EXECUTIVE SUMMARY

Background

Glacier Power Ltd. (Glacier Power) is proposing to construct build a 100 megawatt (MW) run-of-river hydroelectric project on the Peace River near Dunvegan, Alberta.

The Peace River is controlled by two hydroelectric facilities located in British Columbia, the W.A.C. Bennett Dam (Bennett Dam), and the Peace Canyon Dam (Peace Canyon), both located in British Columbia. Williston Reservoir provides storage for the Bennett Dam, while Dinosaur Lake behind Peace Canyon functions as a run-of-river reservoir. These two dams operate together to generate 3430 MW of hydroelectric power.

In 1977, Feasibility Studies were completed by the Alberta Hydro Committee for the Dunvegan Hydro Power Site, located immediately upstream of the Highway 2 bridge crossing of the Peace River at Dunvegan. The objective of these studies was to assess the engineering feasibility and environmental effects of three development alternatives: low (41 m head), intermediate (69 m head), and high (120 m head) head dam structures with reservoirs. The high-head dam alternative would have a reservoir covering 518 km² and back water 250 km up into British Columbia all the way to Hudson’s Hope. The Dunvegan site was not considered suitable for development due to poor foundation conditions required to support large dam structures; as a result the Project was abandoned.

In 1998, Glacier Power initiated feasibility studies for the Dunvegan Hydroelectric Project (the Project), a low head, modular, run-of-river hydroelectric development which would minimize flooding and resultant environmental effects.

Conceptual plans and preliminary feasibility studies were completed in December, 1998 on the basis of the present regulated flow regime in the Peace River. Subsequently, conceptual design engineering, environmental programs, and public and First Nations information programs were implemented throughout 1999 and into 2000.

On June 19, 2000 Glacier Power submitted an Environmental Impact Assessment (EIA) to Alberta Environment (AENV). At the same time Glacier Power submitted to the Natural Resources Conservation Board (NRCB) and the Alberta Energy and Utilities Board (EUB) applications to construct and operate a 40 MW run-of-river hydroelectric project on the Peace River approximately 2 km upstream of the Dunvegan Bridge on Highway 2.

A Supplementary Information Response (SIR) Report was submitted in March 2001 in response to queries from provincial agencies, public stakeholders, and the EUB and NRCB. The SIR report also described the updated design of the plant which increased its capacity to 80 MW. Public Hearings were held in October 2002 and the EUB-NRCB Joint Review Panel announced their decision not to support the Project on March 25, 2003.
The EUB-NRCB Joint Review Panel stated in their report that “they saw significant uncertainty remaining with respect to the relationship between the potential benefits and costs of the Project”, and that they were “not convinced that potential negative effects could be satisfactorily mitigated.” The two issues that played a major role in the application being denied were:

- the understanding of the effects of the Project on the Peace River ice regime and, consequently, its effects on the Town of Peace River and the operations of the ferry at Shaftesbury; and
- the effect of the Project on fish resources in the Peace River.

As the development of renewable, low impact electrical energy coupled with sensitive environmental design is a top priority for Glacier Power, and its parent company Canadian Hydro Developers, Inc. it was felt that the concerns identified by the EUB-NRCB Joint Review Panel could be resolved by providing additional information on the Project. Glacier Power has been working to provide and compile this additional information in a new application since 2003. This has been accomplished through further project optimization, additional studies, cooperative agreements with stakeholders, and the development of specific monitoring, adaptation, mitigation, and compensation strategies. Since 2003, Glacier Power has put a substantial effort into developing a single, comprehensive ice model for the Peace River, in collaboration with independent experts in the field and interested stakeholders. Additional information has also been collected on fisheries resources as well as mitigation and compensation strategies. Refinements have been implemented to project design based on these studies. The cumulative results of the additional information gathered since 2003 are provided in the current applications to develop the Project.

Through discussions with equipment suppliers, it became evident that the capacity of the plant could be increased without affecting the design or size of the headworks structure and headpond, thus retaining the overall objectives with respect to environmental effects. As a result, the plant capacity has been increased to 100 MW and will generate approximately 600 GWh/annum while still operating as a run-of-river facility producing power from the flow of the river without storing water, and therefore without regulating or changing the flow regime downstream of the facility.

*The Proponent: Glacier Power Ltd.*

Glacier Power is a wholly owned subsidiary of Canadian Hydro Developers, Inc. (Canadian Hydro). Canadian Hydro is a developer, owner and operator of 18 EcoLogo® certified generating facilities totalling 230.0 MW net to the Company’s interest located in British Columbia, Alberta and Ontario: 12 run-of-river hydroelectric plants, 5 wind plants, and 1 biomass plant. Publicly listed since 1990 (TSX symbol KHD), Canadian Hydro is Canada’s largest independent developer of EcoLogo® certified low-impact renewable energy. In addition to its operating plants, the Company currently has an additional 384.5 MW of renewable energy projects that have been awarded power purchase contracts and are in various stages of permitting and construction over the next two to three years. In Ontario, the 132 MW Melancthon II Wind Project, the 197.8 MW Wolfe Island Wind Plant, and the 20 MW Island Falls Hydroelectric Project are all well underway and expected to be commissioned between June and October 2008. In July 2006 in British Columbia, Canadian Hydro was awarded power purchase contracts with BC Hydro for the construction of four run-of-river hydroelectric projects totalling 44.5 MW of capacity, with projects expected to come online between 2008 and 2009.
**Project Location and Site Conditions**

The Dunvegan Project site is located on the Peace River approximately 2 km west of the Highway 2 bridge crossing at Dunvegan Historic Park (Dunvegan). Dunvegan is located 80 km north of the City of Grande Prairie and 20 km south of the Town of Fairview. Access from Highway 2 to the project site is feasible along both sides of the river through a combination of existing and new roads across private and crown land.

The Peace River occupies an entrenched valley with high, irregular, and relatively steep slopes with varying degrees of stability and gully formations. The valley walls are generally bare or grassland on the northern (south-facing) wall and moderately forested on the south (north-facing) wall. At the project site, the Peace River valley is deeply incised into glacial drift overlying mudstones. River valley bottom width is around 420 m and the valley walls are approximately 180 m high. Channel width at the powerhouse site is approximately 400 m at the 1500 m³/s mean annual flow (MAF), with an average depth of approximately 4 m. The valley bottom is infilled with sand and gravel up to 30 m in depth.

**General Project Description**

The Project entails building a spillway and powerhouse across the Peace River to increase the water level in the river at the headworks by an average of 6.6 m. This will create adequate differential in head for the operation of a 100 MW low-head hydroelectric plant. The headpond created by the headworks structure will extend up to approximately 26 km upstream of the powerhouse and spillway. The increase in water level will result in a new water-bank interface zone that will inundate between 106 ha and 215 ha when comparing the pre- and post-Dunvegan 5 percent and 95 percent river flow exceedance conditions¹, respectively. The Project will be a run-of-river facility that produces power from the flow of the river without storing water, and therefore does not regulate or change the downstream flow regime.

The powerhouse will consist of 30 turbine units constructed side by side extending from the south bank of the main channel, and 10 turbine units arranged side by side extending from the north bank of the main channel, for a total powerhouse length of 288 m. A crest-gated spillway will extend between the north and south sets of powerhouse units across the remaining 110 m of channel width to maintain water level differential across the structure. The facility incorporates a boat lock for upstream and downstream passage of river traffic and a boat ramp upstream of the headworks to provide direct boater access to the headpond. Ramp fishways (fish ladders) will be placed on each bank to provide for upstream fish migration and 10 fish sluices will be placed between groups of five powerhouse units for downstream fish migration. Power is transmitted along a new 144kV line transmission line for approximately 4.3 km to the southeast of the Project to interconnect at the existing ATCO 144-kV line (7L73-1).

¹ A 95 percent exceedance flow is the flow that is exceeded 95 percent of the time for a given period of record.
**Land Tenure**

The project headworks structure is in the river channel except at each end where the abutments will be on Crown Land. The headpond will be adjacent to Crown Land, much of which has been assigned grazing leases and traplines. The Project also influences several parcels of deeded land, one of which is upstream of headworks in the headpond, and the remainder of which are affected by access roads and the transmission line. Contact has been made with each grazing lease holder and private land owner potentially affected by the Project, and agreements have been signed with most. Although agreements have not been signed with the owner of the land parcel in the headpond (unoccupied), and a land owner on the north bank of the river downstream of the headworks (land unaffected but in close in proximity to the Project), discussions with these land owners are ongoing and neither land owner has any objections to the Project.

**Regulatory Framework**

Glacier Power submitted a Disclosure Document to AENV, the Canadian Environmental Assessment Agency (the Agency), the NRCB and EUB in February 2004.

The Project is a mandatory activity under Alberta’s *Environmental Assessment (Mandatory and Exempted Activities) Regulation*, and Glacier Power was notified by the Director of Environmental Assessment on February 27, 2004 that an EIA for the Project would be required, pursuant to section 44(1)(a) of the *Environmental Protection and Enhancement Act* (EPEA). Approval of the Project from AENV is also required by the *Water Act*.

The proposed Project is defined as a “hydro development” under the *Hydro and Electric Energy Act* (HEEA) administered by the EUB, and therefore requires approval from the EUB pursuant to Section 9. As a new hydroelectric development in Alberta, the Project is also likely to require the passing of a bill in the legislature in order to be built.

Because the Project requires an EIA under the EPEA, it meets the definition of a water management project under the *Natural Resources Conservation Board Act* (NRCBA) and is therefore considered a reviewable project requiring an approval from the NRCB.

The Project is subject to the requirements of the *Canadian Environmental Assessment Act* (CEAA), since the Project will require a permit under the *Navigable Waters Protection Act* and an authorization under the *Fisheries Act*. The Project will trigger a screening-level review under the CEAA according to the discussions with the Agency in February 2004. Fisheries and Oceans Canada (DFO) and Transport Canada are the federal government responsible authorities for the Project. However, the Province of Alberta is taking the lead role in the project review, which will proceed in accordance with the *Canada–Alberta Agreement for Environmental Assessment Cooperation* (2005).

Subsequent to approval from the EUB and NRCB, Glacier Power will pursue final approvals from AENV (Water Act), DFO, and Transport Canada. Glacier Power will also require approval to interconnect the Project and transmission line from the EUB and Alberta Electrical System Operator (AESO), and will need to obtain formal Crown Land tenure for the headworks, and development permits from local municipalities. Discussions with the M.D. of Fairview, Saddle Hills County and Birch Hills County have all confirmed that no rezoning of lands will be required. Prior to construction, various other approvals
will be required, including agreements with Alberta Infrastructure and Transportation (AIT), and Alberta Sustainable Resource Development (ASRD) (timber management).

**Project Development Schedule**

Glacier Power anticipates a six month review period for the EIA, and a subsequent four to six months to prepare for and conduct a EUB and NRCB hearing, should one be required. Glacier Power is hoping that it will receive approval for the Project by end of September, 2007. This would be followed by detailed engineering and equipment procurement in 2007 and 2008. Site preparation work could commence as early as spring 2008. Construction of the Project components could be completed in 2011, with commissioning of the Project in the fall of that year.

**Project Need**

Given the expected pattern of supply and demand for electricity in northwest Alberta over the next 10 to 15 years, the Project has the potential to provide significant benefit to all Alberta’s electricity consumers through an otherwise lower transmission tariff that would result from a combination of lower losses, reduced ancillary service costs, and an overall lower cost-of-service due to possible delay in transmission development and the associated capital investment.

As a result of the deregulation of Alberta’s electric power industry, the decision to develop a power project in Alberta today lies solely with the investor (once all approvals and permits have been obtained), which contrasts to development under the previous regulated environment. Even in a competitive environment the decision to develop one project over another requires a comprehensive cost-benefit analysis to assess the better investment. Any project that provides a substantial net-benefit should be considered in the public interest and is therefore “needed”. In addition to the direct project, economic, social, and environmental cost-benefits, the “need” for any electric generating facility can also be supported by other or indirect benefits (externalities) associated with any positive impact on:

- market fundamentals relating to electricity supply, demand and price
- electrical system benefits relating to technical interconnection and delivery
- other factors such as government policy relating to environmental objectives and standards

A substantial portion of Alberta’s electric generating capacity will reach the end of its useful life in the foreseeable future. At the end of 2004, Alberta’s total gross installed generating capacity was approximately 13,000 MW (10,500 MW net-to-grid) of which almost 25 percent will reach retirement age in the next 15 years and just under 40 percent will reach retirement age in the next 25 years. Replacing generating capacity that will reach retirement age in the next 15 to 25 years, plus the need to meet rising new demand, will be a formidable challenge in Alberta. It will be complicated by potential opposing forces of competition to reduce cost and environmental pressures to reduce emissions associated with energy use and production—particularly Green House Gases (GHG).

Alberta total electric energy sales, as measured by Alberta Internal Load (AIL), have grown by an Annual Compound Growth Rate (ACGR) of 3.4 percent per year over the last 15 years (1987-2003)
and is anticipated to grow by 2.7 percent ACGR per year over the next 15 years (2004-2018). The majority of incremental load growth is expected to continue to be a result of domestic industrial activity, particularly as it relates to further resource development in the oil, gas, petrochemicals and forestry sectors. This level of demand growth coupled with retirements would necessitate the development of between about 4500 to 6000 MW of new electric generation capacity or approximately 50 percent of today’s total capacity to replace retired units and to meet the expected demand over the next 12 to 15 years.

The future electricity generation changes in the Northwestern quadrant of Alberta have been outlined by the AESO in their Need Identification Report (October 2005). Currently, the northwest regional total coincident peak load is approximately 1,142 MW, though it is expected to grow to 1,310 MW by 2015 due to normal residential and industrial load growth. The total installed capacity in the NW is currently 695 MW; therefore, only about 60 percent of the regional energy need is supplied within the region. The northwest region is located relatively far from Alberta’s primary generation centers, and has a weak transmission system. Therefore it has to rely on transmission must run (“TMR”) generation to provide real and reactive power support in the region. The AESO currently spends $40 to 50 million per year on TMR payment, the majority of which are in northwest Alberta. The Project, because of the expected nature of its operations, could reduce northwest Alberta area transmission losses and TMR requirements by approximately $5 million dollars per year, which would result in a direct reduction in AESO transmission costs by 11 percent.

Another very important ancillary service provided by some generation is “black start” capability, to re-energize the system in the event of a system wide blackout. The nature of the Project and its ability to self-generate its own electrical needs gives the Project the ability to provide black start capability to the northwest region. The AESO currently spends approximately $1 to 2 million per year in black start ancillary service payments to various generators in Alberta.

The northwest Alberta transmission grid experiences heavy loading and, as a result, high thermal losses, particularly during peak demand periods. Additional generation in the northwest region would reduce transmission load levels and, therefore, transmission line losses. The monetary savings of lower losses would represent a direct and potentially large benefit to Albertans through the transmission tariff. Lower system wide losses tend to provide an overall lower level of system demand and therefore would also tend to lower the overall system pool price. This indirect effect would provide benefit to all consumers in Alberta through lower energy costs. The AESO currently spends approximately $160 to 180 million per year to cover the cost of transmission losses.

Capital costs to build the Project are estimated at $319 million (2004 dollars). The Project represents a significant contribution to economic activity in the northwest region of Alberta, accounting for almost one-quarter of the total major project expenditures of $1.4 billion. Beyond the boundaries of the County of Grande Prairie, the Project is even more significant, accounting for three-quarters of $446 million in major project expenditures.

Given its expected operating characteristics, the Project would provide a significant reduction in GHG emissions in Alberta, in the order of 500,000 Tonnes annually (assuming 0.8 Tonnes per MWh) by displacing other thermal generation sources. This reduction is anticipated to save the electric industry approximately $5 million dollars per year in potential CO2 offset costs assuming a cost of $10/Tonne.
Reasonable capital cost projects, especially those with lower operating costs, such as the Project, are in the best interest of electricity consumers in Alberta. Further diversification of Alberta’s power sector’s fuel supply, particularly away from carbon-based fuels, provides additional value to the electricity consumer by mitigating long-term fuel supply risk. Direct and indirect technical benefits also potentially arise from the interconnection of a facility in the northwest Alberta transmission grid that will benefit both regional and system-wide consumers. In addition, the environmental attributes of the Project will provide a long-lasting benefit with respect to global warming through reduced GHG emissions in Alberta, which is clearly in the public interest.

**Market Setting**

The Project has become viable as a result of the deregulation of Alberta’s electric power industry. The adoption of a competitive market for wholesale power through the Power Pool allows new generation to compete with existing utilities.

Alberta has enjoyed strong economic growth for some time, which has lead to increased demand for electricity across all consuming sectors. This trend is expected to continue with the ongoing development of Alberta’s vast oil sands and in situ bitumen resources. Recently, high natural gas prices and long-term supply concerns, coupled with low electricity prices and localized transmission issues, have served to slow down the development of surplus generating capacity from Alberta’s oilsands cogeneration potential. The most active recent supply additions, coming from the wind power sector, were constrained in the spring of 2006 by a moratorium on new development. Slower generation development coupled with several unit retirements over the next few years will lead to a decline in capacity reserve margins.

The continued rise in natural gas prices has already had a profound affect on Alberta’s electricity market in the short term, and is expected to have a lasting effect over the longer term as well. The most immediate effect of higher natural gas prices has been on the electric energy spot price. In many hours the price of electricity in Alberta is determined by a marginal natural gas fired electricity generator, and has therefore resulted in much higher electricity prices. The longer-term impact of higher forward natural gas prices is a shift in the decisions made by generation developers with respect to the technology of choice for future supply options. The implementation of a new competitive market in Alberta places the risk of capital investment squarely with the investor and passes the fuel cost to the consumer through the marginal price of the energy spot market. This new risk profile in the market clearly supports the development of smaller, more efficient, relatively lower capital-cost projects at the expense of higher fuel cost options.

Given the current natural gas price environment, while base-load coal is the least costly generation option in Alberta (absent any significant environmental costs related to GHG emissions), the Project is the least costly option relative to other mainstream generation technologies.

In the spring 2004 the Alberta government accepted recommendations from the Clean Air Strategic Alliance (CASA) regarding an emissions management framework. One of these recommendations calls for 3.5 percent of all electricity traded through the Alberta Interconnected Electrical System (AIES) to be sourced from renewable or green energy sources by 2008. This target requires that approximately 800 MW of incremental green power capacity be developed. The Project will play a critical role in the
ability of the province to meet this target, particularly in light of the recent moratorium placed on the development of wind power in Alberta.

The Canadian Government has shown its commitment to the development of renewable energy through programs such as the Wind Power Production Incentive (WPPI) and the contemplation of a broader Renewable Power Production Incentive. The Alberta Government currently purchases 90 percent of the electricity used in government owned facilities from green power sources (wind and biomass). The British Columbia government has committed to procuring 50 percent of new power generation from clean power, and 10 percent of new generation from green sources. In 2004 and 2005 the Ontario government, through the Ontario Power Authority, contracted for the long term supply of green power from 1300 MW of new renewable energy sources.

Renewable energy credits (RECs), also known as green credits, can be sold with or separately from their associated electrical power. Green power contracts, such as those Glacier Power’s parent company Canadian Hydro has signed with the British Columbia, Alberta, and Ontario governments and crown-owned utilities, are generally long-term contracts (i.e., for 20 or more years). This underlines another advantage of renewable energy, the low fuel price risk and the ability to forecast operating costs well into the future. In Alberta, power from some of Canadian Hydro’s existing wind and hydroelectric plants is sold on the spot market, and the RECs are sold separately. Recently Canadian Hydro has found that the demand for RECs is greater than the company’s ability to supply them, even without the development of a formal regulated GHG emissions trading framework.

Glacier Power has had informal discussions with a number of potential buyers regarding the sale of electricity and green credits from the Project. Alberta-based companies, such as TransAlta, Nexen, EPCOR and Enmax have expressed interest in the Project and are considered to be good prospects for long-term power sales contracts.

**Alternatives to the Project**

There are several alternative technologies available that can be applied to generate 100 MW of electrical energy. However, not all are as well suited to the Peace River region as hydroelectric generation is. Many alternatives use non-renewable resources, which generate higher GHG and other forms of emissions.

Alberta’s northwest is deficient in local generation (the northwest transmission area currently imports 500 to 600 MW of power). The alternative of no project development would mean that this area of Alberta would continue to be supplied with electrical energy from plants in the southern and central areas of the province, transmitted with some inefficiency over long distances, and the forecast increased electricity demands would have to be made up by development of new generation elsewhere.

During feasibility studies in 1975 the project site was determined to lack suitable bedrock to support a large hydroelectric dam structure. While they do not produce emissions, large hydroelectric structures typically flood large areas of land and have substantial environmental effects. Notable advances have been made in photovoltaic (solar) power generation in recent years, particularly in remote and off-grid applications. However, large central generation applications are still not cost competitive with other technologies. Also, compared to the rest of the province, the Dunvegan area has the lowest potential
for development of wind-generated power, eliminating the feasibility of this alternative technology in this region.

Natural gas-fired generation is the next most feasible form of energy generation in the region, after hydroelectric generation. However, a 100 MW gas-fired plant would be dependent on a non-renewable and variably priced resource, and produce a significant amount of GHG and other air emissions.

The Peace River region has active agriculture and forestry industries that could supply the raw materials needed for biomass or wood waste technology. There is an existing 25 MW biomass facility in Grande Prairie, the Grande Prairie EcoPower® Centre, which brings in fuel from northwestern Alberta and northeastern British Columbia, and it is unlikely that there is sufficient fuel to sustain another wood waste facility in this region. Also, the cost of this type of generation exceeds both the hydroelectric and natural gas options described above.

Given the relatively low cost of coal-fired generation, new coal-fired plants are expected to be built in Alberta. However, the most economic and therefore most likely locales for new projects are located in central-southern Alberta, close to the larger coal deposits, where it is possible to maximize project economics and efficiencies. Coal-fired generation produces the highest amount of GHG and other polluting emissions (including nitrogen and sulphur oxides) relative to other available generation technologies. Coal-fired plants are also large consumptive users of water, which is becoming an increasingly scarce resource in Alberta, and is the focus of many conservation initiatives. All new coal-fired generation built in Alberta will be required to seek out ways of reducing emissions of pollutants and GHGs. This may include the purchase of offset credits from low- or zero-emission green power sources, such as wind or hydroelectric. Therefore, although more coal-fired power is likely in Alberta’s future, in light of the serious environmental challenges it presents it will not be the sole-source technology of new power generation in Alberta.

Given all of the details regarding alternative technologies, Glacier Power believes that a 100 MW small run-of-river hydroelectric facility is the best means for generating 600,000 MWh/annum of clean, renewable energy to meet the growing demands of the northwestern Alberta region. The proposed Project will provide numerous benefits to the local economy, stabilize the electricity grid, and provide long-term investment with little to no burden on local essential services and minimal impacts on the local, regional and global environment.

**Alternate Site Considerations**

Run-of-river hydroelectric projects are positioned and sized to fit the environment in which they are to operate. Since the overall objective of run-of-river projects is to provide low impact, green energy from running water (a renewable resource), they must adhere to several engineering and environmental criteria.

The Project location was selected for several reasons. These include the physical characteristics of the river channel and valley configurations, transportation networks and access to both sides of the river, proximity of an existing power line, and availability of a nearby labour force, materials, supplies and services.
Within the local area, three alternative sites were assessed: (i) one downstream of the proposed site, approximately 500 m upstream of the Dunvegan Bridge, (ii) one 3 km upstream from the proposed site, and (iii) one 80 km downstream of the proposed site in the Shaftesbury area. Each of these sites were rejected for one or more of the following reasons: (i) proximity to the Dunvegan Historic Park and the Dunvegan Bridge, (ii) lack of geotechnical suitability for abutments, (iii) limited access to both sides of the river, (iv) non-uniform river channel geometry, and (v) proximity to multiple landowners. The proposed location for the headworks represents the lowest-impact best fit into the existing landscape.

**Project Sustainability**

The life of the Project is expected to be at least 100 years. The Project is dependent on the flow of the Peace River, and benefits from the regulation of the Peace River by the Bennett Dam. The amount of water stored behind the Bennett Dam in the Williston Reservoir exceeds 1.5 years worth of river flow, providing significant storage and resilience against the effects of annual climatic variations. Climate change trend forecasts indicate both warmer weather, and increased precipitation in northeastern British Columbia. These trends are not expected to necessitate changes in Bennett Dam operations, particularly given the large amount of storage available in the Williston Lake.

Historically, operational changes (i.e., reduced flow) have been required at the Bennett Dam to facilitate repair and maintenance activities. As in the past, any future changes to the operating regime to facilitate maintenance activities are expected to be short-term and will not affect the long-term viability of the Project.

The commonly used definition of sustainable development from the 1987 Brundtland Report, *Our Common Future* is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” From the outset, the conceptual definition of the Project has balanced economic, environmental and social considerations. It is designed specifically to avoid the adverse environmental and social effects of large hydroelectric dam projects, while making best use of vast and sustainable energy resource in the Peace River.

**Project Design Considerations**

The Project has evolved to a preliminary design level in consideration of alternatives from engineering, environmental, and cost perspectives. The size of the Project was determined through a best fit analysis involving a combination of factors:

- Gross head (water differential from upstream to downstream of the headworks), which ranges between 5.5 and 7.6 m, was selected based on a target of containing the headpond level increase within the river’s natural banks below pre-Bennett flood levels.

- Capacity of the plant was determined based on the available gross head and river flow. The plant capacity at the design flow of 1800 m$^3$/s is 100 MW. At the 100 percent exceedance flow (e.g., the flow in the river exceeded 100 percent of the time) of 400 m$^3$/s, the minimum output capacity of the plant is 19 MW.
• Turbine unit size was selected on the basis of submergence requirements. A 2.5-MW unit capacity at the design head requires a depth setting of about 3 m. Normal tailwater depth at the site is about 4 m at full operational flow; therefore, the unit centreline is set about 1 m above bed level.

• Turbine units were selected based on a modular concept using 40 identical units. The turbines are simple bulb propeller turbines based on the philosophy that at lower river flows, instead of throttling down all of the turbines, some turbines will be shut down entirely, while others will continue to operate at peak efficiency.

• Spillway design will consist of a concrete overflow structure with adjustable gates installed on the spillway crest. The gates will be lowered during flood events so they do not impede flow. This configuration is ideal for this application, given the size of the river, the trees and other large debris it transports, and the ice regime at this site.

**Project Components**

Figure ES-1 shows the project components and their layout. Each of the Project components including the powerhouse, spillway, boat lock, fishways, power transmission line and access roads, have been planned with environmental management strategies and contingencies built into the design, construction, and operations plan.

The powerhouse, containing the 40 modular turbine units, will be constructed on the riverbed with a total structure height of 11.4 m. The powerhouse will be designed to overtop if flows exceed about the 1 in 2 year flood, and to withstand and pass extreme flood events up to and including the estimated Probable Maximum Flood (PMF) of 28,000 m³/s. A concrete and riprap apron extends 38 m downstream of the powerhouse (52 m downstream of the spillway) to prevent riverbed scour in the turbulent tailrace zone.

Boaters wishing to pass upstream or downstream of the facility will use the boat lock that will be installed adjacent to the south fishway ramp in the headworks structure. The style of lock will be such that frequent users could operate the facility unassisted if desired. Dual safety booms, signs, and navigational aids will be in place upstream and downstream of the headworks to guide boaters safely to the boat lock and boat ramp.

A boat ramp providing access for upstream or downstream river travel is currently located 2.5 km downstream of the Project on the south river bank immediately below the Dunvegan Bridge. A new boat ramp associated with the Project is proposed to be located in the headpond upstream of the headworks structure.

Fishways will be required to provide safe passage of fish migrating upstream and downstream of the Project. Figure ES-2 shows a schematic of the fish migration passage. Fish passage facilities consisting of two ramp fishways (one on each bank) for upstream passage have been designed and incorporated into the headworks. The proposed fish passage facilities were extensively modeled, both physically and numerically, over a three-year period through a collaborative process that included DFO and ASRD. The proposed fish passage facilities have been the subject of several technical papers and presentations at conferences, both in North America and abroad are considered state-of-the-art.
Each upstream ramp fishway is comprised of two structural components; the ramp portion and the submerged vertical slot headworks portion. The ramp section of the fishway is 10 m wide x 132 m long and consists of a series of riffle/pool sequences with rock riprap along the edges. Riffles are created by a double row of v-baffles, offset to provide hydraulic conditions suitable for the swimming abilities of fish greater than 150 mm in length. The pool sections provide resting areas for fish between the riffle sections. Flows down the ramp are controlled by gated openings in the submerged vertical slot headworks, and ramp operation will be possible at the full range of headpond elevations, except flood conditions. The submerged vertical slot headworks portion is also designed to be functional regardless of headpond level. Hydraulic conditions in the lower section of the ramp can be adjusted by an auxiliary water supply system in combination with the adjacent fish sluice flows to provide a range of attraction flows best suited to guiding fish to the fishway entrance.

Fish sluices will be required to provide safe passage of fish migrating downstream of the facility. There are ten fish sluices located across the width of the structure. One at either abutment adjacent to the fishway ramps, two between the spillway and the powerhouse, and the remainder located between every set of five powerhouse units. Guidewalls extend out from the downstream end of the fish sluice for about 20 m to guide fish away from the turbulent tailrace zone.

The Project will not affect the flow regime of Peace River downstream of the structure and flooding effects in the headpond will be minimal. All water entering the headpond will flow directly through the powerhouse and/or over the spillway with no regulation of downstream flows. Flows within the headpond will be deeper and therefore slower than present flow velocities. At present, under mean annual flow conditions of approximately 1500 m$^3$/s, flow takes approximately five hours to pass through the proposed headpond section of the river. During operation of the headpond, this time will increase to approximately eight hours.

The extent of area to be inundated by the headpond is restricted to shallow-sloped bank sections (uncommon in the headpond reach, as most banks are steeply sloped), some islands and side channel areas. The total extent of inundation is approximately equal to the post-Bennett 1:100 year flood level, and will represent an average of less than 20 m on either side of the river valley bottom along the headpond. The effects of flooding will diminish towards the top of the headpond. At approximately 26 km upstream of the headworks structure, headpond levels are within 0.5 m of the present daily water level fluctuations. The headpond will require a minimum of site preparation since the majority of its newly wetted area is contained in the natural river channel. Minor clearing of some trees may be required along shoreline areas closest to the facility and potentially in some low lying areas.

Permanent roads are required on the north and south banks of the river to provide access to the powerhouse and boat lock for construction, operations and boat access to the headpond. Access roads will cross a combination of Crown and private land, in accordance with landowner and leaseholder agreements. Bridges will be required to cross Dunvegan and Hines Creeks, on the south and north banks, respectively. The results of slope stability studies in the facility area have been incorporated into the design of the access roads. Detailed final design of access roads will occur in coordination with landowners and AIT. As much as possible, access will be routed along existing roads to minimize new road construction.
The energy produced by the Project will be carried along a 4.3 km long 144-kV power line from the powerhouse to the interconnection point with the ATCO 144-kV line 7L73 at NE 31-79-4-W6. The Project's 144-kV power line will use single wooden pole construction similar to existing ATCO lines in the area. For the most part, the transmission line will follow existing road allowances or cultivated land, except where the line follows the new south access road from the plant substation to the crossing of Dunvegan Creek.

The Project is a low-visibility facility as a result of the relatively small size of the headworks compared to the size of the river and valley, the use of existing roads and trails for Project access and transmission facilities, and limited visibility by the public traveling on Highway 2.

**General Construction**

**Construction Schedule**

Construction of the Project will require four years – one to prepare and complete access roads and shore-based components, followed by two years of instream work, and then the final year for completing the structures and commissioning. Construction of the major instream works - the powerhouse and spillway - will be substantially completed during two summer construction seasons (April to October). In order to achieve this scheduling objective it will be necessary to mobilize construction, complete site preparation work, construct access roads and prepare the entire site in the year prior to undertaking instream work on the powerhouse and spillway. Major consideration will be given to pre-assembly and precasting of various components in order to minimize the amount of instream work required.

The project schedule has been developed to accomplish a number of project objectives as follows:

- undertake engineering field investigations and survey in 2007
- complete preliminary engineering in 2007
- procure turbine and long delivery items in 2007 upon final Project approval
- complete detailed engineering by early 2009
- mobilize site, undertake site preparation work, and construct access roads, boat lock and fishways in spring/summer, 2008
- tender and award major construction work in 2007 upon final Project approval
- construct major instream work (powerhouse and spillway) from spring to fall, 2009 and 2010
- complete and commission plant in 2011

The approach adopted for this Project allows sufficient contingency to accommodate weather and other external factors preventing unnecessary winter construction.
Construction Staging Areas

Several construction laydown and staging areas will be required for the Project. It is currently envisaged that four areas are required: one on each side of the river adjacent to the proposed works, one area for the pre-assembly of the turbine units and barge construction and one for contractor plant and offices.

Construction Camp

The workforce required will average about 125 workers on site with a peak of 300 workers in years 2 and 3 of construction. Given the current labour market in Alberta, it is expected that a construction camp will be required. Should this be the case, it will be run by the contractor and all appropriate approvals will be obtained. Interest in hosting a construction camp has been expressed by several nearby landowners.

Construction Traffic

Although traffic on secondary highways will increase slightly over the four year construction period, particularly during summer and fall months, the maximum increase in traffic is 13 percent during year 3, and overall it is anticipated that disruption to the general public will be minimal. All traffic will use Highway 2 and access the Project site by both the north and south access roads. Procedures will be implemented for the protection of the general public (e.g., flag persons, signage and lights). Road maintenance and dust control will also be implemented and discussed further with AIT.

Hazardous Materials

All hazardous goods will be transported and stored as required by current government regulations. Transport, storage and handling of explosives will be in compliance with the Transportation of Dangerous Goods Act and by qualified persons. Safety requirements for the transportation, storage and handling of all dangerous goods will be adhered to as stipulated by the Transportation of Dangerous Goods Act.

Sewage and Domestic Waste

Disposal of sewage at the Project site during the construction period will be handled by portable toilets serviced by a contractor. Permits for establishing a construction camp, including permits for management of camp sewage and waste, will be the responsibility of the camp contractor. Solid waste disposal at the project site during the construction period will be handled by a waste disposal contractor. Bins will be set at the site and hauled to the authorized landfill for disposal. Material will be recycled as much as possible.

Borrow and Waste

Numerous existing borrow areas for gravel and backfill have been identified for the Project, all within 30 km of the project site. Final selection of the appropriate borrow areas will depend on detailed design and material testing/suitability. Materials excavated for the project will be reused or disposed of in accordance with current government regulations. It is anticipated that some unused fill material will be disposed of in existing borrow pits near the project site. All waste disposal areas will be restored (i.e., topsoil placement and seeding).
**Site Preparation**

Headpond inundation will require minimal site preparation since the majority of its newly wetted area is contained in the natural river channel. Removal of vegetation cover will be required for the new portions of access roads, laydown areas and the power transmission line. Merchantable timber will be salvaged while non-merchantable timber and slash will be burned according to government regulations. Where possible, vegetation, particularly mature or potential wildlife trees, will be left intact and root systems undisturbed. Before construction begins, mitigation works such as sediment traps and pumping systems will be installed at key locations, as determined during detailed design.

Reclamation of disturbed sites will be on-going throughout the construction phase. Disturbed areas will be re-vegetated to establish plant cover and assist in controlling erosion and stabilizing slopes. A complete reclamation plan will be developed following approvals but prior to commencement of any site preparation or construction activities.

**Access Road and Transmission Line Construction**

Both north and south access roads cross Crown and private land in accordance with landowner agreements. The proposed alignments of both access roads will not impinge on any existing areas of instability along Highway 2 and hence they will not have any effects on the stability of the main highway. The access road design will minimize disturbance to the existing soil and groundwater regime, and avoid disruption to existing surface water drainage paths.

Upgrades are proposed to the existing intersections on Highway No. 2 to facilitate construction traffic including semi-truck traffic. These would be completed in the first year of construction. Final design will incorporate the results of consultation with AIT. Construction signage and possible speed reductions would will remain in place until Project completion in 2011.

The transmission line will be constructed during the first year of construction and, once appropriate approvals have been applied for and received, it will be used to provide construction power. The transmission line right-of-way is expected to be 20 m wide and will run adjacent to the proposed access road and along existing roads and trails.

The substation will be constructed in the fall of the second year of construction and will include all necessary protection and switching equipment required to tie into the provincial grid. The substation will be completely fenced in for public safety.

**Headworks Construction**

Construction of the headworks will start simultaneously from each shore using a barge and caisson construction method. This method involves the construction of precast concrete barges, which will be floated and sunk in place to form the permanent upstream and downstream sections of the structure. Construction will be conducted in flowing water conditions without any other form of cofferdam; however, dredging will be required in order to achieve the proper bottom elevations for the barges. Dredging will be carried out using equipment such as a suction dredge to minimize the amount of
suspended sediment introduced into the river, and will occur during periods when high levels of suspended sediment transport occur naturally.

The barges will also be used as working platforms in order to drive sheet piles, which will create working cells to allow for the construction of the main sections of the powerhouse and spillway structures. Construction within the cells will involve excavation of river bed material to the depths required for the construction of the substructure for the powerhouse and spillway. The excavation and subsequent pouring of the foundation concrete will occur in the cell in wet conditions. Seepage water entering the construction site will be pumped to settling infiltration ponds near the works and tested for acceptable water quality before being released back to the river.

Construction activities in the river will be initiated in spring and extend into the late fall, potentially until initial freeze-up depending upon weather conditions and BC Hydro releases from the Bennett Dam.

It is anticipated that no more than 30 percent of the river flow will be constricted at any one time. The headworks components including the abutments, boat lock, and fishways are currently planned to be constructed in the first year. Fish movement and boating traffic will be unaffected during year 1, may be affected in year 2, and will be affected during years 3 and 4 due to high flow velocities between the construction cells as they are built out from either bank. Although both the fish passage ramps and the boat lock facilities will be completed during year 1 of construction, neither will be operational until final closure of the river is achieved in year 4.

Fish movements during construction will be monitored as a component of the Fish Monitoring Plan using telemetry and observation. During years 3 and 4, and 2 if necessary, flows will be passed through the fish sluices and the turbine ports in order to provide attraction flows for upstream migrating fish to lower velocity areas downstream of the works where a safe fish collection and transfer program can be carried out. Water may also be pumped into the boat lock and down the fish passage ramps to provide suitable fish collection areas.

Boat traffic past the Project will be regulated during construction primarily while barges are being set in place. Once the barges are in place, boat traffic can pass through the unobstructed portion of the river. When final closure of the river is being carried out (year 3), boat traffic on the river past the Project will not be available. It is anticipated that boat traffic will need to be transported past the Project for approximately one year while final closure and commissioning are completed.

**Project Start Up**

Once the powerhouse and weir closure segment has been constructed, the river will continue to flow through the turbine water passages and the sluiceways through the weir. Closure bulkheads will be placed in each weir sluiceway from a barge and then the turbine wicket gates will be closed in each turbine water passage. This will slowly result in the filling of the headpond, and flow will eventually begin spilling over the weir.

Once the headpond level increases to the fixed crest level the fishways and boat lock will be commissioned and made fully operational. The permanent safety boom and associated navigational warning systems will be put in place and the temporary construction safety boom systems will be removed.
Project Operations

The Project will operate to meet all or part of a sustained and constant portion of the electrical load (base-load plant). As it is a run-of-river project, operation of the plant will be continuous throughout all seasons based on the flow available in the river. Flows downstream of the headworks will remain the same as flows entering the headpond, although local conditions below the structure will likely result in a turbulent regime that extends approximately 60 m downstream with residual eddies and boils extending as far as 150 m under some flow conditions.

The powerhouse will contain full control systems including Supervisory Control And Data Acquisition (SCADA) systems. During transmission grid outages, the turbines will be shut down and flow will continue over the spillway section. The hydroelectric plant will be manned 24 hours a day (likely with three operator-shift rotations per day). Maintenance will be undertaken daily, and turbines will be shut down for maintenance on a routine rotational basis.

The turbine inlets will be protected by removable trash racks. A 25-mm bar rack spacing will be provided during the predominant period of downstream fish migration to physically exclude adult fish from passing through the turbines. After the migration period, the 25-mm bar rack will be removed leaving a coarse debris rack with an open spacing of 100 mm. Due to potential frazil ice problems, the 100 mm trash rack will be removed prior to freeze up (end of November), leaving the rack supports in place. The 100 mm rack will then replaced after ice breakup (end of March).

The spillway will be used to maintain a gross head differential (headwater minus tailwater) of between 5.5 and 7.6 m at the powerhouse under the majority of flow conditions. During normal and low flow conditions, such as late summer and fall, the spillway gates will be fully raised in order to maximize the net head available for power generation. In this case, water will be flowing through the powerhouse units with none going over the spillway. During high flow events (exceeding 1850 m$^3$/s) the spillway gate will be in its lowered position to maintain steady headpond levels.

The boat lock will be operational throughout the open water ice-free season, including during periods of darkness or reduced visibility so as not to limit navigation on the river. Boat lock operation may periodically be limited by flood or heavy debris events. The lock will have hydraulically operated main gates and electrically activated watering and dewatering valves. This type of lock has been used extensively and successfully in Ontario, the United States, and elsewhere around the world.

The ramp fishways will operate independently from the powerhouse or spillway during the open water season from about the first of April to the end of November. The fishways will not be used during the winter ice cover period. The auxiliary water supply system in combination with the adjacent fish sluices will be operated to provide optimum guidance flows at the fishway entrance.

Fish sluices will be operated to convey fish downstream of the headworks structure. Particular attention will be paid to operating the fish sluices to accommodate downstream fish migration from the beginning of August to end of October annually. During this period, the plant will not be operating at full capacity due to lower river flows. This will allow turbines adjacent to the sluices to be selectively shut down, enhancing the influence of the guidance flows towards the sluices.
**Adaptive Management for Fish Passage**

Rigorous modeling and collaboration from many experts on the fish passage strategy for the Project has produced a thoroughly researched and well understood strategy that includes significant operational flexibility to allow for adaptive management of fish passage in conjunction with a detailed monitoring program. Adaptive management strategies were assessed during the fishway modeling program and subsequently included in overall operational and economic planning for the Project, providing a wide range of choices and conditions for upstream and downstream fish passage. This range of conditions is possible as a result of the ability to selectively turn turbines on or off, to change the relative influence of fish guidance flows, to vary upstream fishway attraction flows, and to selectively turn on or off or vary the flows through fish sluices. The proposed monitoring program will provide essential information to measure passage success and identify preferred and default operational settings.

**Project Decommissioning**

The Project has a minimum life span of 100 years. A notable feature of the project design is that each of the components can be replaced as necessary. However, in the event that closure becomes necessary, a closure plan will be prepared for regulatory agency approval. The plan will describe methods to remove all components from the river channel as well as timing considerations for removal. Many of the machine components such as the turbines, hydraulic lifts for the lock, and the adjustable spillway gate will be removed. The protruding concrete structures will be demolished and hauled to an approved landfill site.

**Accidents and Malfunctions**

The powerhouse, spillway, boat lock, and fishways are designed to withstand the anticipated water, ice and debris loading and extreme flood and seismic events, so failure is very unlikely. An initial dam safety hazard consequence evaluation, prepared in accordance with the Canadian Dam Association Guidelines, indicates the hazard potential is “low”; however, it is nonetheless intended to design this facility to a “high” hazard potential standard. In the highly unlikely event that complete structural failure did occur, a preliminary estimate is that the resulting flood wave would have a maximum 3 m high crest at Dunvegan that would attenuate to a 1 m high crest at the Town of Peace River.

Failure of the adjustable spillway gate could release the upper 2.5 m of the headpond causing a minor wave of about 1 m at the structure, dissipating to less than 0.3 m at the Town of Peace River. This is well within the normal variability of flows in the river.

The potential for fluid spills is minimal because the turbines and associated equipment use very small quantities of hydraulic fluids, and the hydraulic fluids used will be vegetable-based (biodegradeable) or environmentally friendly products. The plants will be well maintained in accordance with the proponent’s Environment, Health and Safety Management System (EHSMS) Policies and Procedures Manual, with drains and sumps capable of retaining more than the full volume of 200 L contained in each turbine generator unit.
Environmental Management and Design Features

The Environmental Management Program for the Project encompasses several aspects of environmental protection, emergency response planning, implementation of mitigation and compensation works, environmental monitoring, and adaptive management. An Environmental Protection Plan for the Project will be developed based on the existing systems in place at many of the other facilities owned and operated by Glacier Power’s parent company Canadian Hydro, and in consultation with the regulatory agencies. The Environmental Protection Plan is discussed in detail in section 5.0 of this EIA.

The Project has been located and will be designed to provide a clean sustainable source of electrical energy using a renewable resource with minimal effects to the environment. The following list summarizes the elements that have been or will be incorporated into the Project to minimize potential environmental effects:

- The Project has been sited in the most stable geology found along the length of Peace River between the Alberta–British Columbia border and the confluence with the Slave River.

- The Project is a run-of-river plant that does not change or regulate flows downstream.

- The Project fits into the active floodplain in the bottom of the valley, and does not extensively flood the surrounding areas.

- The Project incorporates fishways to provide for upstream and downstream fish passage.

- The Project turbines are designed to be fish friendly to the extent possible while being able to utilize the low-head differential to generate electricity.

- The Project trash racks will be designed to minimize entrainment of fish and provide guidance to safe downstream passage facilities. Physical hydraulic modelling has been used to evaluate guidance flows for safe downstream passage.

- The Project spillway is designed to prevent or minimize the formation of supersaturated water downstream of the spillway.

- The Project access roads and transmission line use existing trail and road corridors as much as possible.

- The Project transmission line uses single wood poles, similar to other transmission lines in the area.

- The Project incorporates a boat lock to pass boaters past the headworks structure.

- The Project incorporates a boat launch on the upstream side of the headworks structure.

- The Project incorporates safety booms on both the upstream and downstream side of the structure to minimize risks to boaters.
• The Project headworks construction will integrate sheet piles into the structure rather than cofferdams, which cause extensive disturbance to the channel bottom and tend to generate high sediment into the water column during installation and decommissioning.

• The majority of construction access will be via each bank abutment, thereby minimizing instream presence of equipment.

• The Project components blend into the river valley causing minimal visual impact.

• The Project scale will not pose a strain on surrounding infrastructure or the environment.

**Effects of the Environment on the Project**

Aspects of the environment that may affect the Project include slope stability, flooding conditions, ice regimes and climate change. The powerhouse, spillway, boat lock and fishways are designed to withstand the anticipated water, ice and debris loading conditions, as well as extreme flood and seismic events, although those events are unlikely.

The flow of the Peace River will pass through the headworks. Variations in the flow will potentially affect project operations. The headworks have been designed to handle flood conditions and low flow conditions. Even extreme floods such as the PMF can be passed.

During normal operations, debris in the Peace River will be captured in the trash racks that operate between the end of March and the end of November (prior to freeze up). The powerhouse will be designed to overtop if flows exceed the 1 in 2 year flood. Debris during these flood events would be passed over the spillway and or powerhouse therefore conditions upstream and downstream of the Project will be similar to what would occur naturally.

Ice conditions in the Peace River will interact with the headworks and could affect project operations by forcing facility shut down. The Project has been designed such that during freeze-up, most of the frazil ice moving downstream will continue through the turbines, while ice will begin to build up along the edge of the river and lodge in the headpond. Eventually, the headpond will freeze over and the plant will continue to operate using under-ice flow.

Climate change could affect the Project through effects on the amount of precipitation and, consequently, the flow of the Peace River, and through changes to the ice regime on the river. Climate change trend forecasts indicate both warmer weather and increased precipitation in northeast British Columbia. These trends are not expected to necessitate changes in Bennett Dam operations, particularly given the large amount of storage available in the Williston Lake. Thus climate change is not expected to affect the availability of water to flow through the turbines. Change to a warmer climate will affect the ice regime on the Peace River but this change is not expected to affect project operations.

The Project has been designed to accommodate effects of the environment without hampering project sustainability.
Environmental Effects Assessment

The assessment of the potential environmental effects of the Project has been done using a rigorous methodological framework developed on the basis of current, accepted practice and professional experience of the study team. The assessment has been focused on those valued environmental components (VECs) determined to be of key interest to regulators and stakeholders, as determined from discussions that have been ongoing since 1999 with regulators, area residents, and interested parties, and the Terms of Reference for the EIA.

For the purposes of assessing potential project effects on VECs, the spatial boundaries consist of a local study area (LSA) and a regional study area (RSA). Variations to the study areas were made depending on the specific EIA component. The VEC study areas are addressed under the spatial boundaries section of the individual VEC assessments.

The assessment scenarios for the project EIA include a baseline case, an application case, and a cumulative effects assessment (CEA) case. The baseline case includes the existing environmental conditions, existing and approved projects and activities. The application case includes the baseline case and the Project. The CEA case includes the baseline case, the application case and anticipated future projects and activities. The CEA case assesses the contribution of the Project to the cumulative effects of all projects in the area.

Geotechnical

Effects of the Project on geotechnical concerns such as slope stability, sliding, slumping, toe erosion, and shoreline erosion, are rated as not significant.

The geologic conditions along the Peace River valley in the headpond area are well suited for small hydroelectric development due to the competency and stability of the valley slopes. The valley in this area is cut through bedrock, rather than through the deposits of the preglacial Peace River valley. The geologic units/features that contribute to large-scale landsliding both upstream and downstream of the Project site are therefore not encountered in the Project headworks and headpond area. In addition, the project area is located in one of the most seismically stable regions of Canada.

The impoundment of the headpond will have the positive effect of decreasing the overall flow velocity along the edge of the river and the negative effect of increasing erosive attack on specific areas by the increased rate of aggradation of sand bars and resulting deflection of flows into banks on the opposite side of the river. This increase in lateral erosion will occur where bars have been forming on an ongoing basis, especially since regulation of the flows by the Bennett Dam.

 Portions of the access road, particularly along the west side of Dunvegan Creek, will cross localized areas of recent or historic slope instability. The proposed alignment for the access road does not impinge on any existing areas of instability along Highway 2 and therefore is not likely to have significant adverse effects on the stability of the main highway. Glacier Power will implement mitigation measures recommended by Thurber Engineering during their geotechnical review of the Project in the design and construction of the south access road.
Surface erosion does not appear to be a problem in the area, however it is a potential effect of road and transmission line construction. The removal of facilities during decommissioning has the potential to affect fish habitat and water quality. Construction, operation and decommissioning activities will be carried out following standard good practices with respect to the design and implementation of erosion control procedures, and the effect of the Project on surface erosion will be not significant.

Post-development wave, or possibly ice, action could accelerate naturally occurring bank erosion or shoreline instabilities. This is more likely to occur in the lower section of the headpond in areas that have not been previously exposed to fluvial processes. Areas that were previously exposed to river reworking prior to river regulation by Bennett Dam will have lag deposits on the surface which will be relatively resistant to erosion.

The types of post-Project slope processes (weathering, lateral erosion, sliding/ slumping, surface erosion) encountered within the headpond will be similar in extent and scale to pre-Project occurrences. The headpond will result in a modest, but not observable, increase in the rate of these processes during the initial few years of operation. Over time, the rates of these slope processes are expected to decrease to current levels.

The effects of the Project on the geotechnical VEC are rated as not significant.

**Climate, Air Quality, and Noise**

The Project’s effects on climate, air quality, and noise have been assessed as not significant. Effects on ambient air quality will be highly localized (i.e., within tens to hundreds of metres of the activity) and reversible because emissions are will be primarily a result of construction and decommissioning activities and will stop once these activities are complete. The Project will have virtually no atmospheric emissions during operation. Effects from construction and decommissioning emissions will be low to medium in magnitude. Mitigative measures will be applied during construction to minimize dust generation.

Construction and decommissioning activities will cause increased noise levels above existing conditions, but they will be of short term and similar to some agricultural activities. During operation, noise generated by the turbines will be minimal due to the submersion and concrete encasement of the turbines and will be masked by noise created by the tailwater and water flowing over the weir. The effects of construction, operations, and decommissioning noise are rated as not significant.

One of the issues raised by local residents is the reduction in visibility due to the development of fog or ice fog at the Dunvegan Bridge, which may affect traffic safety. The frequency of fogging and icing due to the Project will generally increase under post-Project conditions, but the increase is expected to remain within 4 to 10 percent relative to existing conditions. Fogging events at bridge deck height will generally be limited to night-time hours and should not persist beyond a few hours following sunrise. The effects of this increase on transportation safety are discussed in the Transportation section; however, due to mitigation proposed to address the transportation-related effects of the increased frequency of fogging events, the effect of the Project on the occurrence of ice fog and icing at the Dunvegan Bridge is assessed as being not significant.
The effects of the Project on climate, air quality and noise are assessed as not significant. The Project effects are predicted to not add to the cumulative effects of other future projects in the area on climate, air quality and noise.

**Water Quality**

With the implementation of the proposed mitigation during construction, operations, and decommissioning, effects of the Project on the water quality VEC have been assessed as not significant.

In general, the water quality of the Peace River within the Dunvegan study area is good and is not significantly affected by anthropogenic influences. Turbidity and total suspended sediments in the Peace River are correlated with discharge, and also vary seasonally with the highest concentrations occurring in the spring and then declining through the summer and fall. Suspended sediment concentrations in the Peace River are highly variable and can exceed the Canadian Water Quality Guidelines criteria, particularly in spring.

Baseline total mercury concentrations on samples of surface water from the Peace River were generally below methodological detection limits (less than 0.05 µg/L). Nutrient (total nitrogen and phosphorus) concentrations in the Peace River mainstem were high, but were within the range reported for large rivers in northern Alberta.

Instream activities during construction and maintenance of the infrastructure will introduce sediments into the aquatic environment; however, with the implementation of the proposed mitigation measures during the project construction and operations, and based on the high background suspended sediment concentrations in the Peace River mainstem during much of the year, significant sediment-related effects during the construction and operation phases are not anticipated.

The potential for increased total gas pressure in the water will be fully mitigated using the current Project design. There will be no mechanism to increase total gas pressure. The low head of the headworks (6.6m), the horizontal configuration of the spillway dissipater, and the absence of a plunge pool in the tailrace zone will eliminate any potential for air to be forced to depth. In addition, the turbines will not utilize air injection systems.

The production of methyl mercury typically occurs in situations where large reservoirs are formed covering thick organic materials such as peat or forested areas where trees are left uncut. With the Project in place, headpond inundation will be largely within the pre-Bennett Dam floodplain consisting of alluvial deposits with no accumulation of organic matter or wetlands. Based on the small area and the limited amounts of organic materials that will be inundated, methyl mercury production caused by headpond formation is expected to be negligible.

The potential for accidental spills is very low due to mitigation protocols limiting transport of potential contaminants to the project area. The exception to this is the transport of concrete into areas adjacent to Hines and Dunvegan Creeks. However, an input of a large amount of uncured concrete to these creeks has a low probability of occurrence. Also, the potential effects are limited in geographical extent, are short-lived and, as such, would not have a significant adverse effect on water quality in the project area.
Although very unlikely to occur, certain malfunctions or accidents could result in increased sediment inputs into the Peace River in the project area. Extreme bank erosion due to a flood event, catastrophic failure of the infrastructure and massive slope failure all have the potential to lead to inputs of large amounts of sediment. Because suspended sediment loads would likely be at their highest during the kinds of flow events that might cause extreme bank erosion or infrastructure failure, the incremental input of sediments resulting from these malfunctions or accidents would likely be small, and no adverse effect on water quality would be expected. Although sediment inputs associated with a massive slope failure into the headpond would have catastrophic consequences to water quality, the occurrence of such an event is highly unlikely.

During decommissioning of the headpond, potentially adverse effects on water quality could occur from introduction or remobilization of sediments into the Peace River. The large amount of sediments potentially mobilized, the extended time when this effect would occur, and the extent of river that could be affected, suggest that dewatering the headpond could adversely affect aquatic resources. Based on the proposed decommissioning plan it is assumed that these effects could be effectively mitigated resulting in the effects of decommissioning on water quality being rated as a rating of not significant.

Given the comparatively limited amounts of sediment that may enter the Peace River as a result of the Project, the limited amount of organic materials to be inundated, and the spill prevention measures to be implemented, the effects of project activities on the water quality VEC are rated as not significant.

**Surface Water Hydrology and Groundwater**

In order to minimize environmental effects, the Project has been designed as a low-profile, run-of-river facility. The Project will not store water in a reservoir, inundation will be minimal and largely confined to the active floodplain, and flows downstream of the headworks will be equivalent to those entering the headpond. As such the Project effects on the surface water hydrology and groundwater VEC have been rated as not significant.

Unrestricted, the discharge of Peace River varied seasonally; however, under regulation due to the Bennett Dam, mean monthly flows have generally decreased in the summer and increased in winter. The Bennett Dam has dampened the range of annual peak and low flows, but increased daily fluctuations.

The peak sediment concentration at Dunvegan occurs in the spring and early summer as a result of snowmelt- and rainfall-derived inflow from unregulated tributary streams. Various reports indicate that the area upstream from Bennett Dam is composed of comparatively erosion-resistant materials that limit the supply of both suspended sediment and bed material load. In contrast, the erosion-prone material comprising the Alberta Plateau produces some of the highest observed rates of sediment production per unit area in British Columbia and Alberta.

Peace River in the vicinity of Dunvegan consists of a single-thread channel that is frequently confined by valley walls approximately 200 m high. Flat valley areas are discontinuous and consist of isolated sections of fluvial terrace and fans built up at the mouths of tributary streams. Three sizeable tributary streams enter the proposed headpond: Fourth Creek, Hamelin Creek, and the Ksituan River. Following construction of the Bennett Dam, the reduced peak flows have been less able to move the coarser
textured components of the sediment load supplied by the tributaries and these materials have deposited on the fans or along the downstream bank.

The interaction between the Project and the discharge of the Peace River is expected to be minimal. The headpond volume is small relative to the river's discharge rate, such that minimal attenuation of fluctuations in flow will occur. River flows downstream of the headworks will not change, and flow velocities and patterns will return to pre-Project conditions within 1000 m.

The project headworks will form a headpond that extends approximately 26 km upstream. The headpond will operate 90 percent of the time between the 95 percent and five 5 percent exceedance flows of 753 and 2500 m$^3$/s (flows will be either below or above these values only ten percent of the time). At 50 percent exceedance flow, the water level increases 6.6 m at the structure compared to the existing post-Bennett levels. At five percent exceedance, the water level increases 6.07 m at the structure compared to post-Bennett levels.

The inundated zone upstream of km 16 will primarily be within the pre-Bennett alluvial channel and below the pre-Bennett 1:100 year flood elevation. The degree of inundation will be reduced in the upstream direction, such that the effects of inundation will not be observable at the upstream end of the headpond between km 22 to 26 where headpond water levels will be within the present daily fluctuations due to the regulated flow regime. The upper limit of headpond operation at five percent exceedance flows brings water levels in the lower portion of the headpond to an elevation slightly above the tree root level of the former channel banks and the first island encountered in the headpond. The new area inundated by the headpond will be 106 to 215 ha (95 to five 5 percent exceedance levels).

Flow velocities at the upstream end of the headpond show minimal change with the addition of the Dunvegan Project. Upstream from the structure the velocity will be reduced by approximately 50 percent. The flushing action of the river will not decrease significantly; at the 1:2 year flood event, it takes only 2.8 more hours for a particle of water to travel 26.3 km down the river. During a 1:100 year flood the time is only 1.2 hours longer.

Groundwater in the area is not usually available and is of very poor quality. There are no water licenses or groundwater wells in the headpond area. The headpond inundation is within the natural river channel, and changes to groundwater base flow or levels are expected to be undetectable.

**Sediment Transport**

Due to reduced flow velocities, sediment deposition will occur within the proposed headpond. Coarser, gravel-sized sediments will be deposited at the upstream end, with sediment size decreasing in a downstream direction. The regulated flows from Bennett Dam have significantly reduced the frequency with which the coarser fraction of the river bed materials is transported. As a consequence, a lengthy period of time could be required for substantial coarse gravel accumulations to occur at the upstream end of the headpond. Velocities through the headpond will generally be sufficient to maintain the transport of fine suspended sediments, although fine-textured material will be deposited in low velocity areas and along headpond margins.
The river channel in the headpond will evolve over time from sand and finer materials to medium sized gravel. Finer material will be intermixed with the gravel during low flow periods. The walleye spawning area associated with the transverse bar at km 17 is expected to undergo a gravel-to-sand evolution.

Twenty-two percent of the total incoming sediment load is expected to be trapped in the headpond over the initial 10 years of project operations. This corresponds to 33 percent of the proposed headpond volume at the 50 percent exceedance flow. Modeling predicts that over 50 years, sediment accounting for 52 to 54 percent of the initial headpond volume at the 50 percent exceedance flow will be trapped.

Ongoing enlargement of the Hines Creek fan is resulting in a narrower and deeper river cross section at the Dunvegan bridge site. It is expected that post-project the Hines Creek fan will continue to aggrade, constrict the river channel and possibly cause further channel downcutting in the vicinity of the bridge. This process has been occurring under the present regulated flow regime, and bedload deposition in the proposed headpond is expected to result in limited acceleration of the process. Because flow patterns and velocities 1000 m downstream from the project headworks will be unaltered from present conditions, the Project is not expected to have a significant effect on downstream erosion patterns or channel shifting.

Wave, or possibly ice action, in the headpond is most likely to result in localized shoreline erosion in sites composed of colluvial fans or aprons. Fluvial terrace deposits are also potentially subject to accelerated erosion as they are composed of unconsolidated materials. Post-project shoreline instability is expected to reflect material characteristics, water level increase and supplementary factors such as fetch and wind direction, vegetation cover, ancillary water supply, upslope land use (such as grazing) and climatic variation. As a consequence the response is likely to be variable and will evolve over time.

The effects of the Project on the surface water hydrology and groundwater VEC are rated as not significant.

**Ice Formation and Breakup**

The outcome of the modeling undertaken to assess the effects of the Project on the ice regime showed that the Project will not result in any adverse effects that cannot be mitigated. While the ice regime will change, of all the stakeholder concerns, only two may require mitigation – a two to three week reduction in the time that an ice bridge can be used at Shaftesbury Crossing, and an expected 0.5 m increase in base freeze-up water levels at the Town of Peace River (TPR) that may affect groundwater levels in Lower West Peace. Mitigation is available and has been proposed in order to address both of these effects. The overall effect of the Project on the ice formation and breakup VEC during construction and operations is not significant to positive.

The natural ice regime has been greatly affected by Bennett Dam. Increased winter flows and the large heat source in Williston Lake have produced an ice regime that is characterized primarily as a “one ice front” system where each year freeze-up occurs downstream of Fort Vermilion (538 km downstream of Dunvegan) in November or December and an ice front advances upstream from there. The rate at which the ice front advances depends mostly on the supply of ice, which is a function of the severity of the winter, and to a lesser extent on the flows released from the Bennett Dam. The overall winter severity will determine how far upstream the ice front will advance. In cold winters it will advance into...
British Columbia, but in warm winters it will not advance upstream as far as Dunvegan. Because of the increased post-Bennett Dam winter flows at freeze-up, the current freeze-up is substantially more dynamic, with thicker ice covers and higher post-freeze-up water levels, than were experienced prior to regulation.

Once the ice front has advanced to its maximum upstream position in early to late March, it begins to recede as warm water leaving Bennett Dam melts the ice cover. This thermal-type of breakup typically occurs upstream of TPR. Downstream of the Town, the breakup may be either thermal or mechanical depending on how much spring runoff is generated from tributaries. If a mechanical breakup occurs, ice-related water levels can be high if ice jams develop. Regardless of whether a thermal or mechanical breakup occurs, the receding ice front moves downstream towards Fort Vermilion at a rate that clears the ice from the lower reaches of the river by late April to mid-May. Post-Bennett breakup is generally more benign than pre-Bennett, especially upstream of TPR where breakup is usually thermal.

The Project will change the ice regime from a one ice front system to a two ice front system. Lodgement will still initially occur downstream of Fort Vermilion, and the ice front will advance upstream from there. However, at some point during the winter, due to the combined factors of winter climate and temperature of the water released below Bennett Dam, lodgement will also occur in the Dunvegan headpond. As a result an upstream ice front will form at Dunvegan at about the same time the downstream ice front has advanced to the Notikewin River (271 km downstream of Dunvegan). Once lodgement in the headpond has occurred, the rate of advance of the downstream ice front will decrease because of the reduced ice supply (cut off by the Dunvegan headpond), thereby delaying freeze-up at all locations between the Notikewin River and Dunvegan.

In the coldest of years the downstream ice front will only advance to within about 10 to 15 km of Dunvegan and in the warmer years only to within 60 to 70 km. The upstream ice front, however, will advance further upstream into British Columbia more often than it does under pre-Project conditions because of the earlier development of an ice cover in the headpond at Dunvegan. The recession of the upstream ice front will be delayed relative to pre-Project conditions due to its farther upstream advance. Downstream of the Project the thermal recession will not be delayed in any systematic way and the timing of breakup compared with pre-Project conditions is not expected to change at Shaftesbury Crossing, TPR, or other downstream locations.

The effects of the Project on the ice regime were quantified using the Peace River Ice Model (PRICE) – the newest and most sophisticated ice model available. The model is a finite difference, fully dynamic model that uses inputs of discharge and water temperature at its upstream boundary, and channel characteristics, air temperatures, snow fall, and cloud cover throughout the model domain to calculate the flow distribution, water temperatures, ice production, ice front location, ice thickness, deposition and transport of frazil slush, snow depth, and thermal (solid) ice thickness throughout the model domain.

On behalf of Glacier Power, the PRICE model was developed by Dr. Hung Tao Shen of Clarkson University at Potsdam, New York and modified and calibrated to represent ice conditions over the approximately 800 km long domain of interest on the Peace River. While Dr. Shen’s model has been in development for over ten years, three years of effort was required to prepare the model for use on the Peace River – including two years of intensive ice monitoring (2002-03 and 2003-04) to provide sufficient data to calibrate the model. Calibration of the model was led by Northwest Hydraulic
Consultants, but included over eighteen months of collaborative review that involved several ice experts as well as stakeholders through a series of five technical ice modeling workshops.

The performance of the PRICE model was assessed on the basis of its ability to reproduce both (1) observed ice front positions and (2) statistically defined measured risks of particular events occurring (freeze-up and breakup dates, ice cover durations, etc). This assessment was made on the basis of information gathered over 23 years between 1981-82 and 2003-04 during which ice conditions were measured systematically by AENV and BC Hydro. The model performed well from both perspectives. The effects of the Project on some key stakeholder ice-related concerns are summarized below:

*Dramatic changes in ice regime may affect understanding of ice processes and require intensive monitoring to re-establish ice forecasting confidence.*

Although the timing of freeze-up and breakup will change, there will not be a fundamental change in the ice processes. The fundamental rules that are currently being used to quantify the relationships between meteorological, hydraulic, and ice conditions will not be changed by the Project. For example, freeze-up processes at the TPR will be fundamentally similar post-project to what they are pre-project. The breakup issues considered pre-project (ice front recession rates and breakup sequences involving the Smoky River) will require the same consideration post-project.

The level of understanding of the basic ice processes on the Peace River has been substantially advanced since Glacier’s initial applications for the Project, as a result of multi-party efforts in field data collection and collaborative improvement of numerical modeling of the Peace River. The measurement of actual secondary consolidation events, for example, has greatly increased the understanding of the forces and factors involved in arresting those events. This understanding can now be applied to basic process-related ice-risk forecasting and management on the Peace River, both with and without the Project. The effects of the Project on the understanding of ice processes on the Peace River are rated as not significant.

*Changes in ice floe characteristics downstream from Dunvegan may alter the fundamental ice formation characteristics, thereby exacerbating existing freeze-up concerns.*

Due to the slower advance rate of the ice front and the relative proximity of TPR to the upstream end of the ice generation reach, it is likely that more frazil ice will deposit under the advancing ice front. This will create a slightly thicker accumulation which is expected to raise freeze-up water levels by 0.2 m. To be conservative for the purposes of effects assessment, consideration of an increase of 0.5 m was used. Although this increase will have little effect on exacerbating high water levels related to secondary consolidations, it may increase groundwater levels in West Peace after freeze-up. To mitigate this effect, Glacier has entered into an agreement with TPR to study and fund the implementation of a permanent engineered solution to the Lower West Peace groundwater issue.

Because of a post-project reduction in the occurrence of key factors that are known to precede secondary consolidations (such as a rapid advance of the ice cover), it is expected that a reduction in the frequency of secondary consolidations will occur. The size and severity of the water surge that would accompany a post-project secondary consolidation, should one occur, would be no greater than such surges pre-project. Therefore a reduction in the frequency of high freeze-up levels caused by

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2 A secondary consolidation is a re-collapse of an ice cover that has already consolidated.
secondary consolidations is expected, and as a result the effects of the Project on freeze-up concerns at TPR are rated as not significant to slightly positive.

Effects on water supply at Taylor and other water intakes in British Columbia
The main ice-related concern at Taylor is access to the water supply wells in the Peace River. The Project will increase the frequency with which an ice cover forms at Taylor. The presence of an ice cover is not expected to affect the performance of the wells, although it will reduce access to the wells during the winter period. The upstream advance of the ice cover will occur in a systematic way and its potential date of arrival will be known in advance. Any potential negative effects of a more frequent ice cover on accessibility of the wells can be mitigated by more systematic maintenance of the wells in late fall or early winter before the development of an ice cover.

An increased frequency and duration of ice cover in British Columbia is not expected to affect other water intakes in B.C., based on discussions with the water licence holders, as these intakes have been designed to work under ice conditions and have experienced ice covers in the past. As a result the effects of the Project on District of Taylor water intake and other water intakes in British Columbia are rated as not significant.

Effects on Power Generation at Bennett Dam and Peace Canyon
B.C. Hydro is required to regulate its operations in order to limit ice-related flood risks at TPR. This involves adjusting flow releases from Bennett Dam during ice cover formation through the TPR. A new physically-based flow control criterion to be applied while the ice cover is forming at TPR was recently adopted on a trial basis. Allowing for future modifications to the freeze-up criterion to reflect the slower and more stable ice advance rate at TPR results in post-project flow control periods that would be only one day longer on the average than what would be experienced under the current regime.

The Project will have no effect on flow controls on breakup. The mitigation proposed to address groundwater levels in Lower West Peace will address the possible slight (0.5 m) increase in freeze-up levels. As a result of the foregoing, the effects of the Project on power generation at Bennett Dam and Peace Canyon are rated as not significant.

Breakup timing and severity at the Town of Peace River and downstream
There will be no systematic difference in the timing of thermal breakup dates at TPR. Therefore, there will be no increase in the likelihood of a mechanical breakup due to the Project. The thermal thickness of the ice will not be systematically greater post-project. Thus should a mechanical breakup occur, the potential for a stable jam to form will not be greater. Because peak water levels are related to discharge and because the Project will not affect river flows, should a stable jam form, jam-related water levels are not expected to be any different than those currently experienced. Due to this, the effects of the Project on breakup-related ice jam risks at TPR and downstream are rated as not significant.

Effects of changed freeze-up processes on ice bridges
There are only two ice bridges officially operating on the Peace River at Tompkins Landing and Shaftesbury Crossing. The Project will not affect the ice regime at Tompkins Landing or any location downstream from the Notikewan River. There will likely be a delay in freeze-up at Sunny Valley in most years, but only by a couple of days.
At Shaftesbury Ferry, the Project will result in a net annual average reduction in crossing days for both the ferry and the ice bridge would of about two to three weeks for a wide range of current climate conditions. Mitigation related to improved ferry infrastructure at Shaftesbury Ferry has been proposed to offset this reduction, as discussed in the Transportation section. As a result, the effect of the Project on the operations of the Shaftesbury Ferry and ice bridge is rated as not significant.

**Ice conditions in the vicinity of Dunvegan**

Ice will lodge naturally in the Project headpond. This will result in the formation of an ice cover in the headpond earlier than it presently forms, but closer to the time when it typically formed prior to the construction of Bennett Dam. Ice-related freeze-up levels will be no higher than pre-project levels. The headpond will trap and cut off the supply of ice downstream from Dunvegan. In very cold winters, the head of the downstream ice cover will advance to within about 10 to 20 km of the structures. Open water will exist all winter downstream from the structure. Secondary consolidations of the upstream ice front will have little to no effect on the stability of the downstream ice front. Flow perturbations produced by secondary consolidations of the upstream front would be attenuated significantly by the upstream cover and storage in the headpond before they would reach the downstream ice front. Effects of the Project on ice conditions in the vicinity of Dunvegan are therefore rated as not significant.

**Winter tailwater levels below the Project causing loss of generation and flooding at Dunvegan**

In the coldest 10 percent of the winters the ice front will advance to within 10 to 20 km of the Project. The resulting backwater from the downstream ice cover will raise water levels in the tailrace by between 1 and 2 m for periods of 30 to 60 days. This is not expected to alter the economics of the Project, or result in overbank flooding in the vicinity of Dunvegan. Due to the persistence of the active frazil generation reach downstream from the Project throughout the winter, anchor ice may form downstream from the tailrace more frequently than under pre-Project conditions, and accumulate up to an average thickness of about 0.3 m for periods throughout the winter. This may result in additional short term head losses. High ice-related water levels will be eliminated through the reach 20 to 60 km downstream from the Project and will be more benign in the 10 km reach below the Project. As a result, the effects of tailwater levels on generation and flooding are rated as not significant.

**Deposition of frazil in the headpond**

Frazil will be deposited in the headpond, and will also be transported through the headpond as cover load. The turbines will be engineered to accommodate the transport of frazil and, as such, the effects of frazil in the headpond on the Project are rated as not significant.

**Accidents and Malfunctions**

In the unlikely event of a structural failure at the headworks during the ice-season, a wave of water and ice would be released from the headpond, the magnitude of which would depend on the timing of the release during the winter (early on during freeze-up or mid- to late winter). The wave would be likely to de-stabilize the downstream ice front, and cause subsequent ice cover thickening and high water levels. This could result in flooding depending on the location and timing of the event. Although these effects would be considered significant, they are unlikely to occur.

The Project will affect the ice regime on the Peace River between Taylor and the Notikewan River. Changes will not significantly affect biological, historic resources and human VECs. The outcome of modelling using the state-of-the-art PRICE model showed that there will be no significant ice-related effects of the Project that cannot be mitigated. While the ice regime will undoubtedly change, of all the
stakeholder concerns only two may require mitigation – a two to three week reduction in the time that an ice bridge can be used at Shaftesbury Crossing, and an expected 0.5 m increase in base freeze-up water levels at TPR that may affect groundwater levels in Lower West Peace. Mitigation is available to address both concerns, and they are therefore rated as not significant.

Effects of the Project on ice-related flood risk at TPR are rated not significant to positive, and effects on the generation capacity of BC Hydro, as well as other stakeholders in B.C., are also rated not significant.

**Fish Community**

Since the 2002 hearing, Glacier Power has spent nearly 3 million dollars studying the Peace River fish community, and designing and modeling fish passage strategies. Baseline fish community studies were completed in 1999 and 2004, and Glacier Power has made a commitment to complete a third year of study prior to project construction. Three years of radio telemetry covering hundreds of kilometres of the Peace River and its tributaries was completed to improve understanding of the timing and extent of fish movements through the project area. Three years of numerical and physical hydraulic modeling, involving one physical model in Edmonton, Alberta and another in North Vancouver, British Columbia were completed in an effort to design the most effective, comprehensive, and adaptable fish passage mitigation facilities possible. Because of this work, the proposed project design represents the lowest-impact hydroelectric structure possible with today’s technology.

While there is expected to be some residual effects on local burbot, whitefish, and walleye populations, the populations of these fish in reaches immediately adjacent to the Project are expected to be unaffected, and overall there is a nil to low potential for the Project to cause significant adverse effects on fish community at the regional level.

Information collected between 1999 and 2005 provides comprehensive baseline data that describes the fish community in the Project area. In general, the fish community does not exhibit large inter-annual differences in species composition, abundance, population structure, or movement.

The fish community in the project area is influenced by the flow regimes and sediment loads of the Peace River and its tributaries. The project area is a transition zone between cool-water and cold-water species. Cool-water species populations dominate the fish community and within this group sucker and minnow species are numerically most important. Sportfish species are not abundant. No endangered fish species populations occur in the project area. Fathead minnows recorded downstream of the Project are considered unique because they have not been previously recorded in the Peace River in Alberta. Spoonhead sculpin are considered a species that "May be at Risk" by the provincial government.

Cold-water species populations that occur in the Project area include mountain whitefish and bull trout. Neither population is self-sustaining, but instead is maintained by an influx of fish from upstream areas. This conclusion is based on evidence that includes atypical age and size structures of each population and the absence of important habitats.
Seasonal movement patterns of goldeye, walleye, burbot, and longnose sucker indicate that most species except goldeye are non-migratory. A portion of the goldeye population in the Peace River migrates upstream into and past the Project area to spawn and/or feed, while the remainder of the population completes its annual movements downstream of the project area. Seasonal changes in catch rates indicate that flathead chub may also be migratory, but it is unclear whether these data represent seasonal movements by this species population or seasonal differences in catchability. Movement data for other species (walleye, burbot, and longnose suckers) indicate that at least a portion of each population spawns outside of the project area.

Fish habitats in the Peace River in the project area are characterized by low complexity and low quality. This is due to the regulated flow regime, the ice regime, and the sediment load of the river. Similarly, the quality of tributary habitats is adversely affected by flow, temperature, and sediment regimes.

Some good quality habitats occur in the project area (shoals and backwaters), but they are not abundant. No protected snyes or side channels are present. Two important habitats were recorded in the proposed headpond area. A potential northern pike spawning area identified in 1999 was subsequently destroyed by ice scour in winter 2003/04. A walleye spawning shoal was documented in 1999 and was also used by fish in 2004. The area is subjected to dewatering during the spawning period.

The environmental effects assessment used fish habitat, fish movement, and fish health/survival to evaluate project effects. The fish community consists of several species populations that may be affected differently by the Project depending on habitat requirements, movement strategies, and population characteristics. Fish habitat is affected by the footprint of the Project and headpond formation. Fish movement is affected by the presence of the Project as a physical impediment to upstream and downstream movements. Effects on fish health/survival may be manifested by water quality changes during construction, operations, and decommissioning, and by the effects of entrainment through turbines and over the spillway.

Fish Habitat
Headpond formation will result in negative and positive effects to fish habitat. Habitat-related changes to the local fish community will be manifested by headpond formation and the resulting sedimentation. The majority of species populations in the Project area are pre-adapted to high suspended sediment loads and sedimentation, and are expected to adjust to changes associated with headpond formation by using alternate habitats. Species populations that are not pre-adapted to effects of high sediment loads and sedimentation will not adjust to the effects of headpond formation. This includes walleye, burbot, and mountain whitefish. The local mountain whitefish population is transitory and is maintained by recruitment from upstream areas rather than by important habitats within the headpond. Local burbot and walleye populations are known to use habitats outside the influence of the headpond, particularly important habitats such as spawning areas. As such, headpond formation will prevent specific local fish populations from using portions of the headpond for some of their life requisites. But, all habitats changed by headpond formation are available elsewhere in the Peace River. Therefore, the adverse effect caused by changes to fish habitat is restricted to the local area. There will be no adverse effect to fish habitat at the regional level.
In addition, the headpond will provide overwintering habitat that is presently limiting the fish community. This is a positive effect that may offset negative effects to some extent. Glacier Power has developed a fish habitat compensation package in consultation with DFO and ASRD to compensate for any negative effects.

**Fish Movement**

Glacier Power has committed to a comprehensive mitigation strategy to provide upstream and downstream fish passage and to protect fish populations from the adverse effects of entrainment. To achieve this goal Glacier Power has completed extensive field work to maximize its understanding of movement requirements of fish populations potentially affected by the Project. Glacier Power has also completed an extensive three-year evaluation and modeling program to develop a fish passage strategy that will achieve its goal: to provide effective fish passage to ensure the long-term viability of fish populations. The modeling work was carried out in close consultation with DFO and ASRD.

During construction, upstream fish passage could be hindered for at least two and potentially three consecutive years. Downstream movements will not be hindered during construction. A comprehensive fish collection and transfer program is proposed as mitigation. Monitoring of fish movements and the occurrence of fish concentrations below the construction site will be used as an early warning signal that upstream fish passage is blocked. As such, it is assumed that the fish collection and transfer program, assisted by use of attraction flows at strategic locations such as the fish passage ramps, sluices, and boat lock, will provide effective mitigation. Based on this evaluation there will be no significant adverse effect to the fish community due to blockage of upstream fish movement during construction.

During project operations, the role of the upstream passage system is to provide fish passage from the tailwater area upstream past the headworks structure to the headpond. Upstream passage facilities include two ramp fishway structures (one on each bank), an auxiliary water supply system (AWS) to provide attraction flow for the fishway entrance over a range of tailwater levels, and a guidewall structure that provides guidance flows to lead fish from downstream migration areas towards the ramp fishway entrance.

The role of the downstream passage system is to provide safe fish passage from the headpond to the tailwater area downstream of the headworks. Eight fish exclusion racks, one in front of each set of five turbine units across the upstream face of the powerhouse, will exclude the adult portion of the fish population (fish greater than 150 mm in length), and provide guidance to the downstream fish sluiceways. The fish exclusion racks consist of tightly-spaced bar racks (25 mm spacing), inclined at 35 degrees to the horizontal. Ten fish passage sluiceways located between each set of five turbine units, between the powerhouse and the spillway, and next to both fishways on the right and left banks, will facilitate downstream passage for fish that are excluded from the turbine intakes.

Based on the mitigation measures to be applied, upstream movements of some species populations will be hindered by the headworks structure during the operations phase, but the effect will not be significant. While upstream passage by small-sized species will be blocked (because fishways are not designed to pass fish less than 150 mm in length), this is not an issue because small fish do not undertake extended upstream movements. Flathead chub is the exception because it is assumed to be migratory, but a large portion of the adult component of this species population is greater than 150 mm; therefore, upstream passage is possible.
For a single large-size species population (burbot) upstream movement will be adversely affected because portions of the local population moves upstream through the Project area during the window when upstream fish passage facilities are not operational. The adverse effect on upstream movement of burbot will not be significant for three reasons: 1) passage will be delayed and not permanently blocked because fishways will become operational starting in April of each year, 2) passage is not time sensitive because these post-spawning movements are to feeding habitats, and 3) feeding habitats are available downstream of the facility.

Downstream fish movements will not be hindered by the Project. Adverse effects on genetic diversity upstream and downstream from the Project is not an issue because of the wide distribution of species populations potentially affected by the Project and unhindered downstream passage.

**Fish Health and Survival**

Fish entrained through turbines can sustain injuries. Fish size is an important factor affecting the injury of fish through turbines. In general, smaller or juvenile fish suffer lower injury rates because they pass through the available gaps and openings in the turbine more easily than larger or adult fish. Turbine characteristics can affect injury rates by influencing the rate of physical strikes and by causing pressure change and shear stress. Glacier Power has chosen a relatively slow rotating propeller type turbine design that is considered the best technology available today for this low-head application, while at the same time minimizing fish mortality. Based on the findings of Alden Research (2001) and a review of the literature it is assumed that fish survival during turbine passage will be as follows:

- 95 percent survival of fish less than 100 mm in length
- 90 percent survival of fish between 100 and 199 mm in length
- 88 percent survival of fish between 200 and 299 mm in length
- 83 percent survival of fish more than or equal to 300 mm in length

Glacier Power has committed to a comprehensive mitigation strategy to protect fish populations from the adverse effects of entrainment. The eight fish exclusion racks will exclude the adult portion (greater than 150 mm) of all large-size fish species populations from turbine passage, and will provide guidance to the downstream fish sluiceways. The fish exclusion trash racks will operate during the primary downstream movement period from 1 August to 15 November. The magnitude of effect on fish health/survival is predicted to be low for all small-sized species populations (less than 150 mm) because of the predicted high turbine passage survival rate. The effect on large-sized species burbot, walleye, and mountain whitefish is expected to be moderate because some adult fish will move through the turbines outside of the main downstream movement period when the exclusion racks are not in place and may have a lower survival rate.

Although several factors during baseline studies suggest that only small portions of local resident species may be entrained, because the portion of fish that will undertake turbine passage cannot be accurately quantified, the conservative approach of the evaluation dictates that the potential adverse effects of entrainment on local burbot, walleye, and mountain whitefish species be deemed significant. However, as noted above, only small portions of project area resident species populations are expected to be entrained, for several reasons. First, all resident species identified in the project area reside upstream and downstream of the headworks. Second, important habitats are available to all resident fish species populations upstream and downstream of the project area. Third, movements by adult
longnose sucker, walleye, and burbot demonstrated that only a portion of each sample population moved downstream through the Project. Local mountain whitefish originate from upstream populations and are likely dispersing through the Project area from upstream populations; therefore it is possible that a large segment of the local pollution would pass through the turbines. Because mountain whitefish are dispersing through the area from upstream populations, and it does not constitute a self-sustaining local population, any adverse effect on the fish community would be minimized by continued replacement of lost fish via recruitment from upstream sources. Despite the assumed significant adverse effect on health and survival of local burbot, walleye, and mountain whitefish populations, this project effect will not be an issue for regional fish populations or the regional fish community.

The potential adverse effect on fish health/survival caused by spillway operation is expected to be negligible for most fish species populations. No migratory species and few resident species populations will require downstream passage during the spillway operation period (April to June). Fish of two resident species populations (longnose sucker and walleye) may move downstream during this period, but it is expected that only fish in close proximity to the structure will be entrained because movement data indicate that these fish move only short distances and only a portion of the populations move downstream.

Consequences of the Project Effects to the Fish Community
The effects assessment concludes that a significant adverse effect by the Project is restricted to the local fish community. It is the result of Project effects on three specific local populations: walleye, burbot, and mountain whitefish. Viable, self-sustaining walleye and burbot populations reside upstream and downstream of the Project area, while a viable, self-sustaining mountain whitefish population resides upstream of the Project area.

It is the conclusion of the effects assessment that there will be no significant adverse effect by the Project to the regional fish community. As such, the Peace River fish community is not at risk from the proposed Dunvegan Project.

Soil, and Vegetation and Forest Resources

The Project will result in the inundation of some vegetation communities, the loss of a small amount of merchantable timber, and some minor soil erosion. The proposed mitigative measures will minimize the effects of the Project on these environmental components and the effects are rated as not significant.

The Project and headpond fall mostly within the Dry Mixedwood Boreal Forest Natural Subregion (Boreal Forest Natural Region) of Alberta, with only the westernmost portion falling within the Peace River Parkland Natural Subregion (Parkland Natural Region). Vegetation in the LSA is generally confined to a narrow and discontinuous river floodplain, with most plant communities occurring on deeply incised, steep-sided valley walls or along the riparian shoreline zone. North- and east-facing valley slopes tend to support mixedwood forests of balsam poplar, aspen, white spruce and paper birch, interspersed with occasional shrublands and sparsely vegetated, eroded slopes. On alluvial floodplains and islands, poplar is the dominant tree type, with willow thickets occurring on wetter, more recent deposits. Periodic shrub communities consist of red osier dogwood, alder, willow and birch. South- and west-facing valley slope grasslands are common, with seral aspen stands and deciduous shrubs in wetter, more protected gullies. Occasional lodgepole pine occurs at the top of the valley.
break. Steepest slopes are often bare and highly susceptible to erosion, resulting in exposed bedrock and mass wasting features such as slump scars.

There are no designated or proposed forestry management agreements (FMAs) in the LSA or nearby region.

Soils in the Peace River valley are dominated by Orthic and Cumulic Regosols, and those of the surrounding uplands are dominated by Black Solods and Dark Grey Luvisols with some Orthic Humic Gleysols in wet areas. The project facilities and access roads are mostly within the floodplain of the Peace River. The transmission line right-of-way is almost entirely in eroded valleys associated with Peace River and Dunvegan Creek. The most southerly 500 m of the right-of-way is in an area dominated by loam to silt loam, grey wooded soils developed on alluvial or aeolian parent materials. These are part of the uppermost terrace deposits associated with the Peace River.

Three confirmed, and one unconfirmed, rare plant species were identified in the LSA during field investigations in August 1999. The species identified in 1999 include the S2 ranked Herriot's sagewort, S2 ranked turned sedge, S3W ranked endolepis, and SU ranked narrow-leaved goosefoot. A second rare plant survey was conducted in June 2000. With the exception of Herriot's sagewort, none of the rare plant populations observed in 1999 were relocated in 2000. The eroded, south-facing slopes from km 0.0 to 3.0 and km 4.0 to 6.5 of the headpond included Herriot's sagewort, which was also found occasionally in the gravel bars of the river. It is expected that although individual plants will be affected by the flooding, part of the Herriot's sagewort population will be unaffected.

No restricted weeds were encountered during the August 1999 field reconnaissance and, therefore, no formal weed surveys were undertaken. Three noxious weeds (Canada thistle, perennial sow thistle, and spreading dogbane) and four nuisance weeds (shepherd's-purse, common dandelion, lady's thumb, and bluebur) were noted within the LSA. The LSA does not contain established wetlands and therefore will not produce any wetland related effects.

The high level of agricultural development in the Peace River Valley has exacerbated alteration of vegetation in the region, particularly in riparian areas and on floodplain terraces. Cattle grazing of valley slopes and terraces, and cultivation of lands along the valley crest and on fertile floodplain terraces in the valley bottom have altered or removed some native plant communities, increased soil erodability, and introduced weedy and undesirable agronomic plant species. Approximately 33 ha of river terrace and slopes within the LSA have been cleared for cultivation. River flow regulation by the Bennett Dam has also resulted in alterations to the vegetation along the Peace River. Transportation and utilities corridor developments (e.g., Highway 2, trails, roads, bridges, powerline alignments and other facilities) have affected vegetation in the LSA.

Construction of the transmission line, access roads, and headworks abutments has the potential to effect vegetation communities Vegetation will be removed along proposed rights-of-way prior to construction of roads. However, the majority of access road development will occur on pre-existing trails, and only a narrow area will be cleared for the transmission line right-of-way, which will also partially follow pre-existing trails.
The proposed alignment for the north access road avoids upland grassland communities and forested portions of the Hines Creek Valley. The south access road will use existing trails to approach Dunvegan Creek. West of the creek, the road cut will intersect aspen-shrub forest, slope shrublands, mixedwood forests, plus very small amounts of coniferous forest, and grassy to unvegetated slopes. The proposed boat ramp and immediate vicinity crosses mixedwood forests, some poplar-dominated stands and a small portion of coniferous forest. Removal of small amounts of each of these vegetation community types, which occur as a mosaic over the first approximately 2 km of near-shoreline forest upstream from the headworks, are not expected to significantly affect the vegetation resource.

It is expected that of 27.21 ha of land, or 0.71 percent of the total LSA (3807.13 ha) will be affected by construction. This includes 24.84 ha of native vegetation, plus 2.37 ha of non-native vegetation (i.e., disturbed, or cultivated lands).

Soils in the LSA are susceptible to erosion by both wind and water. Mitigation measures will be taken to prevent wind and water erosion of cleared areas during and after construction. A water management plan will be prepared for construction of the Project. There is some potential for increased erosion in some localized areas of the headpond shoreline, however it rated as not significant.

Construction of the road alignments will not result in the loss of any specific vegetation type in the LSA and the effects of construction on vegetation types and biodiversity are assessed as not significant. Mitigation measures to minimize effects on significant plant communities are part of good operating practices, and include minimizing the width of clearing and the use of existing rights-of-way wherever possible. Specific measures will be developed following the findings of the rare plant survey that will be carried out prior to construction. Other mitigative measures that will be used, as appropriate, include realignment or rerouting around special plant communities, shrub salvage and transplant, natural recovery, and the use of native seed mixes for reclamation. Given the small area affected by construction and the existence of other significant plant communities outside of the LSA, the effect of the Project on plant communities is assessed as not significant.

Where practical, all productive and unproductive harvestable merchantable timber will be salvaged from forested lands along proposed alignments, along the headpond, and in other construction zones in the LSA and sold. The use of pre-existing rights-of-way and the small amount of land expected to be cleared for the transmission line will result in a small amount of lost merchantable timber. The effects of the Project on merchantable timber are not significant.

Standard weed control measures will be employed to prevent importation and distribution of weeds, and to monitor and control weed spread in disturbed areas during construction and operations. Control methods may involve spraying, mowing, hand-scything or hand-pulling to control noxious or nuisance weeds. Exposed areas will be revegetated after construction to help eliminate the spread of potential weeds. The small-scale localized shoreline erosion expected to result from headpond creation is not expected to have any effect on weed introduction and spread.

During Project operations, vegetation along the headpond may be permanently or seasonally inundated. Based on the relatively small areas of vegetation that will be inundated, even during the 1:100 year flood event, and the presence of similar vegetation units in the LSA and RSA, the effect of headpond development and operations on vegetation and biodiversity is assessed as not significant. Glacier Power commits to undertaking additional detailed rare and significant plant community surveys.
of areas to be disturbed prior to construction. Should rare plants or special plant communities be observed, potential mitigation measures will include removal and transplanting of rare plants or communities affected.

Given the mitigation measures that will be implemented and the fact that the disturbed vegetation is not unique to this area, the effect of the Project on the soil, vegetation and forest resources VEC is rated as not significant.

**Wildlife**

The Project will minimally alter wildlife habitat, cause minimal wildlife disturbance, provide little restriction to habitat accessibility, offer little increase in vulnerability to predation and little change to inter- or intra-specific competition. As a result, the effects of the Project on wildlife are assessed as not significant.

The local study area supports a diverse and representative faunal community typical of the Dry Mixedwood and Peace Parkland ecoregions and the Boreal Forest Natural Region. Land use and associated human activity have reduced habitat suitability for many species, particularly large carnivores and avian species closely associated with either mature forest cover or large forest interior areas. The local and regional study areas provide potential seasonal and/or year-round habitat for approximately 44 species of mammals, 204 species of birds, seven species of reptiles and amphibians, and likely several thousands of invertebrate species.

Ecosection units were identified on the basis of slope, aspect, association with contemporary floodplain process, soils and vegetation. Five ecosection units were defined, including river island, river terrace, erosion slope-warm aspect, erosion slope-cool aspect, and shoreline. The ecosection units were further refined into broad vegetation ecosection subunits on the basis of vegetation classification and community types mapping produced. Fourteen broad vegetation ecosection subunits were defined, including willow flat; willow-herbaceous; beach-herbaceous; tall shrub; mixedwood forest; deciduous forest; coniferous forest; aspen-shrub transition; shrubland; aspen-grassland transition; grassland; unvegetated or mass wasting slope; cultivated; and, disturbed.

Generally, post-project effects are limited to the headpond inundation effects on nearshore habitats such as river islands and shoreline ecosection units along Peace River and into a small number of tributaries near the proposed headworks. Approximately 45 vertebrate wildlife species of the 175 wildlife species potentially occurring in the LSA have primary habitat associations closely linked to the riparian environments. None of these 45 species are considered “at risk”, either provincially or federally.

Permanent inundation of habitats in the shoreline and river island broad vegetation ecosection subunits ranges from 20 percent of total area available within the LSA under baseline condition for willow-herbaceous, to 90 percent for tall shrub. Elevated water levels causing permanent flooding of these habitats, which were previously seasonally flooded, will result in loss of those areas. However, seasonal flooding of previously drier habitats will result in a shift from drier habitat types (e.g., mature deciduous or mixedwood riparian forest) to seasonally flooded habitat types (e.g., tall shrub, willow-herbaceous, beach-herbaceous, willow flat), and largely equivalent riparian habitats will become re-established along the new wetted margins of the headpond. Similarly river island ecosections are also
predicted to re-establish in the upper headpond because of bedload deposition in this area over the long term.

Losses of drier habitat types, such as those newly subject to seasonal flooding under the post-project water regime and those altered by infrastructure construction are unlikely to be counterbalanced under processes similar to those described above. However, in terms of the amount of drier habitat types available under baseline conditions, losses will occur to a lesser degree than those experienced by the nearshore habitats. Residual environmental effect ratings of the loss and alteration of habitat types as a result of the Project are considered to be not significant.

The incorporation of fishways into the headworks is unlikely to have any material effect on wildlife or wildlife habitat, though it will help reduce effects on fish and hence species such as bald eagle, osprey and otter that prey on them.

Changes to the water velocities in the headpond and to the ice regime are not expected to result in negative effects on riparian mammals or other wildlife that may migrate across the river. To the extent smoother ice conditions develop on the headpond and more stable ice conditions develop downstream along the ice front, moose crossings may be somewhat improved by the Project. Decreased flow velocity upstream from the headworks may slightly facilitate wildlife crossing. Observations gathered from project wildlife surveys and consultation with local riverboat operators suggest that:

- the Peace River presently affords good opportunity for wildlife crossing during both frozen and open water conditions
- ice conditions created in the headpond area are likely to be used by wildlife for crossing, similar to conditions at present
- open water below Dunvegan is unlikely to present a barrier

In summary, post-project effects were evaluated for direct habitat loss and alteration, as well as for wildlife species including habitat fragmentation, wildlife disturbance, wildlife access to habitat, vulnerability to predation, hunting, accidents, and inter- and intra-specific competition. These evaluations resulted in identification of potential effects, many of which are temporary, associated with the construction phase. All of these are rated as not significant.

**Transportation**

The principal issues regarding the effect of the Project on transportation are increased fogging and icing on the Dunvegan Bridge and a reduction in the period of use of Shaftesbury Ferry. Mitigative measures in place for the fogging and icing, and options for addressing the Shaftesbury Ferry issue result in the effects of the Project on transportation being assessed as not significant.

The project site is located approximately 2 km west of the Dunvegan Bridge where Highway 2 crosses the Peace River. Highway 2 is a paved two-lane highway that connects the northern and southern halves of the Province of Alberta. On the north side of the Peace River, the project site is linked to Highway 2 by a road that is located on a combination of titled land, Crown Land, and municipal road allowances. On the south side of the river, the project site is linked to Highway 2 by a road that is located on a combination of titled and Crown Land. Traffic on Highway 2 is heavily influenced by trucks hauling logs and processed lumber.
Ice fog is a common occurrence in cold regions where there is a supply of water vapour and where vertical mixing of the air is limited. At the Dunvegan Bridge, fog events usually occur because of radiative cooling at night. Thus, extensive fog that could affect visibility on the bridge usually occurs early in clear mornings when the air temperature is at its daily minimum, relative humidity is at its daily maximum, and the conditions are completely calm.

Shaftesbury Crossing on the Peace River, at Highway 740 approximately 80 km downstream from the Project, is serviced by a ferry and an ice bridge. The capacity of the ferry is four to six passenger vehicles or two large trucks with a maximum capacity of 38 tons. The operating season of the ferry is subject to considerable variation. It is put into service each spring after ice breakup, and is removed each fall or winter prior to freeze-up. Timing of the ferry removal is determined by Alberta AIT using a combination of weather forecasts and ice conditions in the river. The operating season of the ice bridge is also highly variable and depends on ice conditions. The ice bridge is constructed by the maintenance contractor for AIT when the ice front has moved past the crossing. The ice bridge takes approximately 7 to 10 days to build up to a capacity of three tons when it is opened for vehicle traffic. During winter commercial truck traffic is prohibited from using the crossing.

Construction access to the Project will be from Highway 2 from both the north and south access roads. Upgrades are proposed to the existing intersections on Highway 2 to facilitate construction traffic including tractor-trailer traffic. Final design will incorporate results of consultation with AIT. Temporary construction signage will likely be installed in April 2008. Road upgrades to Highway 2 and the north and south access roads will likely be completed in the fall 2008. Construction signage and possible speed reductions will remain in place until the end of construction in 2011.

The traffic effects of the Project on Highway 2 will be greatest near the Project, specifically on Control Section (CS) 68, the section of Highway 2 that connects with the north and south access roads leading to the project site. The peak construction traffic effects on CS 68 from the Project from 2008 to 2011 are expected to result in temporary increases to the average annual daily traffic on Highway 2 of 4 percent in August and September 2008, 13 percent in August 2009, 11 percent in August 2010, and 8 percent in June 2011. Construction traffic effects during other months during construction will vary, dropping at times to zero from January to March when construction activities will be suspended. Concrete and gravel truck traffic is expected to peak at 100 vehicle movements per day each, while tractor-trailer traffic is expected to peak at 20 vehicle movements per day.

During operations the effect of traffic associated with the Project on traffic volumes nearby is expected to be minimal. The project facility will be operated on a 24-hour basis with three shifts per day. Two operators will be on duty for each shift. Traffic associated with these three shifts will total 12 vehicle movements per day. Some additional operations traffic will be generated by the contractors traveling to and from the site for regular maintenance activities. In addition, recreational users and boaters will use the new roads to access the new boat launch. Decommissioning activities will be similar to construction activities in terms of traffic flow to and from the site.

All hazardous goods associated with project construction and operations will be transported and stored according to current government regulations. Transport, storage and handling of all explosives will be in compliance with the regulations (Transportation of Dangerous Goods Act, Schedule 2: List 1) and by qualified persons. Glacier Power's employees will receive safe driver training, and will adhere to speed
limits and road traffic rules as outlined in the company's Environment, Health, and Safety Management System.

An analysis on the incremental effects of the Project on the likelihood of fogging and icing events at the Dunvegan Bridge found that post Project fogging and ice at the bridge is expected occur just over 27 percent of the time in January (compared to 22 percent pre-Project), 9.7 percent of the time in February (compared with zero percent pre-Project), and less than 5 percent of the time in March (compared to below 3 percent pre-Project conditions). Glacier Power, in consultation with AIT, has committed to take steps to minimize the potential for collisions in fog and ice conditions at Dunvegan Bridge. Such steps may include the installation of lighting at or on the bridge, as well as the installation of advanced warning signs (such as Telvent or similar) indicating when hazardous conditions exist on the bridge. It should be noted that AIT has plans to rehabilitate the Dunvegan Bridge deck within the next three years and also plans to install improved lighting on the bridge itself within the next year. Currently, only the northern approach to the bridge has lighting.

Based on extensive ice-modeling, it is estimated the Project will reduce the ice bridge season at the Shaftesbury Crossing by an average of two to three weeks annually during the operations phase. Over the last 25 years, operating days of the ferry have ranged from approximately 195 to 275 annually. Although official data are not available for the ice bridge, anecdotal information from local residents and results from ice modeling indicate that operating days for the ice bridge likely range from 0 to 120 days annually. Therefore, the expected decrease of two to three weeks falls within the range of existing variability in the crossing availability.

Several options to mitigate the effects of the Project on the Shaftesbury Crossing have been discussed with AIT, and presented to a local stakeholder group, the Concerned Residents for Ongoing Service at Shaftesbury (CROSS). The preferred option is one considering Glacier Power’s advocacy and partial funding of the replacement and optimization of the ferry or ferry shoreline infrastructure. Replacement of the ferry with an improved design better able to withstand flowing ice (such as those used in the Northwest Territories) and improvements to the ferry docking infrastructure to ease the removal and replacement of the ferry, have the potential to more than offset the two- to three-week delay in ice bridge construction, and provide year-round benefits to all ferry users as well. Glacier Power has had conceptual discussions with AIT regarding this ferry upgrade option, and their initial response has been supportive.

The Project will not have any effects on downstream flow conditions or channel scour in the vicinity of the Dunvegan Bridge, and is not expected to affect the stability of bridge piers or abutments. Neither headpond formation nor the proposed alignment of the south access road is expected to have any effect on the stability of the Highway 2 bridge at Dunvegan. The Project will have no negative effects on river crossings downstream from the Shaftesbury location, including those at the Town of Peace River, Diashowa-Marubeni or La Crete. The formation of the ice cover at the Diashowa-Marubeni and Town of Peace River bridges will be delayed each year, and while freeze-up water levels are expected to be marginally higher (0.5 m) than present, the overall reduction in the likelihood of secondary consolidations post-Project will reduce the likelihood of freeze-up ice jams and related extreme high water levels at those crossings.
The overall effect of project-related activities on transportation in the regional study area is expected to be negative during construction, but not significant. Depending on the traffic mitigation measures that will be executed in cooperation with AIT, the road infrastructure at the Dunvegan Bridge may be improved. The Project will reduce the ice bridge and ferry season at Shaftesbury, however the duration of the reduction is short, and mitigation acceptable to AIT has been proposed. As a result of the foregoing, effects of the Project on the transportation VEC are rated not significant.

**Land and Water Use**

Glacier Power has been in discussion with local land users who will be affected by the Project and have received permission to use the land from all but two, neither of whom is opposed to the Project. Boaters will be able to pass the headworks using a boat lock and Glacier Power will construct a new boat ramp for public access. As a result, the effects of the Project on land and water use are assessed as not significant to positive.

The project site is in the M.D. of Fairview immediately adjacent to the Saddle Hills County, and Birch Hills County. Land and water use activities that currently take place within the vicinity of the Project site include:

- agriculture (farming and market gardening) and livestock grazing
- commercial guide outfitting
- trapping
- non-commercial recreation activities (e.g., boating, canoeing, camping, hiking, horseback riding, and snowmobiling)
- tourism and site interpretation (visitors to the Dunvegan Historic Site and park, eco-tourism)
- gravel and sand quarrying

Current disposition of the land adjacent to the Project site includes:

- leased Crown Land (agriculture, grazing, existing highways and roads)
- provincial park land (Dunvegan Provincial Park and Historic Site)
- private landowners (agriculture, home owners, market gardens/commercial greenhouses)
- municipal land

The Duncan’s Indian Reserve 151A is located north and east of the project site.

Although there are numerous oil and gas leases in the area, none are within the boundaries of the assessment area. Two natural gas pipelines cross the Peace River immediately downstream of the project site. Canadian Forest Products’ Forest Management Agreement is approximately 26 km west of the project site. There are no known mineral claims or leases near the project site, and exploration and development of mineral resources is strictly controlled within the valley walls of the Peace River. There are many sand and gravel operations in the area, most of which are on the upland areas beyond the river valley walls. A gravel extraction site owned by the Dunvegan Historic Society is on the south side of the river valley near the Highway 2 bridge, and a former extraction site is located on the Hines Creek fan, within the Peace River floodplain.
The M.D. of Fairview operates a water intake system from the Peace River for domestic water use located approximately 10 km downstream of the proposed Project site.

Dunvegan Provincial Park and Historic Site are on the north side of Peace River, where the Highway 2 Bridge crosses the river. Visitors come to the park and historic site year round. The Maples day use area, west of Dunvegan Provincial Park, is also used year-round by tourists and area residents. The Dunvegan West Wildland Park, designated under Alberta’s Special Places 2000 Program, is located on the south side of the river and extends in discontinuous pieces west from the Dunvegan Provincial Park to the Alberta-British Columbia border. Two small sections of the Dunvegan West Wildland Park border on the headpond area. The Project was under regulatory review during the establishment of the Dunvegan West Wildland Park, and Glacier Power was represented as a stakeholder on the committee charged with the establishment and definition of the Dunvegan Park. As such, the boundaries and park designation took place in consideration of the proposed Project and all of its components.

On the north side of the Peace River, through the project area and continuing along the length of the river, the area is designated ungulate wintering and calving range with special conditions noted for resource development.

Boating patterns are dependent upon the type of watercraft being used. The Peace River is highly accessible both upstream and downstream of the local Project area. Jet boats represent the main form of boating, but canoeing is also popular. The Peace River is not recognized as a good fishing destination, although recreationists will partake in fishing activities on a casual basis while travelling along the river. River access for hunting is highly regarded by both the local fish and game association and guide outfitters in the area. Spring season hunting for black bear and fall season hunting for deer and moose are the primary hunting activities along the river. Commercial recreation activities along the Peace River within the Project boundaries include guided tours and eco-tourism. Snowmobiling and ATV use are random activities.

Post-project headpond water levels will be near historical high water levels, and are not expected to have any significant effects on park areas, vegetation, or wildlife resources.

Glacier Power has obtained permission from private landowners who are directly affected by the access roads and transmission line components of the Project. The headworks components will be located on Crown Land. There is only one privately owned property directly affected by the headpond, approximately 9 km upstream of the headworks. The property is presently unoccupied. Inundation at the property is expected to be confined to the existing shoreline areas below the top of bank. Glacier has had an ongoing dialogue with the owners of this property and they are not opposed to the Project.

Jurisdiction of the M.D. of Fairview includes all of components of the Project on the north bank, and extends across the river to the south bank. The south abutment of the headworks, along with portions of the access road and transmission line, will lie within the Saddle Hills County. Other portions of the south access road and transmission line lie within Birch Hills County. Glacier Power has obtained a land use permit from the M.D. of Fairview. Discussions regarding development permits have been initiated with the Saddle Hills County and Birch Hills County.
Construction traffic will interact with users of the recreational sites on the north bank; however, this interaction will be short term and will cease once construction is complete. Traffic related to facility operations will consist of 12 to 20 truck trips per day, primarily on the south side, and will not significantly affect recreational use of these areas.

Navigability of the river will be maintained using a boat lock, to be incorporated next to the south bank of the river. Boaters wishing to travel upstream of the facility will be able to use a new boat ramp located upstream of the headworks. Parking facilities will be provided for boat trailers and vehicles near the boat ramp. Dual safety booms, signs, and navigational aids will be installed upstream and downstream of the headworks to guide boaters to the navigation lock and boat ramp.

The Project is anticipated to have effects ranging from not significant to positive residual environmental effects on land and water uses.

**Visual Resources**

The Project has been designed to be low profile to minimize environmental, as well as visual and aesthetic, effects. Simulations of the Project infrastructure, including the headworks, access roads and transmission line, were created to facilitate the visualization of the Project.

Visual effects of the Project during construction will result from clearing of road and transmission line right-of-ways, use of laydown areas, presence of barges and heavy equipment, and instream works. These effects will be temporary during the four-year construction phase, primarily during spring and fall. During operations, the Project will be visible to motorists driving Highway 2 on the south side of the river, paddlers and jet boaters using the river, visitors to the Dunvegan Historic Park and Maples Recreation Area, and residents in the area. The Project is not visible to Highway 2 travelers on the north side. The transmission line is visible to southbound travelers approaching the Bridge from the north, although most of the transmission line follows existing trails, so the incremental effect of the poles will be minimized.

The Project components blend into the river valley causing minimal visual impact. This design approach has led to a Project that is integrated with the existing natural and cultural environments and which maintains the character of key views. The effects of the Project on the viewscape of the area is assessed as not significant.

**Historical Resources**

Mitigation measures in place for avoiding or, in cases of disturbance, recording the heritage resource sites affected by the Project will result in there being no significant effects. The Project will not interact with a local area of traditional land use.

Historical Resources Impact Assessments were carried out for the Project in 2000 and 2004. A Traditional Knowledge and Land Use Effects Assessment of the Project was conducted in 2006. After the 2002 joint EUB and NRCB hearing, the panel decision document noted that effects of the Project on downstream Aboriginal communities such as Paddle Prairie (350 km), Fort Smith and Fort Resolution (1000 km) would be insignificant given the design and scale of the Project. The Project and its downstream environmental effects have not changed since the previous application in 2000.
Twenty-five historical resource sites were identified within the LSA during the archaeological field reconnaissance. These consist of 22 precontact sites and three historic period sites. Eleven of the precontact and all three of the historic sites are undisturbed. The remainder of the pre-contact sites have been disturbed by either agricultural practices (N = 7) or previous development (N = 4). Twenty-one of the sites are not in direct conflict with the development. One site could be subject to erosion and flooding and may require some mitigation. This site is currently undisturbed and is of sufficient historical resource value to warrant either avoidance or further study. Two sites with high and moderate historical resource values respectively are adjacent to proposed access roads. These sites will be avoided by the Project. Because of the uncertain effects of erosion, an additional two currently undisturbed sites with moderate to high historical resource values will be monitored during construction and operations.

In the unlikely event of unanticipated discovery of historical resources during construction-related activities, work will cease in the immediate vicinity of the discovery pending notification of the provincial regulator and approval for resumption of work. To assist in unanticipated site discovery, an education program will be delivered by an archaeologist to environmental monitors.

During the field assessment for paleontological resources, in situ fossils (Ostrea) were found at the base of the sandstone approximately 3.0 kilometres upstream. Float fossil finds of mussel coquinas were common whereas unionid shell fragments were observed on the talus slopes. No further study is required relative to these finds. Strata on the south side of Peace River in the area of the south access road are poorly exposed and will be monitored during road construction.

The Duncan’s First Nations identified a medicinal or sacred plant area near the confluences of Hines and Dunvegan Creeks. The north access road will cross the lower portion of Hines Creek but is not expected to interact with the this traditional land use area. Glacier Power will continue to consult with the Duncan’s First Nations regarding activities that may affect their traditional land use.

After mitigation, the effect on the historical resources within the proposed development zones will be not significant. While site contexts will be destroyed and some of the site contents will be lost, the recommended mitigation measures of recording the sites and their contents and collecting artifacts are acceptable to Alberta Community Development. The effect will also be positive in that the sites have been recorded and added to the provincial data base, and scientific data will be retrieved as a result of mitigative studies.

Health and Safety

There are no predicted potential interactions between human health and project-related emissions. During consultation for the Project, one landowner on the north bank noted a concern about dust emissions during construction. Dust control measures will be used to mitigate this concern. During project operations, the turbines in the powerhouse structure will create mechanical noise; however, the turbines will be submerged and encased in concrete, and it is not anticipated that this noise will be audible outside of the immediate vicinity of the powerhouse. The sound of the water moving out of the powerhouse through the tailrace or over the spillway is expected to be louder than mechanical noise from the turbines. The headpond will not have any effects on water quality that may subsequently affect fish health or warrant fish consumption concerns.
Safety issues could occur during all phases of the Project. During construction and decommissioning, accidents or malfunctions, while unlikely, have the potential to harm both workers and the public. Construction of the access roads, transmission line and headworks facility will be contracted to a successful bidder; however, the contractor will be required to meet all the criteria, guidelines, and requirements outlined in the Emergency Response Plan and in Glacier Power's parent company Canadian Hydro’s EHSMS Policies and Procedures Manual. As a result, the potential for accidents and malfunctions during construction decommissioning will be extremely low.

During operation, the headworks will present safety issues for both the general public and plant operators. The main concern with respect to public safety will be boaters on the Peace River in the vicinity of the powerhouse and spillway. The powerhouse intakes are near the bottom of the river; the upper portion of the water column above the intake will contain relatively calm water. The powerhouse presents a less hazardous situation to recreational boaters than the spillway. Spillways present safety hazards to boaters should they go over and get caught in the turbulence on the downstream side. These hazards can be mitigated to a safe level, provided the operators and boaters use common sense and respect the safety and navigational aids put in place. Glacier Power has included safety booms in the project design to minimize the potential for boaters to come in contact with the powerhouse and weir from both the upstream and downstream sides of the headworks.

Glacier Power further commits to developing a thorough boater safety, rescue and education program specifically designed for the Project. The operators of the plant will undergo first aid and swift water rescue training, and will demonstrate and conduct safety education programs at the project site. Glacier Power will have equipment in place at the plant to effectively execute a rescue.

During consultation on the Project, area residents and stakeholders also raised safety concerns related to increased fog and ice formation at the Highway 2 Bridge at Dunvegan. This issue and related mitigation are addressed above in the discussion on transportation.

In the unlikely event of a complete failure of the headworks structure, it is expected that the maximum crest of water to result downstream would be 3.3 m. This would be contained within the present river banks, and would attenuate to a 1.5 m high crest at the Town of Peace River, where it would be similar to the daily water-level fluctuations presently experienced. No residents or landowners along the Peace River downstream of the headworks site will be affected as they are all situated above the river bank. If there are any boaters downstream of the headworks site at the time of a complete facility failure, they could be affected (i.e., swamped or overturned depending on the type of watercraft being used).

As a result of the Emergency Response Plan, Environment Health and Safety Management Plan, and the training outlined above, no significant adverse effects on human health and safety are predicted as a result of Project-related activities.

**Socio-economic**

The total construction expenditure for the Project is estimated at $319 million in 2004 dollars (or $344 million in inflation-adjusted 2008 dollars). The Project represents a substantial contribution of almost one-quarter of the $1.4 billion total major project expenditures in the RSA. Viewed in the context of its contribution to economic activity beyond the geographic boundaries of the County of...
Grande Prairie, the Project accounts for three-quarters of $446 million in major project expenditures. The Project is a substantial industrial facility in M.D. of Fairview, an area that has traditionally seen relatively limited investment. In a regional context, the Project counterbalances the main flow of investment, which tends to be concentrated on Grande Prairie and its surrounding area.

An estimated 10.6 percent of the total expenditure will likely accrue to the region and 41.6 percent of the total to the rest of Alberta. The GDP and labour income effect of the Project is estimated at $277 million and $186 million, respectively.

The labour force in the RSA was estimated at approximately 50,000 persons in 2001. Industries employing that the largest portion of the RSA labour force are as follows:

- retail and wholesale trade (15 percent)
- health, education and social services (14 percent)
- agriculture and other resource-based industries, including forestry (10 percent)
- construction (9 percent)
- mining and oil and gas extraction (9 percent)

The construction phase is expected to need approximately 500 person years of work onsite. Based on this, the onsite construction work force for the Project is estimated to average 125 workers over the four construction seasons and to peak in years two and three at approximately 300 workers during the third quarter. The workers employed on the Project will come from a range of construction trades, with the key trades including carpenters concrete finishers, iron workers, heavy equipment operators, and power system electricians.

The Project will be competing for construction workers with other projects in the region and elsewhere in the province. Glacier Power’s parent company Canadian Hydro encourages hiring of local workers and contractors where they are available in sufficient quantity and quality and at competitive prices. In line with this general policy, the contractor managing the Project will hire locally where possible and the regional construction labour force of 4800 would be large enough to supply most of the workers required for the Project under normal circumstances. However, the tightness of the regional labour market suggests that a good number of the workers employed on the Project will likely come from elsewhere in the province or beyond. It is likely that a construction camp would be required to house workers from outside the region. Several local landowners have indicated an interest in hosting a construction camp.

Given the peak construction work force of 300, the peak population effect during construction will represent a temporary 0.3 percent increase in the RSA population. Viewed in relation to the Town of Fairview, the peak population effect associated with the construction phase of the Project would represent a temporary increase of about 9 percent.

In addition to bringing benefits to the RSA by way of employment, income to individuals and businesses, and taxes, the construction phase of the Project will also likely make some demands on local infrastructure, including housing, and public service providers, including providers of emergency services and health services. The Project’s effect on fire and rescue, emergency response, policing,
and health care services during construction has been assessed, and is expected to be within all departments’ response capabilities.

During regular operations, the Project will directly employ six full-time operators. Glacier Power anticipates operators will be hired and trained from communities in the region. The total direct, indirect, and induced employment is estimated at 19 person-years annually.

Annual operations costs of the Project are expected to average $3.8 million, consisting of $5.0 million in operating costs and a $1.2 million offsetting income stream related to the AESO projections on Project positive contribution to system-wide reduced transmission losses. About 38 percent of the operating expenditure accrues to the region, mostly in the form of wage income and taxes. An additional one-quarter of the operations expenditure accrues to the rest of Alberta.

The fiscal effects of the Project will be felt in the M.D. of Fairview, where the headworks are located. The municipal taxation that the Project may pay is subject to uncertainty, as both the actual assessment of the facility and the tax rates in effect when it becomes operational are unknown. A very preliminary estimate of the Project’s municipal tax payment is $1.4 million per year. This estimate uses the proposed 2006 tax rates as a proxy for the rates that may be in effect when the Project becomes part of the assessment base. In view of the size of the Project and the assessment growth that it implies for the County, the mill rate may well change and the actual property tax payment may be lower.

The operations phase of the Project could involve a maximum population increase of 32 people (6 full time operations staff, 4 indirect support jobs, each with an average size family), assuming Glacier is unable to meet its goal of hiring locally and it is necessary to bring in operations staff from outside the region. This population effect would be imperceptible within the RSA, and would represent an increase of 1 percent to the population of Fairview. This potential population increase is expected to result in virtually imperceptible increase the demand for services in the RSA, notably in the areas of education, health services and emergency services.

The Project will decrease the ferry and ice bridge operating season at Shaftesbury by an estimated average of two to three weeks. This reduction will affect people living south of the Peace River who use the ferry or ice bridge to gain access to services in Grimshaw, Fairview and Peace River. The reduction is within the current range of variability of the crossing availability at Shaftesbury. Nevertheless, Glacier Power is engaged in ongoing consultation with the local stakeholder group CROSS, as well as AIT, to develop suitable mitigation measures to address this decrease, as described above in the transportation section.

Although unlikely, malfunctions, accidents, and other unplanned events may occur at any time during the construction and operations phases of the Project. Except for the loss of human life, the effects of any accidental event are expected to be temporary. From a socio-economic point of view, a malfunction or accident occurrence with temporary consequences may be either deleterious or beneficial, depending on whether or not the costs outweigh the benefits.

Overall the Project will have positive economic effects on employment and income. It will significantly increase the assessment base of the M.D. of Fairview, and will have a positive effect on the fiscal position of the Province through corporate and personal tax payments. The Project will have a positive
effect on the efficiency of Alberta’s interconnected transmission grid, without the generation of pollution externalities.

**Cumulative Effects Assessment**

The Baseline Case placed the Project in the context of existing and approved projects that define the existing conditions. The Application Case assessed the effects of the Project on the Baseline Case. The Cumulative Effects Assessment looks at the contribution of the Project to the effects of future projects in the area. Future projects that have been announced or are reasonably expected to occur and which the Dunvegan Project has the potential to interact cumulatively with are new borrow pits, the expansion of the Dunvegan Historic Site, the expansion of transportation and utility corridors, and the development of B.C. Hydro’s Site C at Taylor. If the Project has a measurable effect on a VEC and the effect will act in a cumulative fashion with other past, present or future projects, cumulative effects are assessed.

B.C. Hydro’s Site C has been announced but there is no project-specific information available. The creation of a reservoir behind the dam would result in effects to ice cover, sedimentation, wildlife, vegetation and fisheries that would act cumulatively with the effects of the Dunvegan Project, but the extent of the effects cannot be assessed at the present time. New borrow pits, the expansion of the Dunvegan Historic Site, and the expansion of transportation and utility corridors have the potential to act cumulatively with Project effects on sedimentation, vegetation, wildlife, and fisheries. Assuming standard good practice is followed, the contribution of the Dunvegan Project to the effects of these other projects will be imperceptible and they are assessed as not significant.

**Environmental Management**

Glacier Power’s parent company Canadian Hydro is a developer of green, renewable energy and is committed to protecting the environment throughout all phases of the Project. Accordingly, Canadian Hydro has traditionally taken a very active, hands-on role with the design and development of its hydroelectric projects. Canadian Hydro has developed an Environment Health and Safety Management System (EHSMS) based on their corporate Sustainable Development Policy. The EHSMS incorporates environmental, health and safety policies and practices for each of Canadian Hydro’s operating plants. The Project will be included in that program.

The Environmental Management Program (EMP) for the Dunvegan Project will be developed in full during the detailed design phase of the Project and will be presented to the relevant agencies for approval before initiating any construction activity. The EMP involves development of the Environmental Protection Plan (EPP), the Fisheries Mitigation and Compensation Plan, and the Monitoring Plan. The EMP focuses on the construction aspects of the proposed project, but also introduces environmental management aspects related to design, commissioning, operations, and decommissioning.

The EPP will be prepared following project approvals during the detailed engineering phase of development, with three main elements:

- design and construction management plan
- environmental protection measures
• emergency response and contingency procedures.

The EPP presents standard, good environmental practices and the environmental protection requirements of provincial and federal environmental departments. It outlines the procedures, organization and instructions to provide project personnel with an understanding and effective means of implementing environmental protection procedures for both routine activities and unplanned events associated with the proposed site development work. The EPP will form part of the construction contract, and will be written in construction-specific format to be read with engineering drawings where specific mitigation measures will be applied.

Emergency response and contingency procedures, outlining key contacts, communications systems and reporting requirements for all potentially hazardous conditions, including spills, seismic events, headworks failure, rescues, and medical emergencies will be documented and in place before construction.

Regardless of the low potential for and minimal downstream effects resulting from a failure of the headworks, Glacier Power will implement a notification system through consultation with Alberta Environment. The basis for the notification system is laid out in the Canadian Dam Association and Alberta Environment dam safety guidelines. Other hydroelectric and irrigation system dams in the province have similar emergency response plans; as such, there is a significant knowledge based on the operation of smaller and larger projects than Dunvegan.

The Fisheries Mitigation and Compensation Plan (FMCP) will be prepared to address the final mitigation and compensation commitments Glacier Power will make to regulatory agencies. It will describe the quality and quantity of habitat potentially affected by the project development, the measures being implemented at the design, construction, and operations phases to mitigate the loss or alteration of habitat (including water quality), and the details of any compensation measures, including timelines for completion.

Glacier Power will develop a monitoring plan to be implemented during the operations phase to verify the predicted effects of the Project on the environment, and the success of mitigation and compensation measures that are implemented. A Fisheries Monitoring Plan has been submitted as a part of this EIA.

Glacier Power and its parent company Canadian Hydro have over 15 years of experience designing, constructing and operating environmentally and economically sound hydroelectric projects across Canada. It is Canadian Hydro’s corporate goal to develop low-impact renewable energy projects, and as such effective environmental management and environmental protection is a top priority for the company.

**Public and Aboriginal Consultation Program**

Glacier Power implemented the Public and Aboriginal Consultation Programs in 1999 before submitting the 2000 EIA and application, and carried those programs through to the public hearings in 2002. Since that time Glacier Power has carried on with the consultation program throughout the current EIA and application process. As a result, Glacier Power has built a substantial consultation information base and developed an in-depth understanding of public and Aboriginal concerns. Glacier Power has made
significant progress towards resolving concerns expressed by the public and First Nations, and will continue to work to address those concerns throughout the project development process.

The objectives of the consultation program are to identify, contact, inform and obtain feedback from the general public, local stakeholders and Aboriginal groups who might have suggestions or concerns about the Project, and to work with the parties to resolve concerns where they are identified. To meet these objectives, Glacier Power has been in contact with and received input from parties from the Bennett Dam to the Peace-Athabasca Delta, including:

- the general public in the project development area
- all landowners (private and Crown Land tenures) within 2 km of project infrastructure
- interested parties (those individuals, groups or organizations that have expressed interest or concerns about the project)
- Towns and Municipalities in the area roughly bounded by Taylor, British Columbia, and Fairview, Town of Peace River and Grande Prairie, Alberta
- Provincial government (Alberta and British Columbia) and federal government agencies
- B.C. Hydro
- First Nations and Métis communities

Consultation for both the 2000 and present EIA and application was implemented through:

- formal public notices in local newspapers of the October 1999 and the July 2004 draft and final EIA Report Terms of Reference issued by Alberta Environment
- open houses in community centres near the project site
- newsletters sent out to interested parties, land owners, Town and Municipal administrations, and Aboriginal communities
- a project-dedicated web site providing quick and easy access to project updates and documents
- formal public notices in local newspapers at the time of the 2000 and the present EIA and application submissions
- distribution of EIA and Application materials at libraries, town and municipal offices and provincial buildings
- presentation, information sessions and workshops with special interest groups
- meetings, and e-mail and phone communications with federal, provincial and municipal government and nearby towns administrations levels, as well as stakeholder groups and landowners
A full record of consultation activities for the present EIA and application has been compiled in an electronic data base.

The results of the public consultation program indicate very positive public support for the Project. Over the course of Glacier Power's public consultation program, the most common concerns raised by stakeholders were related to the topics of ice formation and break-up, fisheries, sediment transport and deposition, fog and bridge deck icing, and recreation and navigation. Glacier Power has studied each of these issues and the results are incorporated throughout the EIA document.

Land owners within 2 km of the project infrastructure were contacted by mail in September 2005, and directly via telephone on May 2006. Sixty-eight land parcels were identified during that process, although project infrastructure and the headpond potentially affects only four landowners and five leaseholders. Each of these individuals or organizations have been informed of the Project and in most cases agreements with them have been reached. Formal agreements have not yet been signed with two landowners, however discussions are ongoing to ensure their concerns are addressed, and neither party has any objections to the Project.

Glacier Power has been consulting with the Town of Peace River since 1999. Subsequent to the 2002 joint EUB-NRCB hearing, at which the Town opposed the project citing concerns about ice-related flooding, Glacier and the Town have continued their discussions. Both Glacier and the Town have made significant progress in understanding the potential effects of the Project on ice-related flooding concerns at the Town. Glacier Power and the Town have signed an “Agreement in Principle”, under which Glacier Power will help the Town to identify and address infrastructure vulnerabilities pertinent to flooding risks. The Agreement in Principle includes finalizing a security agreement for payment of funds. Glacier Power will work with the Town to develop a terms of reference for an engineering study to assess current flood-related infrastructure concerns, in particular stormwater outfalls and the groundwater issues in Lower West Peace, as these relate most directly to the potential effects of the Project. Glacier Power will pay for the execution of that study, and will subsequently provide funding to the Town for implementing the flood mitigation measures.

Consultation with BC Hydro has been ongoing since 2000, with discussions primarily focused around the potential changes to the Peace River ice regime and the subsequent effects those changes may have on the control flow criteria enforced by the Joint Task Force on Peace Ice (JTF). During the 2002 joint EUB-NRCB hearing, BC Hydro neither supported nor opposed the Project. Subsequent to the 2002 hearing, Glacier Power, BC Hydro, and AENV began a rigorous winter ice data collection program to improve the data base from which to consider potential changes to control flow criteria, and from which to calibrate ice models. Through the ice data collection program, and BC Hydro’s participation in the PRICE model calibration, Glacier has developed a very good and open working relationship with BC Hydro. Glacier Power has made recommendations regarding ice management and post-Dunvegan flow control criteria that would mitigate potential effects of the Project on the duration of flow controls for BC Hydro. The acceptability of those recommendations to the JTF will to some extent determine the effects of the Project on BC Hydro. As such, BC Hydro has not yet expressed either support for or opposition to the Project.

CROSS is a stakeholder group formed with the purpose of participating in the review of the Dunvegan Project with the goal of maintaining the status quo in terms of the ability to cross the Peace River at Shaftesbury. Thus any change to the ice bridge operation is considered by CROSS to represent an
unacceptable effect on the community. CROSS has retained legal counsel, and has at Glacier Power’s expense retained the services of an ice expert (Mr. Rick Carson, P.Eng.) to assist in the interpretation of the PRICE model and its outputs. CROSS was invited to, and participated in, all five technical ice modeling workshops.

In July 2004, Glacier Power proposed a travel-cost compensation package to address the potential two to three week reduction in the ability to cross the river at Shaftesbury. This was rejected by Ms. Carolyn Chenard on behalf of her group. In July 2006, Glacier Power proposed a possible solution to the Shaftesbury crossing issue: a public-private partnership that would see Glacier Power contribute funding to AIT to accelerate the pending replacement of the current ferry at Shaftesbury with an improved ferry or shore infrastructure to extend ferry operation into the ice season and offset the two to three week reduction in ice bridge availability. Glacier Power has received positive feedback on this concept from AIT, but at the time of writing has not heard feedback from CROSS on this proposal. Glacier Power will continue to communicate regularly with CROSS to address their concerns in a reasonable, and timely manner.

Other stakeholder groups consulted include the Friends of the Peace, the Pembina Institute, Trout Unlimited, river user groups (Grande Prairie River Rats and Peace River Boaters Association), the District of Taylor, British Columbia, and water licensees upstream of the Project in British Columbia.

Consultation with Federal, Provincial, and Municipal governments has been ongoing throughout the Project. DFO has been involved continuously in the review of the Project since 2000. DFO involvement has focused primarily on the design of fisheries related studies, and of the fish passage facilities. During the physical hydraulic modeling program, which extended roughly from 2002 through 2005, DFO participated in reviews of modeling reports, attended model demonstrations, and collaborated on strategies to improve the fish passage design. DFO has also worked with Glacier to refine and improve its Habitat No Net Loss Plan, and its Fish Monitoring Plan.

On a provincial level, Alberta Sustainable Resource Development was also very involved in the review and design of fish passage facilities and study design along with DFO. Alberta Environment, River Engineering Branch has actively participated in all five technical ice modeling workshops, and in three years of winter ice data collection. Glacier Power has meet with Alberta Infrastructure and Transportation several times to discuss issues pertaining to the Highway 2 Bridge at Dunvegan, and the Shaftesbury Crossing.

Regular update newsletters have also been sent to Towns and Municipal Districts since 2003.

In June and July 2006, Glacier Power contacted, met with, or made a presentation to many Towns and Municipal Districts in the regional study area. Open houses held in 2006 in the towns of Wanham, Fairview, and Peace River saw representatives from the host towns as well as the towns of Rycroft, Spirit River, and Grimshaw in attendance. Apart from the Town of Peace River, consultation with which is described separately above and who have not yet taken a formal position, general support for the Project was expressed by all, and no objections were expressed.

The Aboriginal Consultation Program, initiated during the 2000 EIA and Application, has continued throughout the present application in 2006. The list of First Nations and Métis groups notified of the Project includes communities well upstream and downstream from potential effects of the Project,
although as noted in the Joint Panel’s decision report (March 2003) after the 2000 Application, effects on downstream communities such as Paddle Prairie (350 km away), Fort Smith and Fort Resolution (1000 km away or more) would be insignificant given the design and scale of the Project.

After submission of the 2000 application, the First Nations and Métis groups who indicated an interest in further information and consultation with respect to the Project were the Duncan’s First Nations (a member of the Western Cree Tribal Council and the closest reserve to the Project), the Mikisew Cree First Nation (in the Peace-Athabasca Delta), the Athabasca Chipewyan First Nation (in the Peace-Athabasca Delta), and the Paddle Prairie Métis Settlement. Many of the actions taken to consult with these First Nations and Métis groups resulted in the creation of agreements defining the long-term relationships, which continue to be upheld through the present application process.

An MOU was signed with the Duncan’s First Nation in October 2002, defining employment opportunities for the First Nation, as well as allocating funding for a traditional land use study, to be conducted by the Duncan’s First Nation. Glacier Power has maintained contact with the Duncan’s First Nation, and both parties continue to honour the MOU. Consultation with the MCFN and ACFN during the initial application process resulted in Glacier Power’s funding of independent reviews of the EIA, and subsequent withdrawal of objections to the Project by both groups prior to the 2002 hearing.

Each of the First Nations groups initially contacted during the 2000 application process has been kept informed of the progress of the present application regardless of their participation or position in the 2002 Hearing. Responses to the draft Terms of Reference in March 2004 were received from the MCFN Industry Relations Corporation, the ACFN Industry Relations Corporation, and the Kee Tas Kee Now Tribal Council (Treaty 8). These groups have been sent subsequent newsletters and letters offering to meet from Glacier Power, as were all the other First Nations and Métis communities. The only groups to respond to Glacier Power’s invitations to consult have come from the Duncan’s First Nation and the Mikisew Cree First Nation.

Glacier Power met with the Duncan’s First Nation in Fairview in July 2006, at which time the Duncan’s First Nation expressed their interest in seeing the Project proceed and gave full support to the Project. Based on consultation to date with the MCFN, it is understood that they will once again request an independent technical review of the EIA and application documents when they are submitted. Glacier Power expects that the review will be similar in scope and outcome as the review done in 2002, as the Project and its environmental effects with respect to the Peace Athabasca Delta have not changed. Although Glacier Power has not had a response from the ACFN to the letters, e-mail, or telephone messages left, Glacier Power expects and is fully prepared to work with the ACFN to honour the spirit of the MOU signed with them in 2002.

Glacier Power has made a concerted effort to inform the public, First Nations and Métis about the Project and to invite and respond to comments. Glacier Power understands that consultation is an ongoing process and intends to continue consultation throughout the development of the Project. Glacier Power is actively working with special interest groups, such as the Town of Peace River, CROSS, and BC Hydro to address and resolve their issues and concerns. Glacier Power is also continuing to work to facilitate review of Project materials by interested or potentially-affected First Nations groups. Although Glacier Power has made significant progress to inform, consult with and mitigate concerns raised by these groups, many have expressed a desire to review the formal EIA and applications before any final solutions or agreements can be reached.
In general, local and regional support for the Project is very strong. Many local residents are excited about the economic and labour benefits, and about the appropriate use of energy in the Peace River for long-term, stable, green power generation in northwestern Alberta.

**Summary of Environmental Effects**

Table ES-1 summarizes the key environmental issues associated with the Project and the mitigation or management approaches Glacier Power is following to address these issues.

<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>Effect</th>
<th>Mitigation/Management Approach</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in the ice regime of the Peace River</td>
<td>Downstream flooding in the Town of Peace River</td>
<td>Glacier's agreement with Town of Peace River provides for study and funding of engineering solutions to mitigate groundwater flooding.</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Reduction in the use of the ice bridge at Shaftesbury Crossing</td>
<td>Glacier is working with AIT to advance the replacement and improvement of the Ferry to increasing its annual operating season.</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Increased fogging and icing on Dunvegan Bridge</td>
<td>Installation of advanced warning signage (such as Telvent, or similar) indicating when hazardous conditions exist on the bridge.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Increased sedimentation in the headpond from erosion and changed river regime</td>
<td>Degradation of water quality</td>
<td>Erosion control methods during construction. Increased sedimentation from the project will be only a small proportion of the existing sediment load of the Peace River.</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Degradation of fish habitat</td>
<td>As above. Most species are adaptable to increased sedimentation. No Net Loss Plan for fish habitat has been developed in consultation with DFO and ASRD, however, replacement of like-for-like walleye habitat affected by sedimentation is not possible in the project area.</td>
<td>Significant for some local fish populations Not significant for regional fish populations</td>
</tr>
<tr>
<td>Presence of the headworks affecting fish passage</td>
<td>Fish movements are blocked</td>
<td>Provision of Fishways will allow adults of most species (fish greater than 150 mm in length) to move upstream.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Environmental Issue</td>
<td>Effect</td>
<td>Mitigation/Management Approach</td>
<td>Significance</td>
</tr>
<tr>
<td>------------------------------------------</td>
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<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Presence of turbines affecting fish passage</td>
<td>Fish injury or mortality</td>
<td>Fish exclusion racks will prevent a dust from passing through turbines during primary downstream movement period. Burbot, walleye and mountain whitefish may move downstream outside of the primary period. While turbine design will allow for most species to pass through unharmed, there will be some mortality. The effects will be local and may be mitigated through continued replacement of lost fish via recruitment from upstream sources.</td>
<td>Significant for local mountain whitefish, burbot and walleye populations Not Significant for regional mountain whitefish, burbot, and walleye populations</td>
</tr>
<tr>
<td>Presence of headpond</td>
<td>Inundation of vegetation communities and wildlife habitat</td>
<td>Limited inundation will occur. A rare plant survey will be conducted prior to inundation and rare plants will be removed if possible.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Construction activities affecting air quality</td>
<td>Increased contaminants and noise</td>
<td>Dust suppression during construction. Standard emission control on vehicles. Emissions and noise will be short term and intermittent.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Construction activities affecting heritage resources</td>
<td>Destruction of historic sites or artifacts</td>
<td>Avoidance of sites, wherever possible. Recording of any sites that will be destroyed, as per Alberta Community Development instructions</td>
<td>Not significant</td>
</tr>
<tr>
<td>Presence of headworks affecting boat movements</td>
<td>Blockage of boat passage</td>
<td>Boat lock constructed as part of the headworks. New boat launch constructed.</td>
<td>Not significant/positive</td>
</tr>
<tr>
<td></td>
<td>Boater safety</td>
<td>Booms restricting access near the headworks. Signage. Boater safety program presented by Glacier Power.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Presence of facilities affecting viewshed</td>
<td>Detriment to visual quality of the site</td>
<td>Design of the project as a low profile facility, blended into the surrounding landscape.</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

Through project design and the development of mitigation measures that will be implemented during all phases, the effects of the Project will be not significant or positive for all environmental components. The effects assessment for the fish community concludes that a significant adverse effect is restricted to the local fish community. It is the result of Project effects on three specific local populations: walleye, burbot, and mountain whitefish. Viable, self-sustaining walleye and burbot populations reside upstream and downstream of the Project area, while a viable, self-sustaining mountain whitefish population
resides upstream of the Project area. It is the conclusion of the fish community effects assessment that there will be no significant adverse effect by the Project to the regional fish community. As such, the Peace River fish community is not at risk from the proposed Dunvegan Project.

**Conclusion**

Glacier Power has been pursuing the development of the low-head run-of-river Dunvegan Hydroelectric Project since 1999. As a testament to Glacier Power’s commitment to developing a low-impact, environmentally sensitive energy project, to date the company has spent over $7 million on environmental studies and design work for the Dunvegan Project. The majority of these expenditures have gone towards fish related studies. At the outset of Glacier’s pursuit of the Project, the extent of information on fish resources in the Peace River was limited. Detailed fish community studies were completed in 1999 and 2004, and three years of radio-telemetry study on Peace River fish populations, consisting of weekly to bi-weekly aerial flights over 500 km of the Peace River and tributaries, were conducted from 2003 through 2005. Fisheries study work done for the Dunvegan Project has in and of itself contributed vastly to the available body of knowledge on the Peace River fish resources in Alberta.

In addition to the contribution towards improved understanding of Alberta’s fish resources, physical hydraulic modeling undertaken to design and optimize fish passage facilities at the headworks has resulted in the collaboration of experts from across the country to advance understanding of fish passage design for riverine fish. The collaborative effort has resulted in the design of a state-of-the-art fish passage system that has already been presented in papers and at conferences both in North America and abroad. By undertaking this three-year hydraulic modeling program to study fish passage, Glacier Power has further demonstrated its commitment to true low-impact project design, and its willingness to demonstrate leadership in advancing the state of technology to in order to achieve environmentally sensitive designs.

Glacier Power and its consultants have also pushed the advancement and application of technology with respect to river ice modeling. Through the collaborative efforts of experts from New York to Winnipeg, Edmonton and Vancouver, the most advanced ice model in the world has now been calibrated to the Peace River, which will likely have utility in terms of river ice management well beyond the assessment of the potential effects of the Dunvegan Project on the Peace River ice regime.

In addition to the thoroughly researched low-impact nature of the Project design, the economic, infrastructure, and societal benefits associated with the Project all contribute to the positive opportunity that the Dunvegan Project presents to Albertans; the opportunity to take advantage of one of Alberta’s important renewable resources to generate long-term, reasonable cost, base-load power, without any GHG emissions, in a region of Alberta where there is a electricity generation deficit and related transmission inefficiencies. This is an opportunity that Alberta needs too consider carefully, as locations in Alberta where the development of this kind of long-term, renewable power is possible are few, and proponents as wholly committed to, and as experienced with, low-impact green power development as Glacier Power and Canadian Hydro are also few. Given Alberta’s focus on the development of non-renewable fossil fuel resources, the need for the development of opportunities such as the Dunvegan Project in order to achieve a balanced electrical generation portfolio is critical.