the rest were scattered all along the river.

Navigation is practised on the Manouane River for both pleasure boating and fishing, on the segments frequented by customers of the outfitters or riverside lease holders of recreational facilities. The main types of watercraft used are canoes and motor boats.

For the past few years, Québec Hors-Circuit, a company from Saint-Fulgence, has been offering canoe excursions along the Manouane River. The river is valued for its high flow, its easy navigability and the wild aspect of its banks, where fauna and flora are abundant.

According to a survey conducted among lease holders with cottages on the banks of the Manouane, fishing is practised all along the river on free access territory.

According to a survey conducted among the two outfitters, most customers of the Pourvoirie du Lac Duhamel fish on the Manouane River, either from their motor boat or from the shore.

Customers of the Pourvoirie Pavillon Boréal will be using the Manouane River for fishing from now on as well, since the company recently acquired harvesting rights on part of this territory. According to a survey conducted among lease holders, the Manouane River and Lake Grand Détour are valued in particular for their landscape and their beaches.

6.3.3 Land use

The Manouane River is bounded mostly by balsam fir spruce stands in the upstream portion of its basin, while the downstream portion is characterized by the shoreline presence of a large proportion of fir and birch. The periphery of Lake Grand Détour is covered mainly by unproductive zones, occupied mostly by alder groves. In the upper reaches of the lake, there are substantial logging zones. Behind the unproductive and logging zones, the main populations are jack pine and black spruce. Toward the Pipmuacan reservoir, black spruce dominates, particularly in the Lake Patrick sector and in the Hirondelles River valley.

The territory is currently subject to 13 timber supply and forest management agreements under the *Forest Act*, covering a total of 997,700 m^2. The main beneficiaries are the logging companies Uniforêt, Scierie Péribonka Inc. of Ascension, and Abitibi-Consolidated. Logging is planned for the next 25 years in the sectors north-east of the Pipmuacan reservoir and south of the Bersimis-2 reservoir. [18]

Aside from road facilities, there are no infrastructures along the Manouane River. The Péribonka River sector, however, includes several infrastructures aside from roads. In fact, several hydroelectric infrastructures are part of the area of influence. Two lines belonging to the Alcan company, of 161 kV and 315 kV, cross the Péribonka River. The sector also encompasses a hydroelectric generating station (Chute-des-Passes) located in the upstream sector of the Péribonka River, and a dam built some 10 km upstream from this generating station, at the Lake Péribonka outlet.

There are few municipal infrastructures connected with the Péribonka River. It should be noted, however, that the municipalities of Sainte-Monique and Péribonka each have a surface water intake in the Péribonka River.

6.3.4 Physical and cultural heritage

The evaluation of the archaeological potential of the area of influence led to the identification of 125 zones, totalling 346 ha of archaeological potential, that would be affected by the project. Twelve of these zones were subject to an inventory carried out in 1999 on the banks of the Péribonka and Manouane rivers. Five of these zones are in the western part of Lake Grand Détour, and seven on the Manouane River. In the 12 zones inventoried, eight archaeological sites were discovered, four dating from the Prehistoric Period and four from the contemporary period. All eight sites are located in the Lake Grand Détour sector. Sampling of these archaeological sites suggests limited human occupation, both from the small number of sites and the small size of the establishments. Further archaeological inventories on the other banks of the lake would provide verification as to whether other places of settlement exist.

Several elements of archaeological heritage are scattered all along the Péribonka River. Of the known archaeological sites, nine are concentrated in the Lake Tchitogama sector. These

archaeological remains appear to be 4,000 years old and are associated with sites where people gathered and stayed. In addition, an Aboriginal burial site is located at the confluence of the Péribonka and Manouane rivers. No archaeological sites located along the Péribonka River have been inventoried within the scope of the present project as no impact is foreseen in this sector.

6.3.5 Current use of lands and resources by Aboriginals for traditional purposes

The planned structures will fall inside the Roberval beaver reserve, awarded to the Mashteuiatsh community, and inside the Bersimis beaver reserve, awarded to the Betsiamites community. The Roberval beaver reserve, with an area of approximately 70,000 km^2, is basically encircled by the basin of the Ashuapmushaun, Mistassini and Péribonka rivers. The Bersimis beaver reserve, which encompasses the basin of the Bersimis, Outardes and Manicouagan Rivers, occupies an area of 82,600 km^2. The Innus of Mashteuiatsh and of Betsiamites do not limit the practice of their activities to the reserves that they hold.

The current method of dividing land is based on the trapping grounds system set up by government authorities and the family hunting grounds system that reflects an older management model.

The area of influence cuts across four trapping grounds of the Roberval beaver reserve and four trapping grounds of the Bersimis reserve:

- lot 43 straddles the Péribonka River and is bounded on the north by the last 15 kilometres of the Manouane River;
- lot 32 is located to the south east of the Péribonka reservoir and covers the portion of the Péribonka River up to its confluence with the Manouane River;
- lot 33 is located to the east of the Manouane River and Lake Duhamel, with its limit corresponding to that of the Bersimis beaver reserve;
- lot P-11 stretches from the Manouane River to the south, up to Lake Raccourci to the north, and from the Petite Manouane River to the west, up to the Raccourci River to the north east;
- lots 131 and 137, on the Bersimis reserve and awarded to the Innus of Betsiamites, are adjacent the trapping grounds of the Innus of Lac Saint-Jean on the west, and occupy the north and north-west of the Baie aux Hirondelles. These two trapping grounds extend beyond the catchment of the Betsiamites River to encompass the segment of the Manouane River between kilometres 78 and 112, Lake Paul and Lake du Grand Détour. The families who hold the right to these trapping grounds have not exploited them for several years. However, they are used by the Innus of Lac-Saint-Jean, who are the main users of lot P-11;
- lots 131A and 139 are both located in the Baie aux Hirondelles of the Pipmuacan reservoir. [4]

The Aboriginal communities use the territory for a variety of activities. These include trapping (beaver, marten, otter, mink, wolf), large-game hunting (moose, bear, and sometimes caribou), small-game hunting (ruffed grouse, spruce grouse, hare), waterfowl hunting, and fishing (brook trout in lacustrine environments, as well as yellow walleye, whitefish, northern pike, lake trout, and landlocked salmon on the larger rivers).

7 Anticipated effects, their significance and mitigation measures

Chapter 6 of Volume 1 of the preliminary project report[22] deals with the project's impact on elements of the biological environment, while Chapter 7 describes the effects on the human environment. The method used by the proponent to assess impacts is presented in Chapter 4 of Volume 1 of the preliminary project report[22] as well as in Appendix C of Volume 2 of this same report.[23] All documents referred to in section 1 of the current document supply additional information as to the project's effects on the environment. The various recommendations of the Federal Authorities as well as some of the information presented by the proponent in this environmental assessment have also been included. Appendix 1 of this document presents a summary of the various effects of the project on the Valued Environmental Components (VEC's) as well as the special mitigation/compensation measures proposed.

The following sections summarize the main environmental effects caused by the project, including those caused by accidents and malfunctions as well as cumulative effects. Mention is also made of the major mitigation measures. Assessment of the project's impact is based on a minimum flow of 3 m^3/s.

For the sake of conciseness, only the main concerns are described in this report. For additionnal details regarding the information used by the federal authorities for the complete assesment of environmental effects of this project, please refer to the documents listed in section 1 of the current document as well as in the text where appropriate.

7.1 Impact assessment methodology

The assessment method used by DFO consisted of identifying the project's effects on the different Valued Environmental Components (VECs) and determining their significance. Identification of the project's effects and their significance is based on information provided by the proponent and the expertise of the various Federal Authorities. It also takes into consideration the application of mitigation measures proposed by the proponent or recommended by the Federal Authorities, as well as the implementation of a follow-up program.

Selection of the Valued Environmental Components (VECs) takes into account the mandates and areas of expertise of the various federal experts, scientific knowledge, and concerns expressed by the public, either directly to the proponent, or to the provincial or federal government.

For this project, the following Valued Environmental Components were identified:

- ichthyofauna and fish habitat;
- wetlands;
- avian fauna;
- physical and cultural heritage;
- human health;
- recreation, tourism and navigation;
- recreational fishing;

- recreational hunting; and
- current use of lands and resources by Aboriginals for traditional purposes.

The DFO is of the opinion that the VECs used for the assessment integrates all of the environmental impacts of the project.

7.1.1 Significance of effects

The assessment method used by the proponent consists of identifying the project's impacts and determining their significance. Identification of the project's impacts is based on information gathered on the technical characteristics of the project, basic data of the receiving environment, lessons learned from similar projects, and scientific literature. This information is analyzed in order to identify the impacts of the project and specify the relationships between the various physical, biological and human components of the environment into which the project will be inserted. This analysis takes into account all the structures set up and all the phases of the project, from construction to operation. The impact assessment also takes into account the systematic application of standard mitigation measures. In addition, some mitigation measures have been integrated into the project's design (minimum flow and spurs) and are therefore taken into account in the assessment.

The proponent determines the significance of the impacts, which are rated as major, moderate or minor, on the basis of four criteria: the value of the affected component, the intensity of the disturbance, the spatial scope of the impact and its duration. [23] This classification differs from that used to define the environmental effects of projects under the CEAA, where adverse environmental effects have to be defined as significant, not significant or uncertain. In making this decision the Responsible Authority must take into account the implemetnation of any appropriate mitigation measures.

The DFO believes that a major impact (as defined by the proponent) corresponds to a significant adverse environmental effects as defined according to the terminology of the CEAA, while a moderate or minor impact (as defined by the proponent) corresponds to an effect that is not significant adverse environmental effect.

Under the CEAA, the Responsible Authority is not bound by the proponent's conclusions as to the significance of effects and, ultimately, must draw its own conclusions, which will take into account not only the proponent's opinion but also the authority's own expertise, the expertise of the other Federal Authorities, and any other information that is available.

During the environmental assessment process, the Responsible Authority must consult other federal authorities by calling upon their collective expertise. Each consulted Federal Authority indicate, to the best of their knowledge and expertise, if the submitted environmental assessment is appropriate regarding their concerns and in the respect of the requirements of CEAA for a comprehensive study. The different consulted Federal Authorities must comment on the proponents conclusions and provide recommendations to the Responsible Authority on the aspects related to that Federal Authority's expertise.

7.2 Project's effects on the valued environmental components

It should be noted that the project's effects on the environmental components were assessed taking into account a minimum flow of 3 m^3/s and the installation of spurs at kilometres 51 and 83.

7.2.1 Ichthyofauna and fish habitat

Expected impacts on the ichthyofauna and fish habitat are described in section 6.4 of the preliminary project report[22] as well as Chapter 4 of the technical report on fish.[1] Overall, the proponent considers that the proposed project would be positive for fish with a minimum flow of 3 m^3/s and the habitat compensation measures proposed in their documents.

DFO's analysis of the project's effects on the ichthyofauna and fish habitat is based on information provided by the proponent. Under subsection 35(2) of the *Fisheries Act*, the DFO may authorize the harmful alteration, disruption or destruction of fish habitat. Determination of the significance of the project's effects on fish habitat will therefore depend on the mitigation and compensation measures. The follow-up program proposed by the proponent will allow validation of the project's effects on fish habitat and necessary ajustments, if needed.

Péribonka River

The 0.1 m drop in water level would be the project's only source of impact on the fish habitat of the Péribonka River. This drop in water level would cause the shoreline exposure of 3.8 ha of aquatic feeding area used by smolts and adult landlocked salmon. The proponent considers that this loss of feeding areas for landlocked salmon would not have a significant impact on the landlocked salmon population in the Péribonka River. DFO does not agree with the proponent's analysis. In fact, as already stated, feeding grounds are a limiting factor for the productive capacity of landlocked salmon in the Péribonka and Manouane rivers.[22] The loss of food supply areas would therefore have a direct effect on the productive capacity of landlocked salmon in these bodies of water. Consequently, the DFO is of the opinion that the 3.8 ha loss of feeding grounds should be fully compensated (for details, see section 7.2.1.2). As mentioned by the proponent, the decrease in water levels should be monitored in order to verify the accuracy of the predictions.[22]

Manouane River

During the construction phase, the installation of retaining structures would be a source of impact for fish. Construction of dike 2, the dam, the two spurs and the cofferdams upstream of the dam and of dike 2 would cause permanent encroachments on the river bottom totalling 10,750 m^2. The construction of the cofferdams and dike 6 would require the excavation of 1,000 m^2 in the riverbed.[17] In all, the aquatic areas that would be affected by the excavation work and the presence of the various structures in the sector of the Manouane River would total 11,750 square metres.[17] The surfaces encroached upon by the structures, excavated or flooded as a result of the installation of the cofferdams would, essentially, destroy the feeding areas that can be used by northern pike and whitefish. No reproduction or rearing sites are present in the areas affected, with the exception of the site designated for construction of a spur at kilometre 51, where there is one potential spawning ground for whitefish.[17] The

spawning of yellow walleye has been confirmed about 500 m downstream of this site. In order to lessen the effect of increased turbidity that would be caused by the installation of the cofferdam downstream of these structures, the proponent proposes to carry out the work in the summer, after the hatching of whitefish and northern pike eggs in this sector. For the same reason, the DFO is of the opinion that the proponent should build the spur at kilometre 51 after the hatching of yellow walleye eggs.

According to the proponent, the presence of the retaining structures (dam and dikes 2 and 6) would not have a notable effect on fish movement given the natural accessibility constraints that already exist in this sector and the sufficient availability of whitefish and northern pike habitats on the each side of the retaining structures. The proponent is also of the opinion that installation of a spur at the Lake Duhamel outlet and at kilometre 83 would not hinder fish movement.[18, 24]

No modifications to the thermal regime of the Manouane River are expected in the first year of construction. In the second year, the Manouane River would be closed by a cofferdam; the water would flow through the diversion canals excavated in the first year, and a minimum flow of 3 m^3/s would thus be restored to the Manouane River. The mean flow of the Manouane River would decrease by 77% (from approximately 39 to 9 m^3/s) at the cutoff point and by 29% (from approximately 106 to 76 m^3/s) at its mouth (confluence point with the Péribonka River). This reduction in flow would cause water levels to drop and would reduce the flow speeds.

The drop in water level caused by the project would result in the shoreline exposure of 188 ha of aquatic areas. The proponent proposes to install two spurs: one at the Lake Duhamel outlet (km 51), to maintain the lake's water levels above those currently observed, and the other at km 83, to maintain the water levels similar to those currently observed in the section between km 83 and km 92.[22] Given the application of these mitigation measures, and assuming that their effectiveness will be verified during follow-up, the total area exposed would be 114 ha.[18] This shoreline exposure would result in habitat loss for ichthyofauna.

In essence, modifications to the water level of the Manouane River following the diversion would result in the shoreline exposure of nearly 3,000 m^2 of landlocked salmon spawning grounds at F2 (km 13.7), F3 (km 13.1), F10 (km 4.4), F16 (km 62.5) and F17 (km 62.4). The drop in water level would also cause a reduction in the underside of the ice cover. The proponent states that in the landlocked spawning grounds located between the mouth and km 14 of the Manouane River, the reduction in the underside of the ice cover would vary between 3 and 12 cm, and would reduce the size of the area where the survival of the eggs is ensured by between 0.9 and 15 m, representing a reduction of 2 to 16% in relation to the current area. In the portion of the river located upstream from Lake Duhamel, the minimum level during the winter would drop between 17 and 29 cm, representing a decrease of between 9 and 43% from current conditions. This situation could cause eggs located above this level to freeze. Taking into account the effect of the reduction in the underside of the ice cover, the loss of spawning areas would total 5,000 square metres. [1]

The installation of a spur dike at the outlet of Duhamel Lake, as proposed by the proponent, would allow to save growth habitat of smolt and adult landlocked salmon.

According to the proponent, reduction in the flow of the Manouane River would result in losses of 17 ha of fry-rearing habitats and 24 ha of parr habitats for landlocked salmon in sectors that are currently shallow. However, the decrease in flow would lead to gains of 59 ha of fry-rearing habitats and 39 ha of parr habitats in the deeper sections. The cut in the flow of the Manouane River would therefore result in net habitat gains of 42 ha for fry and 15 ha for parr between kilometres 0 and 68 of the Manouane River.

According to the proponent, in the case of fry-rearing and feeding habitats for yellow walleye, the project would result in a net gain of 20 ha of habitats for fry and a loss of 5 ha of habitats for juveniles. The DFO is of the opinion that the net gain of 20 ha in fry habitats would compensate for the 5 ha loss for juveniles. Although no net loss of yellow walleye spawning areas is expected as a result of the project, the proponent nonetheless proposes to carry out a follow-up of the evolution of yellow walleye spawning grounds so as to validate the impact assessment. [24]The temperature of the Manouane River downstream of the cutoff point should remain the same, but diurnal variations would be slightly amplified (variations of up to 2°C). During major heat waves, the instantaneous maximum temperature in the reduced-flow section of the Manouane River could increase by 2°C. According to the proponent, given that optimum temperatures for fish in the Manouane River would be exceeded only occasionally and that the Manouane River sector does not represent a distribution limit for the species present, temperature modifications would not have a notable effect on fish. In order to compare the temperature regime before and after project construction, the proponent proposes to conduct thermographic recordings in the Manouane River on a continuous basis.

The reduction of flows in the Manouane River would result in modifications to the aquatic and riparian vegetation. The lower water level would cause part of the riparian vegetation to evolve into terrestrial-type vegetation. These losses of riparian environments are mainly feared in the upstream segment of river located between km 78 and 83. The spurs that would be installed at the Lake Duhamel outlet and at km 83 would mitigate the project's effects on the riparian ecotones. Despite these structures, we can expect temporary losses of between 5 and 10 ha of herbaceous vegetation that serve as spawning habitats for northern pike, due to the drop in water levels and the shoreline exposure of riparian ecotones in the segment of the Manouane River upstream from Lake Duhamel (particularly upstream of km 70).[17] According to the proponent, this loss would be quickly compensated (within one to two years) by the development of a new strip of herbaceous vegetation along the exposed banks. In addition, the proponent is of the opinion that this loss of area would not limit the reproductive success of the northern pike, given the large areas of herbaceous vegetation that will remain (67 ha between km 0 and 97).[17] The DFO considers that, despite the temporary nature of this habitat loss, delays in the regeneration of these habitats would cause losses in the reproductive capacity of the northern pike.

In the reduced-flow sector, the project would also cause total losses of 75 ha of aquatic areas through shoreline exposure, eliminating potential fry-rearing and feeding grounds for the northern pike and whitefish.

The changes associated with the project would also diminish the availability of benthic food supply resources in the sector downstream of the cutoff point (km 75 to km 97). This loss of

benthos would necessarily lessen the drifting of these organisms downstream of km 75. The decrease in the benthic food supply would be equivalent to the area exposed following the project's completion, that is, 114 ha after construction of the two spurs. This loss in benthic resources would have a considerable adverse long-term effect on fish species that usually take advantage of this resource in the Manouane River. Whitefish could therefore be affected by this impact.

However, the DFO is of the opinion that the loss of usable habitats for northern pike and whitefish which would be caused by the encroachment of the retaining structures, the cofferdams and the spurs on the river bottom, by excavation work, the drop in water level and the shoreline exposure of aquatic areas, would be largely compensated by the gains in usable habitats for these two species associated with the creation of the Grand Détour reservoir. In fact, it is recognized that the creation of a reservoir would be particularly advantageous for the northern pike and whitefish populations.[15, 10]

According to the proponent, the reduction in the water levels and flows of the Manouane River would not hamper fish movements in the portion between kilometres 0 and 68. In the sector between kilometres 68 and 82, fish movements are currently limited by several obstacles. In the sector downstream of the cutoff point (km 82 to km 97), drops in the water level during the summer low-water period of August could restrict fish movement (whitefish and northern pike) at some shallow riffles. This impact should be mitigated by the installation of the spur at kilometre 83, which would maintain the water level of this sector and thus facilitate fish movement.

The drop in water level in the Manouane River would also result in drops in the levels of its tributaries. According to the proponent, the retreat of the entrenchment of the tributaries located downstream of Lake Duhamel would be minor, given the current strong degree of entrenchment. The Duhamel and Petite Manouane rivers would not be problematic zones since the level of Lake Duhamel would be maintained by means of a spur placed at the Lake Duhamel outlet. The tributaries located upstream from Lake Duhamel, which currently flow on superficial deposits, would deepen in the deltas that would have formed at their confluence with the Manouane River. The entrenchment distances would be very short due to the rocky riffles that already exist at the confluence between these tributaries and the Manouane River. According to the proponent, only the tributaries located between kilometres 79 and 83 would be problematic. Their entrenchment could vary between 150 m and over 500 m long. Nonetheless, the proponent does not believe the entrenchment of the tributaries upstream from Lake Duhamel, between kilometres 61 and 83, will harm accessibility.[25] As well, according to the proponent, accessibility to the landlocked salmon spawning ground of the Houlière River would not be affected, since only one natural riffle located immediately upstream from the river mouth would prevent its entrenchment.[24]

From kilometre 64.5 to kilometre 83, the sand and gravel banks would remain sensitive to erosion. The entrenchment of the tributaries of this sector would have the effect of increasing erosion of the banks and, consequently, the amount of suspended materials sedimenting near the mouth of the tributaries. In addition, there would be an overdeepening of the river near the dam and dike 1, especially when floods would go back entirely to the Manouane River, once every seven years on average. The sediments thus stirred up would deposit themselves

in the section created by the spur built at kilometre 83, and would extend from kilometres 83 to 92. The proponent does not intend to create any new banks or entrenchment in this portion of the river.

The quality of the substrate of the landlocked salmon spawning grounds could suffer from the increase in deposits of sand and fine particles resulting from the reduction in flow speeds and from the temporary increase in the amount of suspended materials, attributable to the entrenchment of tributaries and to the exposure of new banks along the Manouane River. As a mitigation measure, the proponent proposes setting up structures (spurs or deflectors) that would maintain sufficiently high flow speeds in the spawning grounds especially affected, that is, sites F3 (km 13.1), F16 (km 62.5) and F17 (km 62.4). The proponent does not consider this mitigation measure pertinent on spawning grounds F5 and F7 (km 6.5), however, since under current conditions the latter are completely exposed during the winter and are therefore not productive.[1] The proponent proposes to monitor the sedimentation rate on the landlocked salmon spawning grounds concerned and to apply corrective measures, if necessary.

In terms of northern pike, whitefish and yellow walleye, the increase in the inflow of sediments in spawning grounds does not constitute a major concern within the scope of the current study. In the case of the northern pike, the accumulation of sand and fine particles in spawning grounds should not harm reproduction activities, since the northern pike reproduces in aquatic and riparian vegetation zones flooded by spring floods, and this vegetation usually develops on a substrate composed of sand, silt and organic material. The whitefish is known as a species that is not very particular about its spawning areas, since it can lay eggs on sand just as well as on coarser materials.[18] For the yellow walleye, spawning grounds appear distinctly overabundant in the accessible portion of the Manouane River (km 0 to km 68) in comparison with the amount of rearing and feeding grounds available to this species, both under current conditions and most likely in future conditions, since the project would not cause a net loss of spawning grounds.[24] It is also important to mention that the reproduction period of the yellow walleye would not be critical within the scope of the current project, since overflows would occur each year downstream of the proposed dam during spring flooding (May-June), allowing for a certain leaching of particles accumulated on the spawning grounds, as occurs under the current conditions.[1] Nonetheless, as part of the follow-up program, the proponent proposes to monitor changes in the quality of the largest yellow walleye spawning grounds for which use by spawners has been confirmed (depth, flow speed, area, sedimentation rate, etc.) as well as changes in the density of eggs deposited on them. The proponent states that if the environmental follow-up should show that a part of yellow walleye spawning grounds have been destroyed or altered by the project, corrective measures will be proposed.[24]

The decrease in turbulence and the increase in staying time of waters subject to reduced flows would result in a slightly lower pH level. This decrease in pH should occur primarily in the segment upstream of kilometre 81. Despite this decrease, the proponent is of the opinion that the pH level would remain acceptable for the protection of aquatic life.[22]

The reduced flow in the Manouane River would cause a drop in the concentration of dissolved oxygen. Despite this decrease, oxygenation conditions in Lake Duhamel should

remain acceptable due to the lotic character of this body of water and its tributaries. These changes should not have any impact on aquatic life. According to the proponent, the lotic character of a considerable portion of the river and of its tributaries would ensure a good oxygenation of the water. The proponent proposes to conduct a follow-up of the water quality (temperature, pH, dissolved oxygen, conductivity, etc.) in Lake Duhamel and the Manouane River. The DFO believes that special attention should be paid to the oxygenation level at the minimum flow restoration point, since the waters coming from the reservoir will have a low dissolved oxygen content. According to the proponent, the environmental follow-up program proposed would allow for the monitoring of the rate of dissolved oxygen at the minimum flow restoration point, so that measures can be taken to foster the re-oxygenation of the waters, should the situation so require. [18] The DFO is of the opinion that corrective measures, eg. the reconfiguration of the minimum flow restoration point to create enhanced turbulence, would be possible.

Lake Grand Détour

During the construction phase, the creation of access roads and the construction of two bridges—one straddling Grand Détour River and the other straddling the watercourse where dike 6 would be built—would result in a temporary increase in turbidity and could cause sedimentation in spawning sites located downstream. This sedimentation should have very little impact on fish since the species that frequent this sector (northern pike and whitefish) are generally not very sensitive to sedimentation increases in their spawning grounds. Nonetheless, the DFO is of the opinion that the creation of access roads and the construction of the two bridges should be carried out after the spawning and egg incubation period of these two species.

The main effect resulting from the creation of the Grand Détour reservoir would be the expansion of aquatic areas. Raising the water level of Lake Grand Détour would cause the flooding of 1,240 ha of terrestrial area, thus increasing the aquatic areas accessible to fish. The creation of the Grand Détour reservoir would translate into a net gain of 1,432 ha of usable habitats for northern pike and whitefish. Both species would see their spawning area expand. In the case of the northern pike, new spawning habitats would be created by the submergence of riparian and terrestrial vegetation. According to the proponent, the increase in primary and secondary production expected in the reservoir would also continue to favour recruitment and push up the growth rate of the fish living in this body of water. This situation would be conducive to the production of abundant cohorts of northern pike and whitefish during the first few years following the impounding of the reservoir, as was observed at the La Grande complex.[1] Unlike the eggs of northern pike, whitefish eggs are sensitive to the winter drawdown of reservoirs. Yet this species has still managed to benefit from the creation of reservoirs and now dominates the fish communities of the La Grande complex, the Côte-Nord reservoirs and the Smallwood reservoir in Labrador.[1] The proponent believes the same phenomenon will occur at the Grand Détour reservoir, particularly since the water level fluctuations in this body of water would follow a natural hydraulic regime. [1]

In the upstream section of the Lake Grand Détour flooded zone, the increased water level and flows would lead to the creation of new banks. These actions would increase the sediment load and favour the settling of silt in slower-flowing areas. The new boundaries created by

the flooding of Lake Grand Détour and its tributaries would be characterized mostly by gentle slopes made of sand and gravelly sand. After the project's completion, the Grand Détour River sector would become highly sensitive to erosion, and a large quantity of sediments would move toward Lake Grand Détour, forming an active sedimentation zone. As stated previously, the sedimentation would have little impact on northern pike and whitefish. The proponent has committed to carrying out a follow-up of erosion changes in the Grand Détour reservoir.

According to the proponent, the dissolved oxygen saturation rate of the greater part of the Grand Détour reservoir (at least 70%) would always remain superior to the quality criterion for the protection of aquatic life, which corresponds, for cold-water species, to between 54% and 63% saturation, depending on the water temperature.[22] The waters of Lake Grand Détour would be temporarily enriched by the leaching of flooded soils and the decomposition of organic materials. A temporary drop in oxygen concentration of the reservoir water should be expected (a maximum of 30% of the reservoir's total water volume would present potentially limiting conditions). The project would cause a notable and significant increase in the pH of the Lake Grand Détour sector due to the inflow of less acidic water from the Manouane River. This impact is not considered negative, however. The proponent offers to monitor the water quality in the Grand Détour reservoir sector.

Hirondelles River

Construction of the diversion canals would require the excavation of 26,600 m^2 in lakes Grand Détour, Numéro Un, Numéro Deux and Patrick. Excavated surfaces would essentially cover feeding areas usable by northern pike and whitefish. [17]

Excavation of the diversion canals would cause a loss of benthos production in the sectors affected by the work, particularly inside lakes Numéro Un and Numéro Deux. These losses would be permanent only in places with exposed bedrock. There would be an increase in aquatic area as a result of the creation of a new watercourse between lakes Numéro Un and Numéro Deux and the widening of the other watercourses affected. In fact, the proponent expects that the increase in flow would cause the flooding of an area of 2.9 ha along the river. On the other hand, the diversion canals would not be very productive and would present little interest to northern pike or whitefish, due to the faster flows and the absence of riparian ecotones favourable to spawning and feeding for the two species. In addition, bedrock exposure in several places would limit the development of benthos resources. The diversion canal sector would be frequented mainly by longnose sucker, which has a greater tolerance of fast-flowing currents.

The construction phase would cause an increase in suspended materials. This phenomenon would be reduced by riprap to protect against erosion during excavation operations in the overburden.

The project would also lead to a decrease in productivity in Lake Patrick. The 1 m lowering of the water level in Lake Patrick would result in the shoreline exposure of an area of 6.7 ha in this body of water as well as the exposure of part of the riparian vegetation conducive to the reproduction of northern pike. The shoreline exposure anticipated in Lake Patrick would also cause the loss of feeding grounds for whitefish. During the closure of the regulating structure (once every 7 years), the proponent expects the water level of Lake Patrick to drop

further, to 3 m below current conditions. This effect would be felt for about one month in the spring. During these years, there would be a recruitment failure for northern pike in this body of water, since most of the riparian ecotones would be exposed. In addition, this drop in the water level could cause significant mortality among whitefish eggs deposited on riparian spawning grounds of Lake Patrick if the drop occurs before the eggs have hatched.

Following the diversion, the mean annual flow would climb from 1.2 to 32 m^3/s. The modification in current speeds in the Hirondelles River would affect the composition of the piscifauna community present. In fact, the relatively fast currents would lead the fish community of the Hirondelles River to become dominated by the longnose sucker. Modifications associated with the project would, in the medium term, have the effect of increasing the drift of invertebrates coming from the Grand Détour reservoir. In the long term, the decrease in staying time of water in the Grand Détour reservoir (resulting from the increase in flow speed) would lower zooplankton and benthic production in the watercourse. This decrease would certainly have an impact on the fish present in the Hirondelles River.[25] Given the already high current speeds in the Hirondelles River, the increase in flow in this watercourse would not have an effect on fish movement since the current flow conditions are already limiting at its mouth.

The increased inflow of sediment displaced from upstream of lakes Numéro Un and Numéro Deux, the creation of new banks in Lake Patrick following the drop in water level, and the increase in active erosion zones in the Hirondelles River—and consequently, the inflow of sediments to the river outlet, the Baie aux Hirondelles and the Pipmuacan reservoir—would have little impact on fish species present. Nonetheless, the proponent proposes setting up ripraps in the diversion canals to mitigate the erosion phenomena. As well, the proponent has committed to monitoring changes in the erosion zones along the Hirondelles River.

The DFO is of the opinion that the loss of habitats usable by northern pike and whitefish in the increased-flow sector would be compensated by the habitat gains associated with the creation of the Grand Détour reservoir.

Betsiamites River

Currently, the quality of the various habitats of the Betsiamites River varies and depends on the water management method. After the diversion project, the biological resources that frequent the river would be subject to changing habitat conditions, as is currently the case. According to the proponent, the increase in the annual flow would have little or no effect on the use of habitats by the species present. Usage success of the river for feeding and reproduction (upstream migration, spawning, egg incubation and fry emergence) would vary according to the water management method. Following the partial diversion of the Manouane, Portneuf and Sault aux Cochons rivers, the mean annual discharge from the Bersimis-2 generating station would increase from 341 m^3/s to 388 m^3/s. The main changes related to management would occur during the winter period where, for the months of December to April, the flow would go from the current 373 m^3/s to 394 m^3/s after the partial diversion of these three rivers. At the river mouth, the mean flow would increase from 401 to 448 m^3/s. According to calculations presented by the proponent, the increase in summer flows of the Betsiamites River following the diversion of the Manouane, Portneuf and Sault aux Cochons rivers would translate into a 2% loss of weighted usable areas (i.e. loss of

quality fish habitat) for salmon juveniles in this watercourse.[1] In accordance with an agreement between the proponent and the Betsiamites Band Council in 1999, the proponent has modified its management of the flow of the Betsiamites River so as to encourage salmon production, notably by limiting the maximal hourly variation of the flow downstream of the Bersimis-2 generating station.[24] By limiting the generation station's production variation to one unit per hour, the maximal hourly flow variation will be roughly 110 to 140 m^3/s from June 15 to November 30 each year, from 1999 to 2004. The proponent specifies that at the end of this period, the assessment of the results of the salmon restoration program could lead to the permanent modification of flow management of the Betsiamites River. The proponent has also agreed to ensure a minimum flow of one unit (about 110 to 140 m^3/s) throughout the year until June 4, 2005. As well, to avoid the exposure of redds and fry during the emergence period, the proponent is commited to increasing the minimum flow at the generating station to increase from the production of one unit (about 130 m^3/s) to that of two units (about 260 m^3/s) from November 15, 2000 to June 2001. This increase of the minimum flow during the egg incubation period represents a gain approximately 3,000 m^2 in spawning areas.[24] DFO considers that the modifications to flow management described above for the Betsiamites River will enable the increase of its annual productive capacity.

At the mouth of the Betsiamites River, the arrival of a greater quantity of fresh water would modify penetration of the saltwater wedge. These modifications would therefore be significant during low spring tides and higher streamflows. The proponent considers that the anticipated flow modifications are too small to have an effect on marine habitats and resources or their exploitation, given the natural variability caused by the tide and climatic influences, as well as the variability introduced by the management method of the Bersimis-2 generating station. The DFO requests that the proponent carry out a suitable follow-up program in order to confirm current and future conditions in the Betsiamites River estuary.

7.2.1.1 Project effects follow-up program

The proponent would set up an environmental follow-up program that would allow for the monitoring of changes to the environment during and after the work. This follow-up, the main elements of which are described in Chapter 10 of Volume 1 of the preliminary project report, in Appendix R of Volume 2 of this same report, and in Chapter 5 of the technical report on fish, would also allow the proponent to verify the effectiveness of the mitigation measures implemented and to determine any necessary adjustments (see Appendix 2 of this document). In addition, a follow-up tied specifically to the 10-year compensation measures would be carried out in order to verify the efficiency of these compensation measures for residual impacts on fish habitat and to apply corrective measures, if necessary.

Generally speaking, the elements included in the follow-up program seem adequate. However, the DFO is of the opinion that some elements of the follow-up program should be adjusted and others added.

The proponent concludes that the spur that would be installed at the Lake Duhamel outlet would not hinder the movement of fish. Given the importance of this water body for ichthyofauna in the Manouane River, the DFO deems that a follow-up focusing specifically on this concern should be conducted in order to validate the assessment of anticipated

impacts on fish movement and to ensure that any necessary corrective measures are applied, such as changes to the spur structure.

The DFO also considers that the proponent should conduct data collection campaigns at different tide amplitudes and different streamflows so as to better understand the current and future conditions of the Betsiamites River estuary. The data collected will allow for a more accurate assessment of the effects of increasing the inflow of fresh water to the estuary on the environment's biological components. Prior to the data collection campaign, the proponent must submit its chosen methodology to the DFO for approval.

The DFO will make sure that the elements mentioned above are included in the follow-up program so as to validate the assessment of anticipated environmental effects, and that the necessary corrective measures are set up, if required.

7.2.1.2 Fish habitat compensation program

The first compensation measure proposed by the proponent consists of installing a spur at the Lake Duhamel outlet so as to slightly raise the current water level to the level that prevailed before the first diversion in 1961. The gain in aquatic area and, consequently, in feeding grounds for landlocked salmon that would thus be achieved in Lake Duhamel would be greater than the expected losses of this type of habitat in the Péribonka River.[17] At the moment, the proponent cannot provide precise figures for this gain. The DFO would like to re-emphasize that feeding grounds are the primary limiting factor for salmonid populations in the Péribonka and Manouane rivers. DFO therefore insists that the gain in feeding grounds for landlocked salmon created by the installation of a spur at the lake Duhamel outlet must wholly compensate for the losses of this type of habitat in the Péribonka River—a minimum of 3.8 ha. In order to verify the proponent's projections, the water level of Lake Duhamel and the gain in feeding grounds usable by landlocked salmon smolt and adults must be monitored.

The proponent also proposes, as an additionnal measure, to study the possibility of introducing rainbow smelt in Lake Duhamel. The DFO does not recommend this measure, since it considers that, although the introduction of rainbow smelt could possibly contribute to the feeding of landlocked salmon, introducing this forage fish into a body of water could involve high risks of destabilizing the food chain.[28, 29]

The proponent also proposes compensation measures for the loss of landlocked salmon reproduction habitats. These measures would consist in, first, relocating spawning grounds F2, F3, F10, F16 and F17 inside the residual flow channel in order to keep all current spawning ground areas submerged. These redeveloped sites would allow for the recovery of the total area lost on these spawning grounds, or 5,000 m^2. The proponent also proposes to set up three new landlocked salmon spawning grounds, occupying a total area of 3,000 m^2 in the sector between kilometres 20 and 51, where a deficiency in spawning areas is currently observed. A follow-up on the use and integrity of the redeveloped sites as well as the new spawning grounds would have to be conducted.

In addition, as proposed by the proponent, the DFO deems that upflow incubation boxes for landlocked salmon eggs should be set up in spawning ground F16 or F17, as well as in the

Petite Manouane River. In fact, considering the importance of landlocked salmon for users of the affected sector,[4] the precarious situation of this salmonid population in the Manouane River, and the fact that the only confirmed spawning ground of the river would be substantially affected by the project, the proponent must ensure, using ascending flow incubation boxes with manual dispersion of the fry, or using stocking, a certain level of recruitment of landlocked salmon originating from the Manouane River basin, for a minimum period of five years. Should the use or integrity of the relocated spawning grounds prove to be deficient, the artificial incubation or stocking must be continued until the said means are proven effective. In this way, landlocked salmon recruitment would be ensured even in the case of a delay in the production of young in the relocated sites. Incubation success of the landlocked salmon eggs must also be monitored. The incubation or stocking, and follow-up protocol must be presented to the DFO for prior approval.

In light of the reasons listed above, the DFO deems that the relocation of 5,000 m^2 of spawning sites for landlocked salmon inside the flow channel, as proposed by the proponent, cannot fully compensate for the losses that would be caused by the flow reduction. However, given that the proponent also proposes to set up 3,000 m^2 of additional spawning sites for landlocked salmon, and on the conditions of the obligation to produce results as to the success of the new and relocated sites, the installation of artificial incubators so that the recruitment of landlocked salmon is assured in the case of a delay in the production of young salmon in the relocated spawning sites, and the implementation of a rigorous follow-up program to monitor the habitats affected and the effectiveness of the mitigation and compensation measures put in place, the DFO is of the opinion that the principle of no net habitat loss would be respected. A description of the interventions to be taken within the compensation program (details of the facilities and follow-up protocols) has to be submitted, at least 30 days prior to the implementation of the compensation project, to DFO for approval, as specified in the authorization under subsection 35(2) of the *Fisheries Act* (FA) to be delivered.

Effectiveness of the compensation program would be measured by means of a follow-up conducted over several years verifying changes in the environment during and after construction work. This program would also verify the effectiveness of the compensation measures and determine any necessary adjustments. The follow-up program should focus, more specifically, on the integrity and use of the spawning grounds set up; the gains in landlocked salmon feeding grounds associated with the installation of the spur at the Lake Duhamel outlet; the efficiency of the incubation boxes; the dynamics of the fish populations in Lake Duhamel, the Grand Détour reservoir, Lake Patrick and the Manouane River; and the movement of fish at the level of the Lake Duhamel outlet spur. The follow-up program, including assessment and sampling methods, must be presented to the DFO for prior approval.

7.2.1.3 Conclusion

Following its own analisys, DFO does not agree with the proponent's conclusions and is of the opinion that the project would give rise to negative effects for fish habitat. However, due to the proposed and recommended mitigation measures and the compensation program for residual impacts on fish habitat.[6] DFO believes that the project is not likely to cause

significant adverse environmental effects on fish habitat. An adequate follow-up program would allow to validate the assessment of the environmental effects of the project on fish habitat, evaluate the effectiveness of compensation measures, as well as adjustments made, if needed.

7.2.2 Federal Policy on Wetland Conservation

The primary objective of the *Federal Policy on Wetland Conservation* (FPWC) is to promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future.[14] The policy intends that there be no net loss of wetland functions: 1) on federal lands and waters; 2) in areas affected by the implementation of federal programs where wetland loss or degradation has reached critical proportions; and 3) in areas where federal activities affect wetlands designated as ecologically or socio-economically important for a region. Even if these conditions do not apply to a situation, a federal body may still wish to satisfy this principle in order to limit losses of wetland functions as much as possible. However, since it is a policy, its enforcement is not rigid and its objectives can be met in several ways. For example, measures proposed within the scope of a compensation program for fish habitat losses could also satisfy the objectives of the FPWC. Environment Canada (EC) experts emphasize that although the compensation measures planned for fish do help to compensate some wetland functions, they are not always sufficient for ensuring that the principle of no net loss of wetland functions is respected.

The wetlands affected by the partial diversion of the Manouane project meet none of the abovementioned policy's conditions. At the request of the DFO, however, the proponent has considered the policy and assessed the wetland functions that would be affected by the project and the losses (areas, functions) or alteration in the functions that it would cause.

The partial diversion of the Manouane River would result in losses or modifications to wetland functions through shoreline exposure and flooding. Most of the effects concerning wetlands would manifest themselves in the submerged zone following the raising of Lake Grand Détour. In fact, an area of 486 ha of riparian vegetation made up of shrub swamp (374 ha) and wet prairie marshes (112 ha) would be flooded. The proponent estimates that in the medium term (5 to 10 years),[25] the areas of riparian habitats that will have regenerated around the lake, combined with the gains expected in the reduced-flow reach, will be of a size comparable to the losses feared.[18]

According to the proponent, a considerable gain in wetland areas can also be expected along the shore of Lake Patrick.

According to the proponent's analysis, the losses in functions or values would be mitigated by the vary nature of the changes, which favour the local regeneration of wetlands, and by the application of the following mitigation and compensation measures:

- maintenance of a minimum flow of 3 m^3/s in the Manouane River;
- installation of a spur at the Lake Duhamel outlet to maintain current water levels;
- deforestation of the reservoir's banks and removal of debris over a 3 m distance above elevation 418 m;

- creation of nesting islands for the black duck and the Canada goose in sheltered bays;
- placement of part of the slash in piles on the deforested banks of the submerged zone, above the maximal elevation;
- spreading of excavation materials from the diversion canals to create swampy areas;
- construction of a spur at km 83 in order to maintain current levels up to km 92.

So, according to the proponent, the federal policy objective on the conservation of wet lands would be achieved.

In terms of the reduced-flow reach, the BAPE deems that the best way to preserve the wetland habitat is to maintain a minimum flow of 9 m^3/s in the Manouane River.[4] Environment Canada shares the opinion of the BAPE and believes that maintaining a greater minimum flow would help reduce the losses in wetlands and would be in line with the spirit of the FPWC. As to the measures proposed by the proponent, EC agrees with the proponent's conclusions and also believes they could contribute to lessening the losses of wetland functions. However, EC remains sceptical about the proponent's hypothesis that the medium-term gains in wetlands would be comparable, in terms of area, to the losses. In addition, the hypothetical nature of the wetland gains anticipated does not, in this case, allow for a firm judgement as to whether the principle of no net loss of wetlands would be respected. For this reason, EC experts recommend setting up a follow-up program to monitor the various sectors where wetland regeneration is expected; the duration and frequency of this monitoring program must be adapted to the anticipated length of this regeneration period.

EC deems that the setting up and implementation of an appropriate follow-up program, combined with the application of an adaptive management approach based on the results obtained, would allow for the respect of the principle of no net loss of wetland functions in the medium term. Adaptive management consists in reacting according to the results of the follow-up program and the daily observations so as to correct unexpected adverse environmental effects or unanticipated problems and to ensure the effectiveness and performance of the mitigation and compensation measures as was expected of them at the time of their conception. In cases where it is impossible to correct the situation in order to obtain the desired results or to prevent unexpected adverse environmental effects, new compensation measures must be put forth. In this respect, an adaptive management program based on the monitoring and follow-up program that is retained becomes essential. EC considers that the adaptive management plan should contain, but not be limited to, the following elements:

- the expectations and forecasts in terms of environmental effects and as pertain to the compensation projects;
- the criteria retained and intervention thresholds to compensate problems for which the corrective measures prove to be ineffective or do not exist;
- the criteria retained and intervention thresholds for correcting unexpected situations or counter-performances;
- the intervention scenarios envisioned for various potential problems; and

- the description and specifications of the compensation project(s) to be implemented.

Given the application of the measures described above, EC is of the opinion that the project will not cause significant adverse environmental effects to the wetlands.

7.2.2.1 Conclusion

In light of the recommendations stated above, the DFO deems that the project is not likely to cause significant adverse environmental effects on wetlands to the extent that the proponent complies with the measures previously outlined. However, the plans and a detailed description of the proposed measures, the monitoring protocol and the adaptive management plan must be presented to Environment Canada beforehand for approval and recommendation to Fisheries and Oceans Canada. The adaptive management plan must be submitted at the same time as the follow-up program.

7.2.3 Avian fauna

The anticipated impacts on avian fauna are described in section 6.6 of the preliminary project report.

Construction of the retaining structures, the diversion canals and the access roads would disturb avian fauna because of the disruption caused by construction and deforestation work. These disturbances would lead to losses in habitat. Environment Canada therefore recommends that the proponent refrain from carrying out deforestation work in June and July so as to preserve the annual productivity of the species that reproduce in the affected areas.

Downstream from the cutoff point, the source of impact on birds would be the reduced water levels and flows. According to the proponent, these modifications would result in movement of the riparian ecotones toward the water line, colonization of the top-bed, exposure of flats and spits that would be populated by herbaceous plants in the short-term, and extension of shrub expanses into better-drained areas. This vegetation would offer nesting sites and shelter, as well as provide food in the form of seeds or rhizomes. Moreover, the reduced duration and amplitude of spring floods could make riparian vegetation available earlier for migrating birds. In the long term, the local expansion of shrub areas would provide shelter and nesting cover for riparian birds. All these effects could be more limited in the upstream segment (from km 78 to km 97), where the flow would be substantially reduced. The installation of a spur at km 83, as planned by the proponent, would serve to maintain current water levels up to about km 92 and to preserve the riparian habitats currently found in this sector.

Following the impounding of the Grand Détour reservoir, nearly 500 ha of riparian vegetation, part of which is conducive to the reproduction of aquatic birds, would no longer be available. The impounding of the reservoir would also cause the flooding of nearly 700 ha of forest crop frequented by forest birds. The proponent proposes to create, in the sheltered bays of the flooded zone, islands that could be used as nesting sites for aquatic birds. The proponent indicates that the clearing of a 3-m wide band along the shore, planned for the waterline corresponding to elevation 418 m, would favour the regeneration of habitats for riparian birds. Despite these measures, the impacts on the avian fauna in the Grand Détour

Reservoir could not be completely eliminated. The loss of avian fauna habitat in the Grand Détour reservoir would be felt especially in the short term. The proponent estimates that it would take 5 to 10 years for the Grand Détour reservoir to develop riparian habitats of interest to avian fauna. [25]

The proponent expects the increased flow in the Hirondelles River to have little effect on waterfowl. Excavation materials from the diversion canals are to be spread along the canal, so as to create swampy areas suitable to aquatic birds.

Given the low density of waterfowl nesting couples, the proponent considers that the intensity of impacts on avian fauna would be minor. The spatial scope of the impacts would be local, and the duration, moderate. Thus, according to the proponent, the overall significance of the impact on this environmental component could be qualified as minor. In its impact assessment, the proponent focuses its efforts on the analysis of the project's environmental effects on waterfowl. According to EC, the assessment of these effects is largely based on hypothetical scenarios concerning the availability and evolution of the wetlands and bodies of water after the project's completion.

Following completion of the river's diversion, some species would see their habitats disappear or be transformed. However, the proponent does not provide precise information on the project's effects on each of the species concerned. According to EC, this uncertainty can be removed by carrying out a follow-up program on the nesting avian fauna (aquatic and terrestrial) of the main ecosystems following the project's completion. EC recommends that the proponent submit a follow-up protocol focusing on this concern. The results of the follow-up will then enable the proponent to better target the species that were most affected during the project's construction. The follow-up protocol must be validated by EC.

As to the potential presence of Bicknell's thrush, an endangered species, in the study area, EC considers that a verification is necessary in order to make sure that the project will not undermine. To do this, EC recommends that the proponent conduct an on-site verification in June and July in the potential habitats, before these habitats are cut down. If major constraints should prevent carrying out such a verification on site, EC deems that is might be acceptable to use a different approach, by first verifying if the forest stands that would be affected by the project could be considered as potential habitats. In both cases, a prior cartography of potential Bicknell's thrush habitats appears essential.

7.2.3.1 Conclusion

Based on the fragmentary information available, and taking into account the application of the follow-up program proposed above as well as the implementation of an adaptive management approach according to the results of this follow-up program as described in section 7.2.2, EC considers that the project is not likely to cause significant adverse environmental effects, in the meaning of the CEAA, on avian fauna. However, the EC considers that, should it be demonstrated that Bicknell's thrush reproduces or is likely to reproduce in the area of study, the proponent will have to first present appropriate measures for the adequate mitigation or compensation of the project's effects on this species.

In light of these recommendations, the DFO is of the opinion that the project is not likely to cause significant adverse environmental effects on avian fauna in so far as the proponent respects the mitigation measures and other elements outlined above. However, the plans and a detailed description of the proposed facilities, follow-up protocols, adaptive management plan and intervention measures for Bicknell's thrush, if needed, must be presented to Environment Canada for prior approval and recommendation to Fisheries and Oceans Canada. As in the case of wetlands, the adaptive management plan for avian fauna must be submitted at the same time as the follow-up program.

7.2.4 Physical and cultural heritage

The project would result in the flooding of 83 zones of archaeological potential and eight known archaeological sites. Consequently, the significance of the project's impact on these sites would be major. To mitigate this impact, the proponent proposes conducting an archaeological inventory beforehand in the zones of potential and carrying out digs in the most important archaeological sites in order to recover all pertinent data before the reservoir's impounding. According to the proponent, after the implementation of the mitigation measures mentioned above, the importance of the residual impact on the archaeology of the area could be considered as weak.

Experts at Parks Canada (PC) consider that, in so far as the sectors identified for the assessment of archaeological potential truly cover the entire area that would be affected by the work, the mitigation measures seem appropriate. However, PC deems that, in selecting the sites to dig, the proponent should base its choice not merely on which sites are oldest, but also on the intrinsic quality of the sites in terms of information content or functional diversity. Given that these sites would be irreversibly lost once the project is carried out, PC recommends recovering all types of information that they may contain. PC insists on the fact that the archaeological digging or inventory interventions must lead to in-depth analyses of the data collected and to the transmission of this data to the populations concerned (Aboriginal or non-Aboriginal) as well as to the scientific community.

Finally, PC considers that the Innus of the region should be informed of the mitigation measures that would be applied with respect to the archaeological heritage, as well as of the existence of a burial site at the confluence of the Péribonka and Manouane rivers. No impact is anticipated at the burial site near the confluence of the Péribonka and Manouane Rivers.

7.2.4.1 Conclusion

Given Parks Canada's expert recommendations, DFO is of the opinion that the project is not likely to cause significant adverse environmental effects on the physical and cultural heritage, to the extent that the proponent respects the above mentioned measures and recommendations.

7.2.5 Human health

The creation of a new body of water usually results in the release into the water of easily assimilated organic mercury (methyl mercury) whose concentration rises with each trophic level in the aquatic food chain. We usually witness a rapid rise in the level of mercury over

the course of the first years following the impounding, and then a return to initial levels within the next fifteen to twenty years.

There has been no evaluation of the mercury content level in the flesh of fish living in the various environments affected by the proposed project, within the specific context of this project. However, data from other natural water bodies and reservoirs in the Côte-Nord region can be used to assess the current mercury level in flesh fish for the main species in the study area—lake trout, yellow walleye, northern pike, longnose sucker and whitefish—while the changes in mercury concentrations in fish flesh after the impounding have been estimated using a semi-empirical simulation model.

The Earth Sciences Sector of Natural Resources of Canada (NRCan) studied the documents received and conducted a more thorough review of a few documents pertaining to the release of mercury in reservoirs. This review confirms the general effectiveness of the model used by Hydro-Québec to predict the temporal evolution of mercury content in fish flesh. However, the great variability of mercury contents in the boreal environment of Québec and the eastern continent remains largely unexplained. In the opinion of NRCan, the characterization of the geochemical composition of the land to be affected by the reservoir's impounding would have allowed a better assessment of the potential heavy metal remobilization and the environmental repercussions associated with this problem. In the absence of this information, NRCan recommends that the follow-up program prescribed by the proponent on the water quality of the Grand Détour reservoir include a follow-up on the remobilization of mercury, and that NRCan be consulted during the development of this detailed follow-up program.

In the Péribonka River, the rise in mercury content in fish flesh resulting from the creation of the Grand Détour reservoir is expected to be hardly perceptible. According to the proponent, the very slight increases anticipated in mercury content in fish flesh in this watercourse would not affect consumption recommendations.

However, the partial diversion of the Manouane River would result in significant increases in mercury content in fish frequenting the Grand Détour reservoir and the reduced-flow segment of the Manouane River upstream of Lake Duhamel (Table 1). Even if no data has been presented regarding landlocked salmon and walleye, it is probable that the mercury levels found in the flesh of these fish would not pose health problem requiring adjustments to the consumption restrictions. It is true that these fish are present only in the Péribonka River and downstream of the impassable obstacle at km 68. Furthermore, the project would elevate mercury concentrations significantly in the flesh of fish present in the Grand Détour reservoir and in the section above km 75, while growth and feeding habitats of landlocked salmon and walleye are downstream of Duhamel lake. Concerning lake trout, it is found only occasionally in the water bodies affected by the project. The expected increases in mercury content in whitefish and longnose sucker would not be sufficient to necessitate applying consumption frequencies inferior to the those suggested in the Québec *Guide to eating freshwater sport fish*.On the other hand, the increases expected in lake trout and pike would be sufficiently high to necessitate applying, for a 15- to 20-year period, a consumption frequency inferior to that recommended in the guide. The proponent predicts that mercury content in the fish in Lake Patrick, the Hirondelles River and the diversion canals would be identical to those observed in fish in the Grand Détour reservoir. The project's repercussions

on fish consumption frequency would therefore be the same as those for fish in the Grand Détour reservoir.

Table 1. Current and anticiped concentrations of mercury in fish flesh and suggested consumption frequency according to the *Guide to eating freshwater sport fish*. [23]

Species	Current Hg concentration (mg/kg)	Current maximum number of meals per month*	Anticiped Hg concentration (mg/kg)	Future maximum number of meals per month*
Area of the future reservoir				
Whitefish and longnose sucker (400 mm)	0.15	8	0.40	8
Lake trout (600 mm)	0.80	4	1.72	2
Northern pike (700 mm)	0.66	4	1.42-2.34	2-3
Manouane River, reduced-flow sector upstream of km 75				
Whitefish and longnose sucker (400 mm)	0.15	8	0.30	8
Lake trout (600 mm)	0.80	4	1.35	3
Northern pike (700 mm)	0.66	4	1.12-1.67	2-3
Lac Duhamel				
Whitefish and longnose sucker (400 mm)	0.15	8	0.19	8
Lake trout (600 mm)	0.80	4	0.94	4
Northern pike (700 mm)	0.66	4	0.77-0.91	4
Yellow walleye	0.6	4	0.97	4

* Considering a permissible exposure of 0.47 µg of mercury/day/kg of body weight, an adult with a body weight of 60 kg, and a portion of 230 g (8 ounces) per meal.

Given the anticipated increases in mercury content for piscivorous species in these sectors, a consumption frequency greater than that recommended would result in mercury exposure levels higher than those deemed safe by public health organizations. Pregnant women, women planning to become pregnant and women who are breast-feeding must be even more vigilant because of the increased risk to the foetus. To minimize human health risks, the proponent would monitor the mercury content levels in fish flesh and produce, in collaboration with regional public health stakeholders, an information leaflet on the mercury issue in this region. Among other things, this leaflet would contain information on the eating habits that should be adopted by pregnant women, those planning to be, as well as those who are breast-feeding.

The proponent allots a strong value to mercury in fish, since this issue is the subject of significant concerns on behalf of the specialists and public. According to the proponent, the intensity of the impact is considered to be average. The area affected would be specific over a relatively long time period. On the basis of these criterion, the importance of the impact of mercury in the flesh of fish would be average. However, the proponent believes that

following the implementation of the information campaign, there would remain a very weak human health risk. The proponent thus estimates that the residual impact of mercury in the flesh of fish could be described as weak to negligible, since it is evaluated according to the health risk to humans.

The measures proposed by the proponent adequately satisfy Health Canada's questions and recommendations. However, Health Canada (HC) agrees with the BAPE's and the Betsiamites Band Council comments pertaining to the implementation of an information campaign on fish consumption based on the consumer profile. According to HC, any change in eating habits due to the consumption restrictions on fish could aggravate existing health problems among the Aboriginals. Consequently, the information campaign should insist on the importance for the aboriginals to maintain the proportion of fish in their eating habits. In that sense, it is to be noted that the recommended consumption for the northern pike would be reduced but still possible, that the consumption frequency of whitefish would remain unchanged and that the aboriginals do not consume fish harvested uniquely in water bodies affected by the project. Consequently, aboriginal consumers will still be able to profit from the beneficial effects on health of the omega-3 fatty acids found in high quantities in fish. Nevertheless, in terms of Aboriginal consumers, HC recommends that the information campaign take into account the species, size, parts and quantities of fish consumed, as well as the mercury content of these fish parts. To determine the total daily intake of all Aboriginal consumers—including pregnant women, women of childbearing age and young children—the campaign must take into consideration the intake of mercury from other sources such as other food consumed (e.g. game meat, other fish species) and non-treated drinking water that might be used for subsistence purposes by Aboriginal populations.

Public health organizations in this region should therefore be consulted to develop mitigation measures to address this issue within the scope of the information campaign.

7.2.5.1 Conclusion

In light of this latest information, and considering the preventive measures to be put in place, consisting of an adequate information campaign dealing with consumption habits that fishermen should adopt in order to prevent any risk related to mercury while taking advantage of the beneficial effects of fish consumption, and that the information campaign would be adapted according to the consumers profiles (aboriginal and non-aboriginals), the DFO is of the opinion that the project is not likely to cause signifiant adverse environmental effects on human health, in terms of risks associated with mercury. An adequate follow-up program would allow to evaluate the evolution, in time, of the mercury concentration in the fish, and adjust the information campain accordingly.

7.2.6 Recreation, tourism and navigation

This component is the object of a strong local concern with regard to the quality of the local recreational/tourism activities.[4] Moreover, the proponent assesses a strong value to this component. The proponent considers that the project would have an impact of weak intensity but in a permanent way. The proponent also considers that in a more regional way, the impacts on the use of the area for the purposes of holiday resorts, leisure activities and

tourism is considered medium. However, the proponent judges that when the mitigation measures, expressed later in the text, are applied, the residual impact of the project on this component would be weak because the impact would be to restricted sectors of the Manouane and Péribonka Rivers and, overall, a limited number of users. [22]

Péribonka River

According to the proponent, the maximum 0.1 lowering in the levels of the Péribonka River could disturb navigation conditions on the Péribonka River by reducing the water level, by setting logs back into circulation, or by exposing candles and logs protruding toward the surface. This last impact should remain of minor scope since most logs were cleared during the natural rehabilitation program carried out by Abitibi-Consolidated on the Péribonka River. Overall, the proponent does not expect the project to cause any notable changes to navigation conditions in the Péribonka River. Additional navigation difficulties can nonetheless be expected near the banks and in the shallower sections of the Péribonka River over a distance of 57 km downstream from the confluence point with the Manouane River. The proponent proposes to implement a follow-up program on the changes in logs in the Péribonka River and on the navigation conditions in the Manouane and Péribonka rivers.

The proponent deems that the project is not likely to disturb the normal usage of the docks of the three cottages along the river in the 57 km segment that would be affected by the project.

The proponent considers that the project will not have any impact on the landscape in the Péribonka River sector.

Manouane River

The reduced flow and drop in water levels would affect navigation. In fact, the changes inherent to the project would render some whitewater sections or currently shallow drafts impassable. The reduced flow in the Manouane River would lower the water levels and modify the flow speeds. The mean flow would be reduced by 77% (from approximately 39 to 9 m^3/s) at the cutoff point and by 29% (from approximately 106 to 76 m^3/s) at the river mouth (confluence with the Péribonka River). The drop in water level was assessed for five strategic sectors covering 57 of the 98 kilometres affected by the flow reduction. The sectors retained by the proponent were selected for their biological and human interests. The segment of the Manouane River from:

- km 0 to 14 would be subject to an approximately 0.4 m drop in the water level and a minimum flow of 3 m^3/s;
- km 33 to 51 would see its water level drop approximately 0.5 m in August, with a minimum flow of 3 m^3/s;
- km 51 to 61 (Lake Duhamel) would be subject to an approximately 0.5 m drop in the water level in August. The proponent plans to build a spur at the Lake Duhamel outlet to maintain the current water levels despite the reduced flow;
- km 61 to 63 would be subject to a drop of approximately 0.7 m;
- km 83 to 95 would be subject to the sharpest flow reduction. In August, the projected flow would represent 8% of the current flow. Following this flow reduction, the water

level would drop approximately 1.6 m in August and 1.8 m in October, with a minimum flow of 3 m^3/s, while current speeds would be practically nil.

Generally, in terms of canoeing, the navigation conditions would be modified by the altered aspect of the rapids, and the increase in difficulty of navigation in calm-water and shallow whitewater areas. The difficulties associated with crossing rapids would be even greater due to the exposure of obstacles; some rapids could even become impassable. In sectors characterized by shoals, canoers would probably have to be wade through.

Navigation by motorboat would be particularly affected by the drop in water levels. In fact, motorboats could crash into or suffer damage from shoals and exposed rocks.

The proponent does not anticipate any impact on sections that are currently impassable or which require portages, such as those indicated on canoe-camping maps and zones of rapids of various classes where navigation is recognized as very difficult due to riffles, falls and dangerous obstacles.[22] As mentioned in the BAPE report, the Fédération québécoise du canot et du kayak (FQKC) does not share the proponent's analysis. This organization emphasizes that all rapids cited by the proponent are navigable. One riffle (at km 65) is classified as RIII (canoeing by intermediate-level canoers) while the others are classified as RI or RII (canoeing by beginners). [4]

The sites of potential impact retained by the proponent are the zones of rapids and shallow drafts currently deemed passable, and which would become impassable once the water levels and flows are reduced. According to the proponent, these sections would be kilometres 93 (riffle), 91 (riffle), 89 (riffle), 86 (riffle), 77 and 78 (riffles), 70 and 71 (rapids and riffles), 35 (riffle), 32 to 34 (rapids and riffle), 30 and 31 (riffles), 27 and 28 (riffles), as well as 20 and 21 (riffles). The addition of a spur at km 83 would render the sections at km 91, 89 and 86 navigable. Impassable sections currently present between km 3 and 14 would be lengthened, and riffles would emerge in some places. The proponent does not expect any impact on navigation at Lake Duhamel since the water level would be maintained by the installation of a spur. The proponent also proposes to install, at appropriate places on the banks or on the islands at the river mouth, signs to indicate the channels where navigation is possible. The presence of dike 1 at km 95 would hinder the use of one canoe-camping portage site used by the FQCK. The proponent proposes to relocate this portage.[22]

The BAPE is of the opinion that the 87% reduction in the flow of the Manouane River during the summer would compromise the canoe route between the Grand Détour reservoir and Lake Duhamel.[4] The new obstacles and impassable sectors expected following the project's completion (km 93, 78, 77 and 70, including the positive impact of the spur km 83, and the segment between km 70 and 74) would excessively fragment the route and substantially lengthen the portages, while the low flow would alter the aesthetic quality of the rapids, cascades and falls along this segment. However, it should be noted that the portion of the river located upstream of Lake Duhamel is less and less used than the portion downstream.[4] The FQCK indicates that certain sections of the river situated upstream of lake Duhamel are interrupted with difficult passages, but if we leave this stretch of water, in km 60, the descent is easier.[11] Moreover, the traditional route for family boating and camping begins on the Lake Duhamel.[12] The Quebec company Hors Circuits Inc. of Saint-Fulgence promises their customers, a good portion of which come from outside Quebec, a descent of the Manouane

River from Lake Duhamel.[4] The Centre de plein air Tchitogama has the Camp of Barks, a tourism/adventure company of tourism which also plans, in summer 2002, to bring customers to boat on Lake Duhamel.[4]

In fact, the proponent states that the bits of information gathered from organizations or companies that use the Manouane River would seem to indicate that not many people currently frequent this river.[18] Indeed, although there would not be any statistics on the frequency of use of the rivers, the FQCK indicates that the Manouane River is largely unknown by the community of paddlers. In addition, the FQCK stresses that the current frequency of use of a river is not necessarily a measure of her future use and that a distant river can be visited infrequently by paddlers because of the difficulty of going there for a weekend, but it may be more favourable and more convenient for boaters and campers[12].

Characteristics of the primitive campgrounds found along the Manouane River could be modified by the reduction in water levels. Beaches at some of these sites would probably become larger as a result of shoreline exposure, while access to other sites might become more difficult as a result of steeper-sloped banks.

According to the proponent, the project's main impact on the landscape would be the reduced flow in the waterfalls, particularly the falls at km 67 et 69, which are considered sites of interest for clients of the Pourvoirie du lac Duhamel and people who enjoy canoe-camping.

The proponent proposes to monitor the drops in water level between km 0 and 97 of the Manouane River as well as the navigation conditions on the Manouane and Péribonka rivers. [25]

Lake Grand Détour

Recreational sites located near the dam, the three dikes, the access roads and the bridges could be disturbed temporarily during the excavation work and construction of the cofferdams, which will create noise, vibrations and dust. This impact could be mitigated by standard measures (selection of the tasks to be carried out during the evening or at night, public awareness campains regarding noisy activities, type of equipment used, use of dust control agents, etc.). The impounding of the reservoir would result in the flooding of the sites of four cottages : one at km 103 of the Manouane River, one at the edge of Rond Stream, one at the edge of the Grand Détour River and one at the north-west extremity of Lake Grand Détour. The proponent suggests indemnifying the property owners of the four sites that would be flooded.

Generally, after the impounding of the reservoir, navigability between the dam and Lake Grand Détour will be improved. However, navigation and access to the lake banks may be hindered by trees left in place in the bodies of water that will have formed from the raising of the water level upstream of the dam. To prevent this, the proponent plans to partially clear a 3 m-wide band along the shoreline above elevation 418 m before the reservoir's impounding.

According to the proponent, the increase in the area of Lake Grand Détour and the creation of water bodies upstream from the dam could create development potential for private recreational sites on public lands along the new body of water. However, Lake Grand Détour is not currently one of the lakes targeted for development of this nature. The proponent

proposes setting up a follow-up program on use of the reservoir for recreational, leisure and tourism purposes.

The Lake Grand Détour landscape, beaches and fishing spots—all cited as elements of interest by cottage owners in the area—would be modified as a result of the project. The proponent does not envision any mitigation measures for changes to the landscape.

Hirondelles River

The presence of a diversion canal could constitute a positive impact on navigation between the Grand Détour reservoir and Lake Patrick. However, this passage would not be navigable during the canal's closing about once every seven years. During that time, signs should be put up to indicate the gradual lowering of the water level.

Construction of a road along the future diversion canal could constitute a positive impact on the projected use of the territory as well, since it would facilitate the development of recreational sites along Lake Patrick. The proponent proposes to implement a follow-up program on usage of the canal for navigation and usage of the access road.

During the construction of the diversion canals, the regulating structure and the access road along the canals, occupants of the cottage on the edge of Lake Patrick will most likely be inconvenienced by the noise, vibrations and dust caused by the work. This work is to be carried out after spring flooding and up to fall flooding—i.e., the period when cottages are the most used. Mitigation measures would therefore be applied to reduce these impacts.

The lowering of Lake Patrick could make access difficult for occupants of the cottage on Lake Patrick. In addition, during the planned closing of the diversion canal during spring floods, the occupants could experience even greater access difficulties. The proponent indicates that the occupants would be informed of the expected water level fluctuation in the lake and the canal. The presence of a road along the canal would constitute a positive impact of the project since it would facilitate access to this recreational site.

7.2.6.1 Conclusion

The effects of the project on navigation were estimated in terms of safety, accessibility and the interest of the people who use the water for navigation.

The main responsibilities of the Navigable Waters Protection Program Division of the Coast Guard (CG) by virtue of the *Navigable Waters Protection Act* (NWPA), consist of the approval of works localized in, on, under, through or over navigable waters, removal of obstructions to navigation as well as the rule of the placement and the maintenance of signs, beacons, etc. to insure the safety of navigation around the construction of certain works. Within the framework of the project of partial diversion of the Manouane River, the experts of the CG reveiwed aspects dealing with the safety and the accessibility of navigation.

Further to their analysis, CG is of the opinion that the flow reduction would modify use of the Manouane River water body by recreational boaters from downstream of the dam up to the river mouth. However, CG considers that the mitigation measures proposed by the proponent and recommended by the GC seem acceptable for ensuring navigational safety in the bodies of water affected by the project —the construction of a spur at the Lake Duhamel

outlet and at km 83; the installation of appropriate signage at suitable places on the banks or islands to indicate secure passages or channels where navigation is possible and potential hazards; the relocation and development of portage trails to bypass principal dam, dikes 1 and 2, and riffle at the outflow of the Lake Patrick; the installation of safety booms at the upstream of selected structures to protect users of different water bodies, removal, if necessary, of wood debris or logs that could be exposed in the zones affected by a drop of water level; a public awareness program regarding the water discharge of the Manouane River, correlated with the water levels in critical zones; and the installation of signs on the banks to indicate the periodic drop in water levels of Lake Patrick and its diversion canals during the swelling of waters. In addition, CG recommends that the proponent prepare a detailed map showing the signage described in the mitigation measures, including the portage trails for the portion of the Manouane River contained between the dam and the river mouth. The proponent should also take the steps necessary to ensure that this map is readily available to users.

Coast Guard is of the opinion that navigational safety and accessibility would be ensured as far as the proponent implements the mitigation measures proposed and complies with the conditions associated with the formal approval to be issued under the *Navigable Waters Protection Act* (NWPA) and where is set up an annual follow-up program aiming at insuring that the navigability status is maintained on the water courses affected by the project and providing for adjustments, if needed (construction of spurs, dredging, removal of riffles for example). Following each year of the follow-up program and before the start of each navigation season, the proponent will have to consult the users regarding control measures, navigability and navigation characteristics and adjustments to be made by him in order to insure the navigability status of the affected water courses, to the satisfaction of the DFO.

On the basis of evaluation of the impacts of the project by the NWPP and by using the method of evaluation of the importance of the impacts, presented by the proponent, DFO estimates that, in terms of safety and accessibility, after the application of mitigation measures, a low value can be allotted to the intensity of the impact on navigation. With regard to the maintenance of the interest of the people who use the waters for navigational activities, DFO thinks that the project would have an impact of low to mean intensity, since the section between lake Duhamel and the proposed dam, is not widely used according to the available informations, that the navigational activities seems to take place mainly on Duhamel Lake and further downstream, where the project would have less effects, and that the tourism companies which organize activities of boating and camping, exploit mainly the sector located downstream from km 60 of the Manouane River. Consequently, by considering at the same time the safety, the accessibility and the interest of the users of the waters, DFO estimates that the intensity of the impact on navigation and the recreotourism would be, overall, low on the zones affected by the project, the area impacted would be local and the time period, long term. Thus, DFO estimates that insofar as the proponent respects the measurements and conditions stated above, the effect of the project on the recreotourism and navigation would be thus of medium importance. Thus, the project is not likely to cause significant adverse environmental effects on the recreotourism and navigation.

7.2.7 Recreational fishing

Nearly 30% of the inhabitants of Saguenay-Lac-Saint-Jean practise sports fishing, giving this activity an important status in this region. More than 1,750 person-days were recorded in 1999 on the territory of the two outfitters located in the study area. The reduction in flows and water levels would have two principle repercussions on recreational fishing: it would modify the availability of some species harvested and restrict access to certain fishing zones. Further details can be found in sections 7.2.1 and 7.5.2 of the current document.

Overall, the proponent considers that the proposed project would have a positive effect on fishing activities, because the potential harvest would be increased for yellow walleye, northern pike and Lake Whitefish, and because the production capacity of ouananiches would remain the same as the current conditions. Furthermore, the constraints in the navigation and the modifications of the conditions of docking, mooring and loading of motorboats would create local disturbances of weak intensity on the activities of fishing.

The text which follows presents the main impacts of the project on the recreational fishing as well as the analysis made by DFO.

Manouane and Péribonka rivers

According to the proponent, given that the project would not cause a notable difference in the abundance of fish in the Péribonka River, no changes in the use of piscicultural resources in this watercourse are expected.

In terms of the Manouane River, recreational activities would most likely be disturbed by the construction site and construction of the retaining structures.

The presence of cofferdams in the river, needed to build the dam and dikes 2 and 6, would impede the free movement of fishers. However, this effect would not be significant since boat movement is already limited in this sector by a zone of riffles and rapids currently considered impassable.

Following application of the mitigation and compensation measures stated previously, the reduction in flows and water levels would not have an effect on landlocked salmon fishing in the Manouane River. According to the proponent, the quality of yellow walleye fishing could improve in Lake Duhamel as a result of the anticipated production gain for this species. The proponent indicates that a production gain in yellow walleye could also be expected in free access territory, especially at the river mouth. As for northern pike and whitefish, the loss in exploitable biomass would be felt mostly in the sector downstream of the cutoff point, particularly in the territories of the Lake Duhamel and Pavillon Boréal outfitters. According to the information gathered by the proponent, however, the outfitters' clients are not very interested in northern pike and whitefish.[22] Moreover, in the brief presented by the Pourvoirie du Lac Duhamel at the BAPE hearings, there is no mention of concerns over northern pike and whitefish.[30] Nonetheless, the proponent proposes to monitor the fishing quality (success rate and size of captures) in the Manouane River and Lake Duhamel on the territory of the Lake Duhamel and Pavillon Boréal outfitters, using fishing statistics compiled by these organizations, and to continue discussions with the outfitters on a partial compensation for the losses and inconveniences caused by the project.

Aside from the harvesting-related aspects, the reduction in flows and water levels would be likely to modify conditions for the practice of fishing activities, such as boat movement and bank accessibility in certain places along the Péribonka and Manouane rivers. In addition, some trails and access roads could become useless, as the fishing potential or navigability of the sites to which they give access will no longer be worthwhile. On the other hand, other sites that will have become attractive in terms of their fishing potential could require new development.[3] As stated in section 7.2.6, the proponent proposes to monitor navigation conditions on the Manouane and Péribonka rivers. However, the DFO is of the opinion that, as suggested by the proponent in the assessment report on the project's cumulative effects,[3] a follow-up of navigation conditions focusing on fishing activities should also be conducted, and corrective measures applied if needed, such as setting up weirs in the river to facilitate navigation in certain segments, building new launch ramps or trails, and creating accesses to banks at appropriate locations.

Lake Grand Détour

Over the long term, creation of the Grand Détour reservoir would result in an increase in the productive capacity of northern pike and whitefish. This increase could benefit the harvest; the proponent therefore deems that the project's impact in this sector would be positive. However, the BAPE feels there is a contraction between the positive effect described by the proponent concerning the increase in use of the Grand Détour reservoir by fishers and the consumption restrictions on fish that would be required. In fact, the rise in mercury content in fish flesh associated with the project would modify the recommended consumption frequency of the fish. However, the proponent believes the decrease in consumption frequency would not affect fishers who store and eat their catches, and would affect catches of northern pike only. The proponent also points out that roughly half of the pike caught is stored, and about 24% of the total weight of fish stored is not eaten. The proponent also notes that while the consumption of northern pike would have to be reduced, it would still be permitted. The DFO considers that the increase in mercury in fish flesh would inevitably have a negative effect on fishing interests in the reservoir. However, in light of the arguments put forth above, the DFO nevertheless agrees with the proponent's conclusions to the effect that the creation of the Grand Détour reservoir would have a beneficial effect on recreational fishing in this sector, despite the consumption restrictions associated with the rise in mercury content in fish flesh.

Trees and waste wood leftover from the reservoir's impounding could modify fishing conditions by obstructing access to banks and thus hindering the launching, docking and mooring of boats. However, improved navigability between the dam and Lake Grand Détour, resulting from the reservoir's presence, would have a positive effect on this activity.

Hirondelles River

Activities associated with the construction of the diversion canals would most likely constitute a source of disturbance for fishers who frequent these bodies of water. During the operational phase, the diversion canals would not be very productive and would be of little interest for fishing. The decrease in productivity of northern pike and whitefish resulting from the loss of habitat in Lake Patrick would probably have an impact on fishing activities in these bodies of water as well. However, the road built along the canal would provide greater accessibility to the bodies of water used for fishing. The creation of a new navigable

link between the Grand Détour reservoir and Lake Patrick would also increase accessibility for fishing. On the other hand, more difficult access to the banks of Lake Patrick due to the drop in water level would harm fishing activities. It should also be remembered that the mercury content in fish flesh would rise within the increased-flow segment, reducing the recommended consumption frequency of these fish and therefore having an adverse effect on fishing activity in this sector.

7.2.7.1 Conclusion

Further to its own analysis, DFO considers that, contrary to the conclusions of the proponent, the project would have negative effects on sports fishing because the exploited resource, the boat traffic conditions and the accessibility to shoreline banks would be negatively affected. However, considering the piscicultural production gains in Lake Grand Détour and the application of appropriate mitigation and compensation measures so as to comply with the principle of no net loss of fish habitat and so as to ensure navigational safety on the bodies of water affected, DFO is of the opinion that the project is not likely to cause significant adverse environmental effects on recreational fishing in the study area as a whole. An adequate follow-up program would allow to validate the environmental impact assessment of the project on fish habitat and the quality of angling activities, and adjustments made, if needed.

7.2.8 Recreational hunting

The proponent attributes a high value to hunting. However, the impacts on birds and ground mammals are judged by the proponent to be weak. Disturbances pertaining to recreational hunting would concern mostly the conditions under which this activity is practised. The project would affect use of the Manouane River and the Grand Détour reservoir, where new boating conditions and the relocation of game would force hunters who use these bodies of water to modify their practices. The riparian strip of hunting territories could be affected by the project, especially around the Grand Détour reservoir, and to a lesser degree, along the Manouane River. According to the proponent, most of the project's effects on recreational hunting would be temporary. As well, the long-term disturbances associated with the loss of some of the habitats in the Grand Détour reservoir area and changes in boating conditions on the Manouane River would be mitigated by the application of adequate mitigation measures.

According to the proponent, since the disturbance would be specific to only a small portion of the territory used for hunting, the spatial range would be local. As for the temporal range, this would be considered medium. As a consequence, the proponent considers the impact to hunting as weak.

7.2.8.1 Conclusion

Base on its own analysis, DFO is of the opinion that given the application of the mitigation measures aimed at preserving navigation safety and accessibility, wetlands and birds, as well as implementing a program of adaptative management of wetlands and avian communities, the project is not likely to cause significant adverse environmental effects on recreational hunting. An adequate follow-up program would allow to validate the environmental impact

assessment of aspects of the project that could affect hunting, particularily wetlands, birds and navigation, and adjustments made, if needed.

7.2.9 Current use of lands and resources by Aboriginals for traditional purposes

The reduction in flows and water levels would have two main repercussions on the use of lands and resources by Aboriginals: modification in the availability of some species harvested, and decreased access to certain harvesting areas. Please see sections 7.2.1, 7.2.2, 7.2.3, 7.2.5, 7.2.6, 7.2.7 and 7.2.8 of the present document for additional information on these questions.

The proponent considers the intensity of the impact in the Manouane River area as strong. However, hunting and fishing by the Aboriginals would not be affected on the Péribonka river. Moreover, according to the proponent, in the section which would be flooded and in the section by which the flow would be increased, the proposed mitigative measures would ensure that the impact would be of weak intensity. Overall, the intensity of the impact would thus be medium. The proponent also considers the spatial range of the impact as small and the temporal range as long. According to the proponent, the value assigned to the use of the territory by the aboriginals is high and therefore the importance of the residual impact would be average.[22]

Péribonka River

According to the proponent, the maximal drop of 0.1 m in the water levels would not disturb the beavers in this watercourse. Only some local movement of some colonies established in the shallow bays might be observed. The proponent does not anticipate any significant changes in habitat conditions for the land otter, American mink, muskrat or beaver. The terrestrial mammals found along the Péribonka River would not in any way be affected by the project. The availability of exploitable resources for hunting and trapping by Aboriginals in the Péribonka River sector would therefore not be affected.

As mentioned in the previous sections, the project would not have any notable effect on fish abundance in the Péribonka River. Consequently, no modifications in the use of piscicultural resources of the Péribonka River by Aboriginals are anticipated.

However, the 0.1 m drop in the water level, which would be accompanied by the exposure of logs, could modify boating conditions and, consequently, the practice of fishing and hunting activities on the river.

Manouane River

The source of impact on semi-aquatic and terrestrial mammals would be the reduction of flows downstream from the cutoff point. Downstream of km 78, sensitive habitats for semi-aquatic and terrestrial fauna would be subject to modifications without having notable consequences on small animals, given the significance of the reduction in flows and the installation of a spur downstream of Lake Duhamel. Upstream of this point, the proponent estimates that the displacement of the riparian ecotone toward the new waterline and the extension of shrub expanses on coarse substrates would offer a relatively larger shrub surface as well as greater food supplies for beaver. In addition, according to the project initiator, the decrease in the flow speed would help create lentic segments that could be used by the

beaver, muskrat, land otter and American mink. On the other hand, the decrease in ice-free clearings would mean a decline in the density of land otters along the Manouane River in winter. According to the proponent, exploitable terrestrial mammals, such as hare and moose, would not be affected by the reduced flows.

In terms of piscicultural fauna, following the application of adequate mitigation and compensation measures, only northern pike and whitefish would be adversely affected by the project in the sector pertaining to the Manouane River. However, as previously discussed in section 7.2.1, these losses would be compensated by the gains associated with the creation of the Grand Détour reservoir. Moreover, one will recall that the losses in habitat for landlocked salmon, the most sought-after species, would be compensated entirely, on a local basis. The project's effects on availability of this piscicultural resource in the study area as a whole would therefore have little impact on the Innus.

On the other hand, the project would cause the deterioration of navigation, fishing and hunting conditions in several sections of the Manouane River downstream of the dam, particularly along the segment between kilometres 70 and 95. The project would also render access and navigation downstream of kilometre 50 more difficult. According to the BAPE, the diversion of the Manouane River could definitively cut off an ancestral navigational link between Lake Duhamel and the Péribonka River. The continuity of this link, which is still used by the Innu of Mashteuiatsh, has so far been maintained, despite the Manouane river 1961 diversion by Alcan company. According to the BAPE, rupture of this link would impede access for the practice of fishing, trapping and moose hunting. However, the DFO is of the opinion that, to the extent that the proponent respects the mitigation measures proposed aiming to ensure navigational safety and accessibility, the use of this ancestral link for the practice of traditional activities by Aboriginals would not be significantly affected and would remain possible. As mentionned in the section regarding boating and sport fishing, an adequate follow-up program would allow to validate the environmental impact assessment of aspects of the project that could affect the land accessibility in the context of traditional activities carried out by the Aboriginals, and adjust the project accordingly.

The project would also affect a valued natural site: the waterfall located between kilometres 100 and 94. According to the proponent, the mitigation measures planned (signage along the river and relocation of a portage trail) would not mitigate the significance of this impact since the presence of a dike would cause the waterfall to disappear.

According to the proponent, the project will not result in any significant impact on Aboriginal camp sites scattered along the Manouane River. It is nonetheless recommended by the proponent to help users redevelop their access-ways to the river.

Lake Grand Détour

The construction of two new access roads would require the deforestation of a small area. According to the proponent, this disturbance would have little effect on terrestrial fauna, since it would involve cutting down softwood stands, which are very common in the region. Furthermore, the clearings created in the forest would be conducive to the establishment of ecotones generally favourable to small animals along the edge of mature and uniform forest stands.

Impounding of the new reservoir would result in the flooding of more than 1,200 ha of terrestrial and riparian areas. In the short term, the increased water level in Lake Grand Détour would result in localized losses for beavers that use the current banks, causing them to relocate to new habitats along the new banks. However, in the long term, this body of water would be able to accommodate a greater number of beaver. In terms of moose and semi-aquatic mammals, the reservoir's impounding would result in the loss of habitats, causing these mammals to move to other sites. However, the submerged zone would not contain any moose habitats of potentially high use. As well, based on the rarity of hardwood trees and the relatively small expanse of suitable habitats in the submerged zone, the proponent believes the project's impact on the black bear will be imperceptible. The deforestation of the banks and removal of debris over a 3 m-wide strip starting from the water limit corresponding to elevation 418 would foster the regeneration of habitats for mammals of riparian environments. In addition, on the deforested areas of the submerged zone, above the maximal elevation of the reservoir, slash could be placed in piles so as to provide food and shelter for small animals. The project would therefore not have significant adverse effects on the availability of terrestrial and semi-aquatic mammals that can be exploited by Aboriginals.

As stated in sections 7.2.1 and 7.2.7, the creation of the Grand Détour reservoir would result in a substantial gain in habitats usable by northern pike and whitefish, which would increase their productivity in the sector and therefore favour the practice of fishing activities by the area's users, including the Aboriginal communities. However, the increases in mercury content in northern pike flesh associated with the project's effects would modify the recommended consumption frequency of that species, thus limiting the possibility for the Aboriginal communities from taking full advantage of the increase in the availability of this resource in the Grand Détour reservoir. As stated in section 7.2.7, the DFO is nonetheless of the opinion that the creation of the Grand Détour reservoir would at the same time have a beneficial impact on whitefish fishing and also, in the long term, on northern pike fishing, despite the consumption restrictions stemming from the rise in mercury content in the latter.

In the Lake Grand Détour sector, the project would result in the flooding and disturbance of five Aboriginal camp sites and would affect navigation on the reservoir. The proponent states that, as prescribed by the agreement with the Aboriginals, money for carrying out corrective work would be allocated to the Aboriginal communities to compensate for the camp site losses caused by the creation of the Grand Détour reservoir. The proponent should help the Innus to relocate or rebuild the sites that would be flooded or otherwise affected.[3] The proponent should also clear trees and debris from the flooded edges of the future reservoir in order to make docking safer.

Hirondelles River

The proponent considers that the increased flow in the Hirondelles River would have little effect on semi-aquatic mammals. The proponent proposes to spread excavation materials from the diversion canal along the canal so as to create swampy areas suitable to semi-aquatic mammals. Small dikes would thus be set up in places where the canal crosses poorly drained depressions.

The decrease in productivity of northern pike and whitefish resulting from habitat loss in Lake Patrick would probably have an impact on fishing activities in this body of water. However, the introduction of a road along the canal would improve accessibility to the water bodies used by Aboriginals.

In the Hirondelles River sector, the construction of the diversion canals, the 1.1 m lowering of the mean annual water level, as well as the 2 m water level drop in Lake Patrick about once every seven years would cause the disturbance of three Aboriginal camp sites and render access to the banks more difficult. However, according to the proponent, the creation of a new navigable link between the Grand Détour reservoir and Lake Patrick would increase accessibility to these bodies of water for fishing. As stated previously, the proponent proposes to set up signs along the banks to indicate the periodic drops in the water level. The proponent also proposes to carry out corrective work, as prescribed in its agreement with the Aboriginal communities.

Overall, the impacts on birds and terrestrial and semi-aquatic mammals targeted for hunting and trapping are deemed of minor significance by the proponent. The latter considers that the habitat losses or modifications would have little effect on waterfowl and moose, and do not in any way compromise the practice of hunting in the area of study as a whole. The short-term losses of territories suitable for hunting would be partially compensated by the development of new environments conducive to this activity, around the Grand Détour reservoir and along the Manouane River. In terms of the use of piscicultural resources, the production gains in Lake Grand Détour and the application of adequate mitigation and compensation measures in the reduced-flow sector would allow for the maintenance of traditional fishing activities and ensure navigational safety on all bodies of water concerned.

In the course of the public hearings held by the BAPE, a representative of the Innus of Betsiamites pointed out that the project would affect use of ancestral land upstream of the Manouane River as well as the sector between Lake Grand Détour and Baie aux Hirondelles by the members of its community. Nevertheless, the Band Council indicated that the compensation money set out in the Pesamit 1999 Agreement could be used to create both a community based fund and a mitigative measures fund which would serve to promote traditional activities on the territory and enhance accessibility to ancestral land upstream of the Manouane River infrastructures.

INAC recommends that the corrective work aiming to preserve the use of the diversion canal sector between Lake Grand Détour, Lake Patrick and the Hirondelles River, be determined in collaboration with the Innus to ensure that it meets their needs and that it is done in respect of patrimonial values. In addition, INAC recommends that the proponent hold information and consultation sessions with the Aboriginal communities concerned, during both the construction and the operational phases, so as to allow them to express their concerns about the project's repercussions, and so as to implement appropriate mitigation measures, if needed. The proponent plans to conduct a follow-up on the Innus' use of the resources and water bodies of the Manouane River, the Grand Détour reservoir and the diversion canals. INAC recommends that the proponent also carry out a follow-up on the Innus' movements in the reduced-flow sectors of the Péribonka River, or in the areas where the exposure of logs could pose a threat to navigation.

7.2.9.1 Conclusion

In light of the information presented above, the DFO is of the opinion that, overall, for zones affected by the project and with the application of the mitigation and compensation measures described in sections concerning fish habitat, wetlands, avian fauna, navigation, human health, recreational fishing and hunting, as well as the implementation of an adaptive management plan on wetlands and avian fauna, the project is not likely to cause a significant adverse environmental effect on the overall current use of lands and resources by Aboriginals for traditional purposes. An adequate follow-up program would allow to validate the environmental impact assessment of the project regarding the use of the resources by the Aboriginals, as well as the aspects of the project that could impact the fish habitat, wetlands, mercury in fish flesh, birds and navigation, and adjustments made, if needed.

7.3 Effect of the environment on the project

Natural events such as floods, waves, climate and earthquakes were taken into consideration by the proponent.

The planned structures would allow for discharge of the probable maximum floods (PMF) that would occur in the Grand Détour reservoir and of the flood that would come from the Manouane reservoir should the PMF occur. The crest elevation of the riprap dikes would ensure a freeboard of 1.5 in the case of a PMF.

The increased area of Lake Grand Détour would modify the wave climate, since the wind would have a greater impact. Some banks facing the western winds could be subject to erosion during periods of strong winds combined with a high water level. However, the reservoir's shape and size would moderate the wind's impact, allowing for limited erosion.

According to the proponent, it is unlikely that the climatic conditions would have any influence on the structures.

The proponent estimates that it is unlikely that the development zone would be affected by seismic activity. If this should occur, the impact would most likely be of limited scope. The proponent points out that few infrastructures are found along the periphery of the reservoir.

In light of the information available, DFO is of the opinion that the identification of environmental impacts of the project concerning this matter is satisfactory.

7.4 Impacts caused by accidents or malfunctions

The proponent has assessed the consequences of a dam failure. The scenario chosen involves the appearance of a rectangular breach 20 m wide at elevation 411.5 m in the dam while the water level is at elevation 418 m. This level corresponds to the dam's spillway crest elevation. The proponent estimates that the maximal flow would reach 570 m^3/s just after the breach's formation. This flow is distinctly lower than the probable maximum flood, which is about 2,078 m^3/s. The maximal flow in the case of a rupture is slightly above the flow rate of floods of a 100-year recurrence interval, which is 520 m^3/s. According to the simulations, the water level would drop from 418 to 414.5 m after 48 hours.

The proponent has prepared an emergency measures plan which could be implemented at any time during construction work. Hydro-Québec has a monitoring program that provides for periodic inspections and behaviour studies on its structures. They are, moreover, equipped with the auscultation instruments necessary for monitoring and analyzing the behaviour of the structures, which would also be the case for the new structures. The maintenance program consists of preventive and curative maintenance for the structures, based on the findings of the behaviour studies.

The proponent describes its emergency measures plan in Chapter 2 of the preliminary project report. It contains the logic diagram for the dam emergency actions and the diagrams on the communication processes in the event of various emergency situations.

In light of the information available, DFO deems the identification of impacts concerning this matter as satisfactory, as well as the proposed prevention measures, intervention measures and emergency plans.

7.5 Project's effect on renewable resources

The proponent estimated the impacts of the project on forest activities and the existing infrastructure (roads, transmission lines, etc.). According to the proponent, the the impact on forest activities would be weak. With regards to existing infrastructure, the proponent considers the intensity of the impact as medium. The spatial range of the impact is localized and the temporal range would be short. So, according to the proponent, the overall intensity of the impact on infrastructure could be considered weak.

During the construction phase, the sources of impact that could harm terrestrial vegetation are the construction of hydraulic structures and access roads. The intensity of the disturbances caused during the construction phase is deemed minor since the work will result in the loss of small forest stands and will not in any way threaten the long-term survival of these local plant populations. According to the proponent, the development of the various work sites would be accompanied by localized and negligible terrestrial vegetation losses.

According to the proponent, the project would result in localized losses almost exclusively in the Lake Grand Détour sector. The flooding or entrapment of some zones and the accumulation of ligneous biomass would lead to losses in productive and accessible forest lands, in forest exploitation potential and in property assets (roads, bridges and sylvicultural works), as well as substantial quantities of biomass left in the cutting areas and in non-recovered forest stands. The losses in productive and accessible forest lands would total 685 ha.

The only impact feared on infrastructures concerns the considerable increase in traffic on existing forest roads during the construction period required to build the new hydraulic structures and the new access roads to these structures. The proponent proposes to set up means to ensure the maximum safety on forest roads during the construction period.

To mitigate the project's effects on productive and accessible forest lands, the proponent proposes to clear a 3 m-wide band along the banks above elevation 418 m, to recover merchantable timber before its flooding, to eliminate residual biomass (removal of all waste wood before the impounding), to implement a sylvicultural program, and to raise the two

bridges and the roads that cross them. According to the proponent, following the application of the proposed measures, losses associated with the project would be negligible and should not disturb the overall supply of logging companies.

For the reasons cited in sections 7.2.1, 7.2.6 and 7.2.7, the DFO is of the opinion that fisheries should not be significantly affected by the project.

7.5.1 Conclusion

The DFO considers that given the application of the measures previously stated, the project is not likely to cause significant adverse environmental effects on the renewable resources of the forest and fisheries.

7.6 Cumulative effects

The assessment of cumulative effects is described in Chapter 9 of Volume 1 of the preliminary project report,[22] as well as in the May 2000 report on the assessment of the project's cumulative effects.[3] It is important to note that only the major concerns are discussed here. For more details, the reader should refer to the documents cited above.

The method used is very broadly drawn from that advocated in the Canadian Environmental Assessment Agency's document.[5] Step 1 consists of determining the importance of the problems and the priorities by identifying the issues and the related valued ecosystem components (VECs), by establishing the spatial and temporal boundaries and by determining the other projects or activities whose negative effects could add to those of the project. The second step consists of analyzing the effects by describing the reference status and by assessing the cumulative effects. The third step consists of defining the mitigation measures, while the fourth step permits the assessment of the significance of the residual effects. Lastly, the fifth step identifies the follow-up required.

The valued ecosystem or environmental components (VECs) represent elements of the natural and human environment with a special value in the project region. The VECs selected for the assessment of cumulative effects may differ from those selected for the assessment of the project's direct effects. Cumulative effects will be discussed for VECs when the project is likely to cause residual effects on that particular component and where a high possibility exists that this effect combines with effects caused by past, present and future projects.

The spatial boundaries for assessing the cumulative effects of the Manouane project correspond to the limits of the watersheds of the Manouane, Péribonka and Betsiamites rivers. It should be noted that Lake Saint-Jean is not part of the study area because the reduced flow caused by the partial diversion of the Manouane represents only a small portion of the annual inflow to this body of water. The potential effects beyond these boundaries can be considered negligible.[3] The boundaries of the study area were adjusted according to the major issues and the VECs considered. Thus, in the assessment of the project's cumulative effects, for each VEC, the area considered is limited to the distribution area (in the case of a species) or contained within the abovementioned watersheds (in the case of an activity).

The temporal bounds of the study were set at ± 10 years from 2000, or from 1990 to 2010. The ten-year limit for past projects is intended to take into consideration changes in the

environment without necessarily covering the entire history (past and future) of the affected zone. Beyond these limits, Hydro-Québec considers that it is difficult to obtain information and that the uncertainty of predictions is too great.

Here are the environmental issues used for the assessment of cumulative effects and defined during the communication program implemented by the proponent as part of the environmental assessment:

- icthyo communities and fish habitat;
- use of the resources by non-aboriginals;
- use of the resources by the aboriginals;
- holiday resort, leisure activities and tourism.

The following list presents other projects or activities that may have (or have had) environmental effects that are likely to add to those of the diversion of the Manouane River during the period from 1990 to 2010:

- operation of three hydroelectric stations by the Alcan company on the Péribonka River;
- operation of two hydroelectric stations by Hydro-Québec on the Betsiamites River;
- pressure on fish stocks resulting from fishing carried out by recreational fishers and by Aboriginals;
- logging;
- forest fires.

It should be noted that the assessment of cumulative effects of the partial diversion of the Manouane River does not take into account the new hydroelectric facility planned on the Péribonka River, for which a feasibility study began in September 2001.This study was undertaken following the results of the last summary assessment begun for this project, in fall 2000. The assessment results confirming the pertinence of conducting a feasibility study were not obtained until spring 2001. According to the *CEAA's Cumulative Effects Assessment Practitioners Guide,* the choice of actions to be studied in the cumulative effects assessment should be made in light of the most probable future scenario.[16] The *Reference Guide* published by the Agency in 1994 specifies that the assessment of cumulative effects of future projects should include only impending projects, that is, projects that have been approved but not yet carried out, or proposals waiting for planning details or other types of formal approval.[5] The Péribonka project was therefore not retained by the proponent for the assessment of cumulative effects of the partial diversion of the Manouane River.

7.6.1 Ichthyological communities and fish habitat

In all likelihood, some factors would have additional effects on the ichthyological communities and fish habitat, in particular those having direct effects, such as fishing pressure and hydroelectric operations, which account for a certain mortality rate in fish of the Manouane and Péribonka rivers, as well as the reduction in flow, which would cause the shoreline exposure of habitats and a decrease in the watercourse's productive capacity. In

addition, fishing pressure could temporarily increase immediately after the diversion since the fish in the Manouane and Péribonka rivers would find themselves in a smaller volume of water.

Other factors would have more indirect effects. For example, logging and use of the forest road network as well as forest fires can cause changes in the hydraulic regime, water quality and the sediment regime.

Landlocked salmon

In its assessment of cumulative effects on fish habitat, the proponent retained four human or natural actions or activities aside from the partial diversion of the Manouane River that are likely to cause a fluctuation in the landlocked salmon population and its habitat in the project's area of influence: fishing pressure, logging, hydroelectric operations and forest fires.

It is difficult to estimate the impact intensity of fishing since the numbers of landlocked salmon in the study area are not well known. Given that the landlocked salmon population has few individuals, it is plausible to assume that fishing would have a noticeable effect on this population. This impact could be considered permanent, assuming that no additional regulations would be set up to lessen or eliminate the harvest, and could add to the project's effects.

In terms of logging, impacts resulting from wood harvesting and the building and maintenance of roads are likely to increase the inflow of fine particles to the river. This increase could lead to a gradual deterioration of the habitat through the sedimentation of fine particles and the clogging of granular substrate beds used by landlocked salmon for reproduction. Moreover, there is a strong possibility that this sedimentation phenomenon caused by logging would be accelerated by the reduction in flow speeds resulting from the river's partial diversion. Special attention would be paid to the follow-up of the quality of landlocked spawning grounds in the Manouane River. This impact, although temporary, could be felt over more than ten years.

In terms of hydroelectric operations, the presence of two facilities (Chute-du-Diable and Chute à la Savane) could lead to the loss of landlocked salmon that swim downriver to reach the feeding areas located downstream. In fact, once the fish have crossed these obstacles, they cannot go back upstream to the Péribonka and Manouane rivers. Moreover, it is recognized that a certain percentage of fish that enter the turbines die as a result of injuries and the pressure variations to which they are subjected. However, the mortality rate associated with these two generating stations is not known; the number of fish that go through the turbines is not known either.

Finally, forest fires can have essentially the same effects on landlocked salmon as logging. However, given that the areas affected in the Manouane River sector are relatively small, the proponent deems that this factor would be low, although it should still be added to those listed above.

Given that the habitat losses attributable to the project will be compensated by fish management measures intended to maintain the productive capacity of landlocked salmon, that a follow-up program will be implemented to monitor the effectiveness of compensation

measures and determine any necessary adjustments, and that, if needed, artificial incubators will be used to ensure landlocked salmon recruitment in the case of a delay in fry production in the relocated spawning grounds, the cumulative effects of the project on landlocked salmon combined with those associated with other human activities or natural phenomena should not be significant.

Northern pike and whitefish

The project's effects on the productive capacity of northern pike and whitefish would add to the pressure of recreational and subsistence fishing. However, it should be recalled that the loss in northern pike and whitefish production in the Manouane and Hirondelles river sectors would be largely compensated by the gains in productive habitats for these species that are expected in the Grand Détour reservoir. In addition, according to data collected by the proponent, northern pike and whitefish are of little interest to clients of the outfitters. [22]

Finally, unlike landlocked salmon, northern pike and whitefish do not appear to be very sensitive to impacts caused by logging and forest fires.[3, 31] Moreover, because these species are not typically migratory species, there is little probability of them going through the hydroelectric turbines.[3] The effects of these activities would therefore not add to those of the project.

Yellow walleye

Overall, the project is expected to foster yellow walleye production. Therefore, no negative cumulative effects are associated with the Manouane river's diversion.

Atlantic salmon

The project's effects on Atlantic salmon in the Betsiamites River could add to fishing pressure, a factor that has been affecting salmon in the Betsiamites River for several years. In an attempt to improve the situation of salmon resources in this river, Hydro-Québec signed an agreement with the Innu Band Council of Betsiamites, and a salmon restoration program for the Betsiamites River was launched. Among other things, the program aims to establish a yearly fishing quota and to limit the number of catches per year. The purpose of this quota is to alleviate fishing pressure on the salmon population of the Betsiamites River.

The diversion project's effects could add to those of logging. The extent of the impacts of logging are not known as there has been no specific study on this factor. However, the size of the area in the affected sectors suggests the effects would be significant. [3]

In addition, the effects of the diversion would add to those caused by the 1991 forest fires. The intensity of the impacts of this natural disaster have not been measured.

Finally, hydroelectric operations affecting the salmon situation in the Betsiamites River and could also contribute to the project's effects. The success of salmon in using the river for food supply and reproduction purposes varies according to the management method of the Bersimis-2 generating station. In accordance with an agreement between the proponent and the Innu Band Council in 1999, the proponent has modified its flow management of the Betsiamites so as to foster salmon production, namely by limiting the maximum hourly flow variation downstream of the Bersimis-2 generating station and by ensuring a minimum flow. [24]

It is therefore plausible that in the long term, a decline in the impacts or pressure on the salmon population of the Betsiamites River may occur as a result of current and future efforts by the various stakeholders (new flow management and decrease in fishing pressure). In addition, the proponent indicates that, according to information obtained from the Ministère des Ressources Naturelles, anticipated logging activities over the next five years should be carried out in the northern part of the Betsiamites basin, far from the river segments frequented by salmon.[3]

Mercury in fish flesh

In the Grand Détour and Pipmuacan reservoirs as well as in the Hirondelle River and the Manouane River, no cumulative effect is foreseen, as no direct effect of the project on the mercury levels in fish flesh would combine with effects of other past, present or future projects or activities. This conclusion is also valid for the Peribonka River, because no significant raise in mercury levels in fish flesh is foreseen downstream of Duhamel Lake following the realisation of the project.

7.6.1.1 Conclusion

In short, the effects of the diversion of the Manouane River would add to the main effects associated with fishing pressure, logging, hydroelectric operations and forest fires. However, given that the losses in fish habitat resulting from the project would be compensated by fishing management measures aiming to maintain landlocked salmon productivity in the affected sectors and by the gains in usable habitats for northern pike and whitefish associated with the creation of the Grand Détour reservoir, the DFO is of the opinion that the project is not likely to cause a significant cumulative adverse environmental effects on ichthyological communities and fish habitat.

7.6.2 Use of resources by non-Aboriginals

Use of resources by non-Aboriginals is directly affected by the project's effects on the ichthyological fauna and fish habitat and on fishing conditions (navigation, access to banks for mooring and docking, etc.). These effects could add to those of various past and future actions and activities such as forestry (including the impact of logs leftover after timber-floating activities, affecting navigation), hydroelectric operations, fishing pressure and forest fires. In fact, these latter actions and activities are also likely to affect fish and their habitats and consequently, fishing success, fishing conditions and the use of sites.

The preceding section, dealing with cumulative effects on the ichthyological fauna and fish habit, as well as the section touching on navigation, presented later on, provide a greater understanding of the project's cumulative effects on the use of resources by non-Aboriginals.

7.6.2.1 Conclusion

Considering the gains in fish production in Lake Grand Détour and the application of adequate mitigation and compensation measures aiming to maintain fish productivity in the study area following the project's completion and to ensure navigational safety and accessibility on the bodies of water concerned, the DFO is of the opinion that the project is

not likely to cause a significant cumulative adverse environmental effect on the use of resources by non-Aboriginals in the area of study as a whole.

7.6.3 Use of resources by Aboriginals

The residual impacts anticipated from the project would not significantly modify use of the territory by the Innu in the Péribonka River sector. While the logging that took place in the 1980s restricted activities along this river, the forest has since been gradually regenerating, and the forest roads provide greater access to the territory. The proponent deems that the project's cumulative effects will be negligible in the Péribonka River sector affected by the project.

The proponent does not expect any significant impact on the availability of terrestrial and semi-aquatic wildlife in the reduced-flow segment of the Manouane River. However, according to the proponent, access conditions to these resources could be adversely affected by the presence of circulation limitationsin the river. Difficulties in accessing the resources in these sectors would combine with effects caused by logging and forest fires on the availability and distribution of wildlife resources. In fact, over the last ten years, logging has intensified on trapping-ground lots 33, 43 and 11. In addition, logging is anticipated in the southern part of lot 32, on the right shore of the Manouane River, up to 2005. In terms of forest fires, the 1996 fire ravaged more than 12,000 ha of forest, affecting a large part of lot 33. Logging and forest fires, which have caused a decline in wildlife species or their displacement, have therefore disturbed trapping in the last ten years, and the effects will continue to be felt over the next fifteen years. The proponent states that some Innu trappers have remarked that in the years following logging, animals have gradually sought refuge in the protected riparian strips, notably along the Manouane River; as a result, trapping has gradually become concentrated in these areas.

In the Lake Grand Détour sector, the proponent does not foresee any cumulative effect on trapping and hunting. The DFO disagrees with this conclusion, and deems that the impounding of the new reservoir, which would lead to habitat loss and displacement of terrestrial and semi-aquatic fauna (mammals and birds), would add to the effects of past and future logging, which would in turn affect the availability of wildlife resources in this sector. However, the improvement of navigation conditions associated with the creation of the Grand Détour reservoir would foster the practice of trapping and hunting in this sector and therefore help reduce the cumulative effects. In addition, according to the proponent, trappers generally adapt fairly well to changes brought on by logging. [3]

The proponent also states that the project would not have any impact on subsistence fishing in the reduced-flow sector since only northern pike would be negatively affected by the project and the Montagnais are not very sensitive to variations in the abundance of this resource.[3] The proponent adds that only conditions for accessing the resource would be modified. According to the project initiator, given the numerous potential fishing sites in this watercourse and the surrounding lakes, and given the presence of access roads along the river, the overall impact of the project on subsistence fishing would be negative but of minor intensity. The DFO is of the opinion that whitefish should also be considered in the analysis, and deems that the points raised in section 7.6.2 concerning recreational fishing (potential harvest and practice of the activity) also apply to fishing by Aboriginals. The project's effects

on the on ichthyological fauna and fish habitat (including the increased mercury content in flesh fish) and on fishing conditions and activities (navigation, access to banks for mooring and docking, etc.)—both likely to affect the use of resources by Aboriginals—could add to the various past and future actions or activities, such as forestry, hydroelectric operations, fishing pressure and forest fires.

The proponent states that the increased fishing potential in the Lake Grand Détour sector could have a positive impact on subsistence fishing. This impact would not add to any other, so there would be no cumulative effects.

With the construction of dike 1, the project would cause the disappearance of the falls located between kilometres 94 and 100 of the Manouane River, a site prized by Aboriginals for its aesthetic and historical value. This direct impact of the project would add to the deterioration of the landscape caused be forest fires and logging that has taken place in this sector; cumulative effects are therefore feared.

According to the proponent, the project would not cause any significant impact on the Aboriginal camp sites located along the Manouane River. The project would therefore not have any cumulative effect on this element. According to the proponent, following application of the measures stated in section 7.2.9, the project's effects on the camp sites of the Montagnais of Lake Saint-Jean and Betsiamites located in the Lake Grand Détour sector would be negligible and would not add to any other effects. Although, on the one hand, the relatively high level of forestry activity has disturbed the natural environment surrounding several camp sites, making them less attractive, on the other, the forest road network has made it possible to establish sites in a number of other sectors hitherto difficult to access.

7.6.3.1 Conclusion

Given the gains in fish production in Lake Grand Détour, the application of the mitigation and compensation measures outlined in the sections dealing with the project's effects on fish habitat, wetlands, avian fauna, navigation, recreational fishing and hunting as well as the use of lands and resources by Aboriginals, the DFO is of the opinion that the project is not likely to cause a significant cumulative adverse environmental effect on on the overall use of resources by Aboriginals.

7.6.4 Recreation, tourism and leisure

According to DFO, the project's effects on navigation in the Manouane and Péribonka rivers would add to the modification of navigation conditions associated with the effects of timber floating. However, since timber floating on the Péribonka River was stopped in 1995 and clean-up work was carried out on the river banks to recover stranded or sunken longs, navigation conditions have improved.

In the diversion sector (Lake Patrick and Hirondelles River) and the Grand Détour sector, the project's effects on navigation would be positive and would therefore not constitute a cumulative effect.

As to the project's direct visual impact, the effects on the landscape would add to existing effects resulting from forest fires and logging activities.

7.6.5 Conclusion

Given the application of the proposed mitigation measures, the compliance with the conditions associated with the formal approval to be issued under the *Navigable Waters Protection Act* (NWPA), and that an adequate follow-up program is set up and the application of appropriate adjustments should they be needed, the DFO deems that the project is not likely to cause a significant cumulative adverse environmental effect on recreation, tourism and leisure in the study area as a whole.

8 Follow-up program

Chapter 10 of Volume 1 of the preliminary project report describes the monitoring and follow-up program proposed by the proponent (presented in Appendix 2 of this document). Additional clarification can be found in certain supplementary documents.[1, 18, 25] This environmental follow-up will make it possible to verify the accuracy of the predictions of the project's impacts and the effectiveness of the proposed mitigation measures. As well, a follow-up tied specifically to the compensation measures will be carried out in order to verify their effectiveness and set up corrective measures, if necessary.

Basically, the follow-up program proposed by the proponent comprises three parts, involving the physical environment (bank stability and evolution, sediment regime, thermal regime, water quality), the biological environment (aquatic and riparian vegetation, ichthyological fauna, terrestrial and semi-aquatic fauna, avian fauna), and the human environment (land use by the Montagnais and land use by non-Aboriginals). The proponent will be responsible for implementing these various follow-up measures.

The DFO deems that these follow-up measures will make it possible to achieve the major objectives targeted by the mitigation and compensation programs. However, some aspects of these follow-up measures will have to be modified so as to provide a better assessment of the anticipated environmental effects. Furthermore, the following additional elements should be considered:

- The proponent concludes that the spur that would be installed at the Lake Duhamel outlet would not hinder fish movement. Given this water body's importance for ichthyological fauna in the Manouane River and the presence of important landlocked salmon spawning grounds upstream, the DFO is of the opinion that there must be a follow-up focusing on this concern in order to validate the assessment of anticipated impacts on fish movement and that corrective measures be made, such as modifying the spur structure, if necessary.
- The DFO also considers that the proponent should conduct data collection campaigns at different tide amplitudes and different streamflows so as to better understand the current and future conditions of the Betsiamites River estuary. The data collected will allow for a more accurate assessment of the effects of increasing the inflow of fresh water to the estuary on the environment's biological components. The proponent must submit its chosen methodology to the DFO beforehand for validation and approval.
- Environment Canada (EC) experts recommend setting up a follow-up program to monitor the various sectors where wetland regeneration is expected; the duration and frequency of

this monitoring program should be adapted to the anticipated length of this regeneration period. The plans and a detailed description of the measures proposed as well as the monitoring protocol must be submitted to EC for prior evaluation and recommendation to DFO.

- The proponent does not provide precise information on the project's effects on each of the avian species concerned. According to EC, this uncertainty can be removed by carrying out a follow-up program on the nesting avian fauna (aquatic and terrestrial) of the main ecosystems following the project's completion. EC recommends that the proponent submit a follow-up protocol focusing on this concern. The results of the follow-up will then enable the proponent to target the species most affected by the project's construction. The follow-up protocol must be validated by EC.
- EC recommends that an adaptive management plan based on the monitoring and follow-up of wetlands and avian fauna be implemented. This plan should contain, but not be limited to, the following elements:
- the expectations and forecasts in terms of both environmental effects and the compensation projects;
- the criteria retained and intervention thresholds to compensate problems for which corrective measures prove to be ineffective or do not exist;
- the criteria retained and intervention thresholds for correcting unexpected situations or counter-performances;
- the intervention scenarios envisioned for various potential problems; and
- the description and specifications of the compensation project(s) to be implemented.

  The details of this plan must be submitted to EC for prior validation and recommendation to DFO, at the same time as the follow-up program on wetlands and avian fauna.
- In the opinion of Natural Resources Canada (NRCan), the characterization of the geochemical composition of the land to be affected by the reservoir's impounding would have allowed a better assessment of the potential heavy metal remobilization and the environmental repercussions associated with this problem. In the absence of this information, NRCan recommends that the follow-up program prescribed by the proponent on the water quality of the Grand Détour reservoir include a follow-up on the remobilization of mercury, and that NRCan be consulted during the development of this detailed follow-up program.
- Indian and Northern Affairs Canada (INAC) recommends that the proponent include a follow-up on the Innu' movements in the Manouane and Péribonka sectors in the areas of reduced flow and where the exposure of logs could pose a threat to navigation.

The follow-up finding are to be forwarded to the DFO who will send to federal authorities for evaluation and recommandation and DFO may, where appropriate, request changes in light of the results obtained.

9 Conclusion

Following the analysis of the nature of the project, the description of the work, the infrastructures and the proposed modifications to the hydraulic regime, the Department of Oceans and Fisheries, as the Responsible Authority as defined in the *Canadian Environmental Assessment Act* (CEAA), has assessed the potential impacts that the partial diversion of the Manouane River is likely to have on the environment.

This review was completed on the basis of the information provided by the proponent, the opinions of the different federal departments that have an interest in the project's construction, and the information arising out of the BAPE investigation and public consultation.

Taking into account the proposed mitigation, compensation and follow-up measures, as well as the proponent's commitments, the DFO has determined that the project as so defined in the scope of this study is not likely to cause significant adverse environmental effects.

Prepared by: *Original signed by* — 2002/09/12

Dominic Boula, Biologist-Analyst
Direction of Fish Habitat Management
Fisheries and Oceans Canada

Date

Revised for the implications on the protection of navigable waters: *Original signed by* — 2002/09/12

Michel Demers, Superintendent
Navigable Waters Protection Division
Fisheries and Oceans Canada

Date

Approved by: *Original signed by* — 2002/09/24

Jean Piuze, Regional Director
Regional Oceans and Environment Branch
Fisheries and Oceans Canada
Quebec Region

Date

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Appendix 1: Summary sheet of the project's environmental effects on the biological and human environments, specific mitigation and compensation measures, and scope of residual impact

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Ichthyological fauna and fish habitat	**Péribonka River**			Not significant
		Shoreline exposure of 3.8 ha of feeding areas for adult landlocked salmon	Gains in feeding areas for landlocked salmon in Lake Duhamel to exceed losses following the construction of a spur at the lake's outlet.	
	Manouane River			
		42 ha gain in fry-rearing habitats for landlocked salmon and 15 ha for parr habitats.	Relocation of affected landlocked salmon spawning grounds (5,000 m^2) so as to maintain all current spawning areas.	
		Shoreline exposure of 5,000 m^2 of landlocked salmon spawning areas and significant decrease in flow speeds over some spawning grounds.	Building of structures so as to allow sufficiently fast flow speeds over some landlocked salmon spawning grounds.	
		20 ha gain in fry-rearing habitats for yellow walleye and 5 ha gain in food supply areas for the juveniles and adults.	Creation of 3,000 m^2 in new landlocked salmon spawning grounds between kilometres 20 and 51.	
		Temporary loss of 10 ha of northern pike spawning habitats caused by the drop in water levels and the shoreline exposure of riparian ecotones.	Installation of upflow incubation boxes in the Petite Manouane River.	
		75 ha loss in rearing and food supply habitats for northern pike and whitefish.	Construction of a spur at the Lake Duhamel outlet.	
		11,750 m^2 loss in food supply habitats for northern pike and whitefish caused by the encroachment of the retaining structures, spurs and cofferdams, and by excavation during construction.	Construction of a spur at km 83 so as to maintain current levels up to km 92.	
		Restriction of fish movements at some riffles due to the drop in water levels between kilometres 82 and 97.	Perform bridge-raising work outside the spawning periods of species present.	
		Increase in turbidity and sediment deposits in the spawning grounds located downstream from the work carried out to raise the bridge where dike no. 6 is to be built.		

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Ichthyological fauna and fish habitat	**Lake Grand Détour**			Non significant
		1,432 ha gain in habitats (food supply, rearing and reproduction) that can be used by northern pike and whitefish, following the reservoir's creation. Increase in turbidity and sediment deposits in the spawning grounds located downstream from the work to be carried out to raise the bridge on Grand Détour River.	Perform work outside the spawning periods of species present.	
	Hirondelles River			
		Increase in the relative abundance of longnose sucker in the increased flow segment, to the detriment of northern pike and whitefish. Shoreline exposure of 6.7 ha of spawning, rearing and food supply areas for northern pike and whitefish in Lake Patrick as a result of the decrease in water levels. 26,600 m^2 loss in food supply habitats for northern pike and whitefish due to excavation work for a portion of the diversion canals. Decrease in zooplankton and benthic production in the Hirondelles River over the long term.	None	
	Betsiamites River			
		Spatial reorganization of saltwater fish species such as capelin, plaice and Atlantic sturgeon, resulting from a greater inflow of freshwater.	None	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Mercury in fish flesh	**Péribonka River**			Not significant[b]
		None	None	
	Manouane River			
		Increase in mercury content and reduction in the suggested consumption frequency of piscivorous fish from the segment between Lake Duhamel and the projected dam (from km 61 to km 97).	Implementation of a information campaign based on the consumer profile (Aboriginal and non-Aboriginal populations).	
	Lake Grand Détour			
		Increase in mercury content and reduction in the suggested consumption frequency of piscivorous fish from the Grand Détour reservoir	Implementation of a information campaign based on the consumer profile (Aboriginal and non-Aboriginal populations).	
	Hirondelles River			
		Increase in mercury content and reduction in the suggested consumption frequency of piscivorous fish from the diversion canals, Lake Patrick and the Hirondelles River.	Implementation of a information campaign based on the consumer profile (Aboriginal and non-Aboriginal populations).	
	Betsiamites River			
		None	None	

a. Assessment of environmental effects is based on maintenance of a minimum flow rate of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.
b. The scope of residual impact of mercury was assessed according to the risk to human health.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Avian fauna	**Study area as a whole**			Not significant
		Site-specific loss of habitats and disturbance of birds in the construction phase as a result of deforestation work related to the construction of access roads and hydraulic structures. Loss of forest bird habitats (685 ha) and aquatic bird habitats (486 ha) as a result of the raising of Lake Grand Détour. In the long term, regeneration of new riparian ecotones on low-sloping banks of sheltered bays. Temporary modifications to riparian habitats in the reduced-flow section. Creation of new habitats on the exposed flats. Temporary loss of close to 3 ha of riparian habitats in the Hirondelles River sector.	On-site verification in June and July of the presence of Bicknell's thrush or the potential habitats, before such habitats are cut down. Prior mapping of potential habitats for Bicknell's thrush. No deforestation in June and July. Construction of a spur at km 83 of the Manouane riverin order to maintain current water levels up to km 92. Construction of a spur at the Lake Duhamel outlet. Deforestation of a 3 m-wide band along the reservoir banks starting at the maximum water level limit, elevation 418 m, in order to encourage the regeneration of riparian habitats. Creation of nesting islands for the black duck and the Canada goose in the sheltered bays of the submerged zone. Spreading of excavation materials from the diversion canals to create swampy areas favourable to waterfowl.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Wetlands	**Study area as a whole**			Not significant
		Losses or modifications in the functions or values connected with wetlands, as a result of the shoreline exposure or flooding during the raising of Lake Grand Détour. Submergence of 374 ha of shrub swamp and 112 ha of wet prairie marshes.	Construction of a spur at km 83 of the Manouane river in order to maintain current levels up to km 92. Deforestation of a 3 m-wide band along the reservoir banks starting at the maximum water level limit, elevation 418 m, in order to encourage the regeneration of riparian habitats. Creation of nesting islands for black duck and Canada goose in the sheltered bays of the submerged zone. Placement of part of the slash in piles on the deforested banks of the submerged zone, above the maximal elevation, so as to provide food and shelter for small fauna. Spreading of excavation materials from the diversion canals to create swampy areas favourable to waterfowl.	
Physical and cultural heritage	**Study area as a whole**			Not significant
		Loss of 8 known archaeological sites and 83 known areas of archaeological potential through the impounding of the reservoir.	Conduct an inventory in the areas of archaeological potential before impounding the reservoir. Perform archaeological excavations at the main archaeological sites before impounding the reservoir. Carry out in-depth analyses of the data collected and communicate this data to the populations concerned (Aboriginal and non-Aboriginal) as well as to the scientific community. Inform affected local Aboriginal communities of the mitigation measures that will be taken with regards to the archaelogical heritage and the burial site at the confluence of the Péribonka and Manouane rivers.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Human health	See section on mercury in fish flesh			
Recreation, tourism and navigation	**Péribonka and Manouane rivers**			Not significant
		Navigation will be a bit more difficult close to the banks and in the shallow bays in the Péribonka River (from km 95 to km 125). Additional navigational difficulties on the Manouane River downstream from the cutoff points, at certain spots and during certain periods, due to the decrease in water levels. Modified portage use at km 95 due to the presence of dike no. 1. Modification to the landscape of the Manouane River falls due to the decrease in water levels and flows, more specifically the falls at km 67 and km 69, which are sites of visual interest.	Construction of a spur at km 83 of the Manouane river in order to maintain current water levels up to km 92. Construction of a spur at the Lake Duhamel outlet so as to maintain levels between kilometres 50 and 61. Removal, if necessary, of wood debris or logs that could be exposed in the zones affected by a drop of water level. Installation, at appropriate spots along the banks or on the islands in the river mouth, of markers indicating the channels where navigation is possible and potential hasards. Relocation and development of portage trails. Drafting of a detailed map to show the signs and locations of portage trails along the Manouane River between the cutoff point and the river mouth. Ensure that this map is made available to watercourse users. The installation of safety booms at the upstream of selected structures.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Recreation, tourism and navigation	**Lake Grand Détour**			Not significant
		Submergence of four recreational sites during the impounding of the reservoir. Slight modification to navigation conditions due to trees or waste wood left on site during the impounding of the reservoir. Improved navigability between the dam and Lake Grand Détour and increased recreational development potential as a result of the reservoir's creation.	Compensation for the cottages located in the submerged zones. Deforestation of the reservoir banks and removal of waste wood over a width of 3 m above elevation 418 m.	
	Hirondelles River			
		Difficult access to the banks of Lake Patrick resulting from a drop in the mean annual water level (1.1 m), and even greater difficulty during the additional decrease (2 m) roughly once every seven years. Creation of a new navigable link between the Grand Détour reservoir and Lake Patrick as a result of the construction of a diversion canal. Increased potential for the development of recreational sites in the Lake Patrick sector due to a new access along the diversion canal.	Installation of signs on the banks to alert watercourse users to periodic drops in the water level.	
Recreational fishing	**Péribonka River**			Not significant
		More difficult access to some fishing areas, particularly in some shallow bays.	All mitigation and compensation measures stated in the ichthyological fauna and fish habitat section and in the navigation section apply to recreational fishing.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Recreational fishing	**Manouane River**			Not significant
		Decrease in the potential harvest of northern pike and whitefish as a result of the loss of habitats, particularly in the territories of the Pourvoirie Pavillon Boréal and Pourvoirie du Lac Duhamel outfitters. Improvement of fishing quality as a result of the gains in yellow walleye production, particularly in Lake Duhamel and at the mouth of the Manouane River. Modification of fishing practices (boat movement, mooring, docking) in some sections of the Manouane River as a result of the drop in water levels.	All mitigation and compensation measures stated in the ichthyological fauna and fish habitat section and in the navigation section apply to recreational fishing.	
	Lake Grand Détour			
		Improvement in the quality of whitefish and northern pike fishing due to the increased recruitment of these species resulting from the reservoir's creation. Bank accessibility impeded by trees and waste wood left on site during impounding, hindering mooring, docking and launching of boats. Improved navigability between the dam and Lake Grand Détour as a result of the reservoir's presence. Decrease in harvesting interest owing to the increase in mercury content in fish flesh, primarily in northern pike.	All mitigation and compensation measures stated in the ichthyological fauna and fish habitat section and in the navigation section apply to recreational fishing.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Recreational fishing	**Hirondelles River**			Not significant
		Creation of a new navigable link between the Grand Détour reservoir and Lake Patrick as a consequence of the construction of the diversion canals. In the long term, decrease in the potential harvest of northern pike and whitefish in the Lake Patrick sector. Access to the banks of Lake Patrick rendered difficult due to the drop in water level, and increased difficulties during the additional 2 m drop about once every seven years. Increased accessibility to affected bodies of water owing to the new permanent access built along the canals.	All mitigation and compensation measures stated in the ichthyological fauna and fish habitat section and in the navigation section apply to recreational fishing.	
Recreational hunting	**Péribonka River**			Not significant
		Accessibility to some hunting and trapping grounds rendered more difficult, in particular in some shallow bays.	All mitigation and compensation measures stated in the wetlands, avian fauna and navigation sections apply to recreational hunting.	
	Manouane River			
		Development of conditions favourable to hunting along the edges of the river as a result of the modification of riparian habitats. Modification of hunting conditions in the areas accessible by boat only, owing to the drop in water levels.	All mitigation and compensation measures stated in the wetlands, avian fauna and navigation sections apply to recreational hunting. Construction of a spur at km 83.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Recreational hunting	**Lake Grand Détour**			Not significant
		Modification of hunting activities on the edges of the reservoir as a result of the loss of waterfowl and moose habitats following the reservoir's impounding. Bank accessibility impeded by trees and waste wood left on site during impounding, hindering mooring, docking and launching of boats. Improved navigability between the dam and Lake Grand Détour owing to the presence of the reservoir.	All mitigation and compensation measures stated in the wetlands, avian fauna and navigation sections apply to recreational hunting.	
	Hirondelles River			
		Creation of a new navigable link between the Grand Détour reservoir and Lake Patrick owing to construction of the diversion canals. Increased accessibility to the territory and its wildlife resources resulting from the development of a new permanent access along the canals.	All mitigation and compensation measures stated in the wetlands, avian fauna and navigation sections apply to recreational hunting.	
Use of renewable resources	**Study area as a whole**			Not significant
		Loss of productive and accessible forest grounds, as well as forest exploitation and realty possibilities, owing to the submergence of some zones or their entrapment and the accumulation of biomass. Increased traffic along existing forest roads during construction work. No effects on fisheries since they will be compensated for the lost habitats and new aquatic areas will be created in the Lake Grand Détour and diversion canal area.	Deforestation of a 3 m-wide band along the reservoir banks at elevation 418 m, and recovery of merchantable timber volumes before they are submerged. Elimination of residual biomasse. Implementation of a sylviculture program. Raising of two bridges and the roads leading to them. Implementation of measures to ensure maximum safety on forest roads during construction work.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Current use of lands and resources by Aboriginals for traditional purposes	**Péribonka River**			Not significant
		Accessibility to some fishing, hunting or trapping grounds rendered more difficult, particular in some shallow bays. Displacement of some beaver colonies established in shallow bays.	All mitigation and compensation measures stated in the sections on ichthyological fauna and fish habitat, wetlands, avian fauna, recreational fishing, recreational hunting and navigation apply to the current use of lands and resources by Aboriginals for traditional purposes.	
	Manouane River			
		Decrease in the potential harvest of northern pike and whitefish. Deterioration in navigation, hunting and fishing conditions in some sections of the river downstream from the dam, as a result of the drop in water levels. /Dewatering of a valued waterfall, and deterioration of a portage at dike no. 1.	All mitigation and compensation measures stated in the sections on ichthyological fauna and fish habitat, wetlands, avian fauna, recreational fishing, recreational hunting and navigation apply to the current use of lands and resources by Aboriginals for traditional purposes.	
	Lake Grand Détour			
		Submergence or disturbance of five Aboriginal camp sites, and obstruction to navigation on the reservoir. Improved navigability between the dam and Lake Grand Détour owing to the presence of the reservoir.	All mitigation and compensation measures stated in the sections on ichthyological fauna and fish habitat, wetlands, avian fauna, recreational fishing, recreational hunting and navigation apply to the current use of lands and resources by Aboriginals for traditional purposes. Together with the affected communities, identification and performance of corrective work aiming to compensate for loss of Aboriginal camp sites.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

VEC	Sector	Principal residual effects[a]	Principal measures	Significance of residual impact on VEC
Current use of lands and resources by Aboriginals for traditional purposes	**Hirondelles River**			Not significant
		Decrease in the potential harvest of northern pike and whitefish. Disturbance of three Aboriginal camp sites as a result of the construction of diversion canals and the reduced water level in Lake Patrick. Improved navigability between the dam and Lake Grand Détour owing to the presence of the reservoir. Access to the banks of Lake Patrick rendered difficult due to the drop in water level, and increased difficulties during the additional 2 m drop about once every seven years. Short-term loss of territories favourable for hunting.	All mitigation and compensation measures stated in the sections on ichthyological fauna and fish habitat, wetlands, avian fauna, recreational fishing, recreational hunting and navigation apply to the current use of lands and resources by Aboriginals for traditional purposes Together with the affected communities, identification and performance of corrective work aiming to compensate for loss of Aboriginal camp sites.	

a. Assessment of environmental effects is based on maintenance of a minimum flow of 3 m^3/s and construction of a spur at the Lake Duhamel outlet.

Appendix 2: Environmental follow-up program presented by the proponent

Element to be monitored	Effect or parameter measured	Measurement frequency (years)					
		Reference	Commis-sioning	Yr 2	Yr 3	Yr 4	Yr 5
Physical environment							
Water quality Physico-chemical analyses of lacustrine sections (Lake Duhamel, Lake Patrick and Grand Détour reservoir) and homogeneous river sections (Manouane and Hirondelles rivers).	PH, dissolved oxygen, temperature, conductivity, SS, turbidity, transparency[a]	√	√		√		√
Thermal regime Thermographic recordings in the Manouane River.	Temperature	√	√		√		√
Sediment regime Changes in erosion zones in the Hirondelles River and the Grand Détour reservoir.	Extent of erosion	√	√		√		√
Biological environment							
Ichthyological fauna and fish habitat							
Yield and dynamics of fish populations (Lake Duhamel, Grand Détour reservoir, Lake Patrick and lentic section of the Manouane River).	Losses and gains in fish productivity, determined through experimental fishing. The size, age, sex and sexual maturity of the fish will be measured so as to characterize the fish communities in the affected sectors.	√			√		√
Density of juvenile landlocked salmon populations (Manouane River and its tributaries).	Abundance of juveniles, determined through electrical fishing.	√			√		√
Use of spawning grounds set up for landlocked salmon (Manouane River).	Redd count	√		√	√		√
Yield of incubation boxes.	Hatching and emergence rate of fry in the boxes.			√	√		
Mercury in fish flesh	Changes in mercury content	√			√		√[b]
Wetlands, semi-aquatic wildlife and waterfowl							
Changes in riparian ecotones (Manouane River, Grand Détour reservoir and Lake Patrick).	Changes in plant groupings in the main wetlands.	√					√
Movement of beaver colonies (Manouane River, Grand Détour reservoir and Hirondelles River).	Number of colonies, determined by aerial fly-over.	√				√	√
Use of nesting islands created for waterfowl (Grand Détour reservoir and diversion canals).	Number of nesting couples and broods, determined by aerial fly-over and ground-based observation.	√					√

a. Other variables may be added to the follow-up program as needed.
b. If necessary, follow-up of mercury content in fish flesh will continue every five years.

Element to be monitored	Effect or parameter measured	Measurement frequency (years)					
		Reference	Commis-sioning	Yr 2	Yr 3	Yr 4	Yr 5
Human environment							
Use of environment and wildlife resources							
Quality of fishing on outfitters' territory.	Fishing success and size of catches	√			√		√
Navigation conditions (Manouane and Péribonka rivers).	Reduction in depths and flow speeds	√			√		√
Changes in logs in the Péribonka River (segment affected by the project).	Accumulations of logs and presence of "candles"	√			√		√
Recreational and tourist use of the Grand Détour reservoir and of the accessways to the diversion canals and to Lake Patrick.	Degree of use of the area and category of wildlife resources use (surveys)	√					√
Use of lands by the Innu.							
Use of the river and reservoir by the Innu.	Decrease or increase in the practice of hunting, trapping and fishing activities in the reduced-flow section and around the reservoir.	√			√		√
	Decrease or increase in the number of camps along the edges of the river and reservoir						
Use of the reservoir and the diversion canal sector to travel from the Manouane River to the Pipmuacan reservoir.	Presence of the Innu of Betsiamites in the reservoir and diversion canal sector.	√			√		√