DUNVEGAN HYDROELECTRIC PROJECT
DISCLOSURE DOCUMENT

Submitted to

Alberta Environment &

Canadian Environmental Assessment Agency

Prepared by

Glacier Power Limited

February 2004

EXECUTIVE SUMMARY

Glacier Power Ltd. (Glacier) is a wholly owned subsidiary of Canadian Hydro Developers, Inc. (Canadian Hydro). Canadian Hydro is a non-utility publicly listed developer of hydroelectric power generating facilities with operations in the Provinces of Alberta, Ontario and British Columbia.

Glacier is proposing to develop a run-of-river hydroelectric project located on the Peace River approximately two (2) kilometres (km) upstream of the Highway 2 bridge crossing at Dunvegan. Access to the Project site is feasible along both sides of the river through a combination of private and crown land.

The Bennett Dam in north-central British Columbia has regulated flow in the Peace River since 1968, altering the physical characteristics of the river as far downstream as the Peace-Athabasca Delta in northeastern Alberta. Ice formation and breakup on the Peace River has been influenced by the thermal effects of the Bennett Dam.

Conceptually, the Project is a run-of-river hydroelectric generation facility with a plant capacity of 100 MW. The headworks will consist of a powerhouse/spillway, boat lock, boat launch on the south bank near the plant control building, two fishway ramps (one on each bank of the river to accommodate upstream fish passage), fish sluices (at various locations across the structure to accommodate downstream fish passage). Access to the plant will be via permanent roads to be placed on both the north and south banks. A 144 kV power transmission line from the south side of the structure will interconnect with ATCO's 144 kV line that parallels Highway 2 to the south of the river valley. The powerhouse will consist of approximately 40 turbine/generator units, each with a capacity of 2.5 MW. The powerhouse and spillway will raise the river water levels by approximately 6 m to form a headpond or pool behind the structure. Because of the run-of-river nature of the Project, the headpond

will not act as a storage reservoir but will form a deeper, slower section of river for approximately 14 km upstream from the powerhouse.

Northwestern Alberta is currently serviced by a 144 kV power transmission line, transporting power to the region over large distances. The Dunvegan Project will add a consistent, reliable, source of low impact renewable green energy to the local supply system, helping to meet energy load growth in the area. Third party long-term energy market price projections indicate that economically Dunvegan will compete favourably with gas-fired generation alternatives, even without consideration of potential green energy premiums. This investment in innovative and sustainable energy projects will diversify Alberta's energy supply, while supporting regional development by investing new capital and creating employment opportunities in a sunrise industry.

Glacier expects the review process to take approximately 1 to 1.5 years, culminating in a Public Hearing in spring 2005. Once approvals have been obtained, the Project will require the passage of a bill in the Alberta Legislature (in accordance with section 7 of the *Hydroelectric Energy Act*), which Glacier would anticipate happening in the fall of 2005. Glacier would initiate construction activities within 6 months of the legislative decision and expects the construction phase to take 2 ½ years to complete, with commissioning likely in the fall of 2008.

Glacier Power applied previously for approval of the Dunvegan Project, submitting applications the Alberta Energy and Utilities Board (EUB), Natural Resources Conservation Board (NRCB), Alberta Environment (AENV), and Department of Fisheries and Oceans in June of 2000. A public hearing was held jointly by the EUB and NRCB. The Joint Panel presiding over the hearing issued their decision to deny Glacier's application in February 2003, citing in particular uncertainty with respect to ice and fisheries issues. Since receiving the decision of the Panel, Glacier has continued to work towards resolving the issues that the

Panel felt were outstanding. This submission constitutes notification of a reapplication by Glacier for approval of the Dunvegan Project.

Glacier Power expects to prepare an environmental impact assessment, in which it will address at least the following major topics:

- Geotechnical
- Climate, Air Quality, and Noise
- Surface Waters Hydrology and Groundwater
- Ice Formation and Breakup
- Aquatic Environment
- Terrestrial Environment
- Wildlife
- Historical Resources
- Land and Water Uses
- Transportation
- Health and Safety
- Socio-Economic Factors

Potential benefits associated with the Project include:

- Low-impact, long-term, reliable, local power generation in a region currently reliant on long distance transmission for its supply of power
- Increasing demand coupled with limited supply of low-impact, renewable energy in Alberta
- Potential reduction of greenhouse gas emissions of 200,000 t/yr
- Estimate of employment during construction is 300 worker-years
- Creation of 3-6 full time operations jobs

- Support of the local economy through purchase of goods and services, including the creation of an estimated 4 indirect jobs during operations and maintenance
- Contribution of an estimated $1,000,000 per year to the MD of Fairview (a community with a low tax base) in property taxes.
- Payment of provincial water rental, provincial and federal income tax.

As a result of Glacier's experience with the Dunvegan Project, the company is aware that the following issues will require particular attention during the review process:

- Ice formation and break-up processes
- Effects on the ice bridge at the Shaftesbury Ferry crossing
- Fish movements and fish mortality

Glacier is developing a public consultation plan. The plan will include directly affected parties, landowners and leaseholders, local and regional communities and governments, First Nations, and other interested parties. Glacier plans to build on the relationships it has already developed with local communities, First Nations, and interested parties. The public consultation plan will include a process that will allow for the effective consideration and resolution of stakeholder concerns.

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1. INTRODUCTION

1.1 Background

Glacier Power Ltd. (Glacier) proposes to develop and operate the Dunvegan Hydroelectric Project (the Project), a 100 MW, low head, run-of-river, electric power generation plant to be located approximately 2 km upstream of the Highway 2 bridge crossing at Dunvegan. The Project consists of a powerhouse containing forty (40) – 2.5 MW turbine units, a spillway, facilities for upstream and downstream fish passage, and a boat lock to facilitate boat traffic.

The Dunvegan Project currently proposed is an economically and environmentally sound project, exemplifying the kind of low-impact renewable energy development that the province of Alberta needs to promote in order to meet its sustainable development and climate change goals. Clean, low-head, low-impact hydroelectric power such as this can also contribute significant (~ 200,000 t/yr) reductions in greenhouse gas emissions, while diversifying Alberta's sources of energy production to reduce the impact of climate change policy on the economy of Alberta. The development of non-renewable hydrocarbon energy resources in Alberta is well established and has accordingly gained great acceptability in Alberta. The Dunvegan Project provides the opportunity for the Province to place the development of its renewable resources on equal footing with the development of its non-renewable resources, to diversify Alberta's energy resource base, and to show initiative as a leader in responsible, low-impact green power development.

Northwestern Alberta is currently serviced by a 144 kV power transmission line. The Dunvegan Project will add a consistent, reliable, source of low impact renewable green energy to the local supply system. In their review of the Dunvegan project, the Alberta Transmission Authority stated: "… given continuing load growth in northwestern Alberta, the Dunvegan Facility will help to meet load growth in the area."

The economic viability of the Dunvegan Project is based on third party long-term projections of the market price of energy. Dunvegan will compete favourably with gas-fired generation alternatives, even without consideration of potential green energy premiums.

This investment in innovative and sustainable energy projects creates diversification of our energy supply, and supports new industrial development in similar projects. These projects support regional development by investing new capital and creating employment opportunities in a sunrise industry.

1.2 Previous Application

Glacier Power applied to Alberta Environment (AENV), the Energy and Utilities Board (EUB), and the Natural Resources Conservation Board (NRCB) in 2000 for approval to develop the Dunvegan Project. The review process involved extensive public and regulatory consultation and review. Although the application was turned down in 2003, Glacier Power collected a great deal of information during that process on all aspects of the Dunvegan Project, including the technical engineering, economic, environmental, and social components. That process also identified key information gaps and outstanding concerns, which Glacier is committed to see resolved so that the development of this green power project can proceed.

2. GENERAL INFORMATION

2.1 Proponent Identification

Glacier is a subsidiary of Canadian Hydro. Canadian Hydro is a publicly traded company engaged in the development and operation of renewable power generation facilities with operations in the Provinces of Alberta, Ontario and British Columbia. Canadian Hydro Common Shares are listed for trading on the Toronto Stock Exchange under the symbol "KHD".

Canadian Hydro specializes in the use of renewable resources for the design, construction and operation of electrical generating facilities such as run-of-river hydro, wind power, and biomass plants. Canadian Hydro owns and operates ten hydroelectric plants with a total installed capacity of 87.5 MW in Canada. The company's assets include four hydroelectric generating plants totalling 21.5 MW of capacity in southern Alberta, two hydroelectric plants in the British Columbia totalling 55 MW, and four hydroelectric plants totalling 11 MW of capacity in Ontario. Canadian Hydro is also in the construction phase of the 25 MW Upper Mamquam Hydroelectric Project near Squamish, B.C. All of Canadian Hydro's hydropower plants are run-of-river facilities, which means they use naturally flowing water to generate electricity while it continues to flow downstream with limited or no use of storage.

Biomass and wind power also comprise a significant proportion of the company's energy production. Over the past three years Canadian Hydro has purchased and/or constructed 77 wind turbines with a total capacity of 48 MW. Canadian Hydro's 25 MW Grande Prairie EcoPower® Center located in the City of Grande Prairie is presently under construction. The corporate information for Glacier Power and Canadian Hydro are as follows:

Company Address:	Canadian Hydro Developers, Inc. 500, 1324 – 17th Ave. S.W. Calgary, AB T2T 5S8
Corporate Contact:	Ross Keating, President Phone: (403) 298-0250 Fax: (403) 244-7388

2.2 Project Contact

The primary contact for the project and information related to the project is:

Company Address:	Glacier Power Limited 500, 1324 – 17th Ave. S.W. Calgary, AB T2T 5S8

Project Contact: Bill Johnson
Phone: (403) 863-7074
(250) 656-5178
Fax: (403) 244-7388
(250) 656-1123
E-mail: focusenv@shaw.ca

Bill Johnson is the main Project contact for project information, however Kelly Matheson (of Glacier Power) will be assisting with Project coordination and should be copied on all correspondence (mail, fax, and e-mail) at the following location:

Address: Glacier Power Limited
500, 1324 – 17th Ave. S.W.
Calgary, AB T2T 5S8

Kelly Matheson
Phone: (403) 209-3398
Fax: (403) 244-7388
E-mail: kelly@canhydro.com

2.3 Scope of the Project

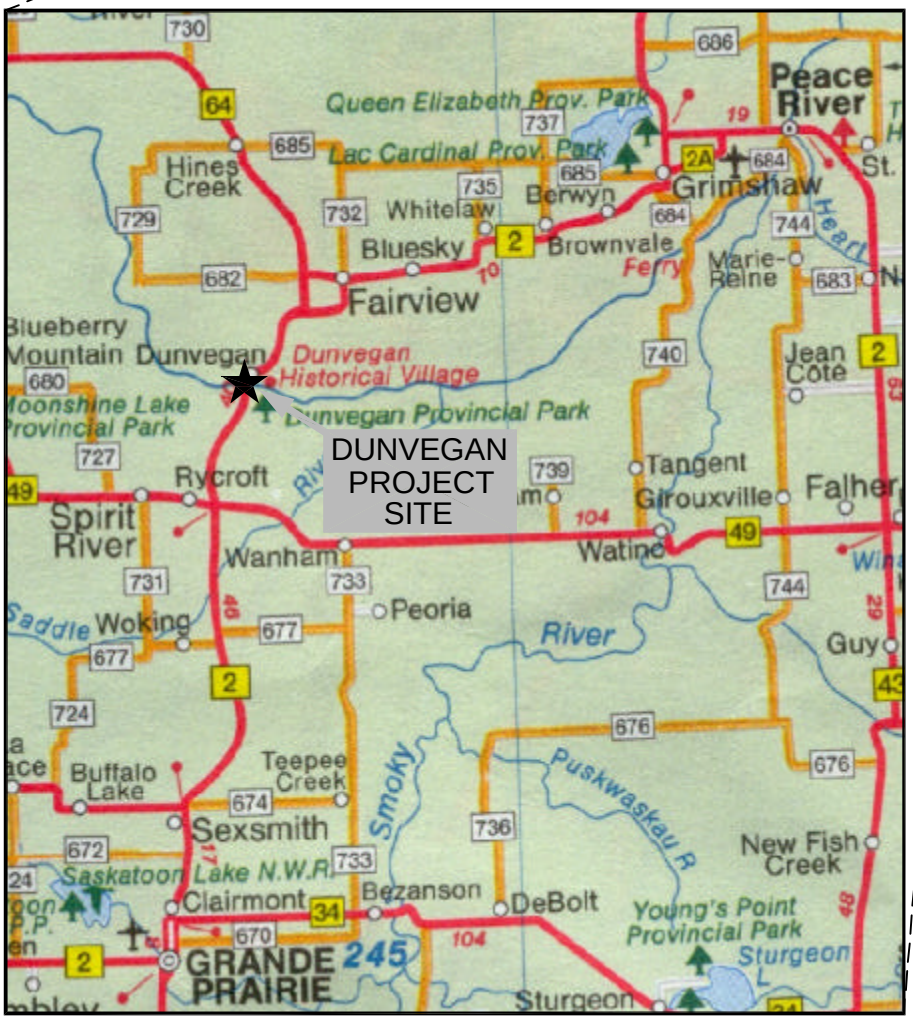
2.3.1 Project Proposal

The Dunvegan Project is a run-of-river hydroelectric project using the potential energy provided by a powerhouse/spillway structure located across the Peace River mainstem channel approximately 2 km upstream from the Highway 2 bridge crossing at Dunvegan. Figure 2-1 illustrates the location of the proposed Project. The powerhouse/spillway will raise the water level in the river at the headworks structure by approximately 6 m, providing the potential energy or 'head' for the submerged turbine generator units contained within the powerhouse. The headpond formed behind the powerhouse/spillway structure is not used for storage and downstream river levels will not be affected. Total plant capacity is 100 MW with a 100-year operating life expectancy.

Electricity generated will be connected to the local existing power transmission grid operated by ATCO and will be sold to the Alberta Electricity Pool on the open market, unless a power sales agreement is entered into with a third party.

2.3.2 Development Phases

Glacier is expecting the review process to be conducted between federal and provincial regulators and to take approximately 1 to 1.5 years, culminating in a Public Hearing in spring 2005. Once approvals have been obtained, the Project will require the passage of a bill in the Alberta Legislature (in accordance with section 7 of the *Hydroelectric Energy Act*), which Glacier would anticipate happening in the fall of 2005. Glacier would initiate construction activities within 6 months of the legislative decision and expect the construction phase to take 2 ½ full years to complete, with commissioning likely in the fall of 2008.. Table 2.1 briefly outlines the phases of development from review and approvals to commissioning.



REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
A	04	02	20	FOR DISCLOSURE DOCUMENT	RJS	CPB	RJS

Canadian Projects Limited
CALGARY, ALBERTA

GLACIER POWER LTD.

DUNVEGAN PROJECT
CONCEPTUAL DESIGN
GENERAL
PROJECT LOCATION

PROJECT NUMBER 1001-002
CADD NUMBER 4.3.104
DRAWING NUMBER FIG. 2-1

Table 2.1 Project Development Phases

KEY ACTIVITIES	DATE
Disclosure Document and Draft Terms of Reference for EIA	February, 2004
Final Terms of Reference for EIA	April, 2004
Submit Application and EIA	October, 2004
Supplemental Information Submission	February, 2005
Application/EIA Complete	March /05
Public Hearing	Spring 2005
Hearing Decision	Summer 2005
Legislature	Fall 2005
Construction Phase	Spring 2006 – Summer 2008
Commissioning	Fall 2008

2.3.3 Project Certainty

Glacier Power has been studying the details of Project design, construction, and operation for over 6 years, and is confident the Project is both technically and economically feasible. Canadian Hydro has over 12 years of experience developing hydropower resources in B.C., Alberta, and Ontario. The company has a very good understanding of the technology involved and the environmental issues driving Project design, construction, and operations. Deregulation of the electric power industry in Alberta has also contributed to the potential for the Project to succeed, by providing both the opportunity and the marketplace for

Independent Power Producers like Canadian Hydro to develop, market, and sell green power. Any uncertainty of the project success is related primarily to the approvals process.

The Project is not likely to influence future development on lands adjacent to or linked to the facility. Approval of the Dunvegan Project is not likely to affect the potential for other hydroelectric developments on the Peace River. Glacier Power has examined alternative development sites on the Peace River though its various studies, however the Dunvegan site is the only site the company is proposing to develop.

2.4 Development Boundaries and Land/Water Uses

2.4.1 Project Boundaries

The Peace River flows through three major jurisdictional boundaries, namely, the Province of British Columbia, Province of Alberta and Wood Buffalo National Park. As there is already significant hydropower development in B.C., the majority of remaining hydropower potential falls within Alberta's jurisdiction.

Major communities located immediately adjacent to Peace River include Fort St. John, Taylor, Dunvegan, the Town of Peace River, and Fort Vermilion, as well as Fort Chipewyan within the Peace-Athabasca Delta. In Alberta First Nations communities and reserve land exist along the Peace River between the Project and the Peace-Athabasca Delta.

The Project structure will be located approximately 2 km upstream of the Dunvegan Bridge. Headpond water levels will remain within 100-year floodplain levels, and headpond effects behind the structure may vary from 14 to 26 km depending on flow levels, plant operations, and ice conditions. As a run-of-river facility the Project will not affect the flow regime downstream of the structure. The Project is expected to influence the ice regime both upstream and downstream of the structure.

2.4.2 Land Tenure

The majority of the Project headworks structure is located in the river channel except at both ends where the abutments, control building, fishways, and boat lock will be on crown land. The headpond will be adjacent to crown land, some of which are assigned Grazing Leases and/or trap lines (referred to as Registered Fur Management Areas). Figure 2-2 illustrates the components of the project within the various land tenures.

The headpond abuts against privately held land located approximately 5 km upstream of the headworks. Sections of the access road and powerline are also located on Private land belonging to the Dunvegan Historic Society and another private owner. Glacier has made contact with all private landowners and lease holders (grazing leases and Registered Fur Management Areas) on Crown Land. Legal land descriptions where Project components are located include:

- the headworks structure is positioned in the Peace River mainstem with abutments, fishways, boat lock, control tower, and boat lock components between two Crown Land parcels NE 12-80-5 W6 on the south side of the river and SE 13-80-5-W6 on the north side of the river;
- the access road to the south side of the headworks is partially on crown land and titled land including NE 12-80-5-W6, NW/SW 7-80-4-W6;
- the access road along the north bank of the river is on crown land and municipal road allowances in SE 13-80-5-W6, and titled land in NW 7-80-4-W6 and NE 7-80-4-W6;
- the power line, which will interconnect at a new substation located 4 km south of the Project will be routed along the south access road through Crown and titled land in NE 12-80-5-W6, then follows the old highway 2 alignment through NW/SW 7-80-4-W6, NW/SW 6-80-4-W6 to the new substation at the northeast corner of NW 6-80-4-W6.

PEACE RIVER

APPROXIMATE U/S END OF RESERVOIR AT MEAN ANNUAL WATER LEVEL

M.D. OF FAIRVIEW NO. 136

DUNVEGAN HYDRO PLANT

HIGHWAY 2

NEW TRANSMISSION LINE ROUTE

SADDLE HILLS COUNTY

BIRCH HILLS COUNTY

INTERCONNECTION AT NEW SUBSTATION TO 138kV TRANSMISSION LINE

EXISTING 138kV TRANSMISSION LINE

M.D. OF SPIRIT RIVER NO. 133

NOTES

1. BASE INFORMATION FROM MUNICIPALITY MAPS DATED PRIOR TO 1999.

LEGEND

- MUNICIPAL BOUNDARIES
- EXISTING TRANSMISSION LINE
- NEW TRANSMISSION LINE
- CROWN OR CROWN LEASED LAND
- TITLED LAND

SCALE 1:80 000

0 0.8 1.6 2.4 3.2 4.0

KILOMETRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
A	04	02	23	FOR DISCLOSURE DOCUMENT	RJS	CPB	RJS

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DUNVEGAN PROJECT
LAND OWNERSHIP AND
MUNICIPAL DISTRICTS
LOCATION PLAN

PROJECT NUMBER 1001-002
CADD NUMBER 4.3.158
DRAWING NUMBER FIG. 2-2

2.4.3 Regional Setting and Land Use

The proposed Dunvegan Project is located in a deeply incised, steep-walled bedrock controlled canyon section of the Peace River near Dunvegan. The Dunvegan West Wildland Provincial Park extends along the upper portion of the Peace River valley from the Ksituan River to Many Islands and is not affected by or crossed by any of the Project components. There are no other protected areas or ecological reserves affected by the Project.

The primary land uses in the region include agriculture (grain crops and cattle grazing), forestry operations, oil and gas operations, and recreational boating and camping. The agriculture, forestry, and oil and gas industry activities nearby the Project site are located on lands above or outside the river valley, and/or well upstream or downstream of the Project site. Grazing leases do extend to the river edge and will be marginally affected due to increased water levels near the headworks structure. Recreational boating on the river includes both jet boating and paddling. The closest organized campground is at Pratt's Landing, located upstream of the Project headpond,.

Development downstream of the Project includes: the Dunvegan Historic Park (2 km downstream of the Project), the Highway 2 bridge crossing (2 km downstream), and a water intake for the Town of Fairview (10 km downstream of the Project).

The Town of Peace River (TPR), located approximately 80 km downstream of the project may be affected by the Project due to changes in the ice regime. The ice bridge at Shaftesbury Ferry, located approximately 60 km downstream of the Project, may also be affected by changes to the ice regime. These potential effects of the Project have been and continue to be examined extensively through research and modelling of ice formation and break up processes.

2.4.4 Water Licences and Current Water Use

Glacier Power plans to submit an application in 2004 to Alberta Environment under the *Water Act* for the purpose of generating hydroelectric power. There are no other water licenses held on the Peace River at the Dunvegan site.

Water licenses upstream of the Project in BC include BC Hydro's Peace Canyon Generating Station, and several water licensees with intake structures near Taylor including the British Columbia Ministry of Transportation & Utilities, Gordon Curtis, Duke Energy Gas Transmission, Slocan/Taylor Pulp Division, Imperial Oil Resources Ltd., and Nels Ostero Ltd.

Other water-based activities in the local area that will interact with the proposed Project are primarily river boating. River boating enthusiasts were contacted during the previous review process. The Project received support from river boaters because Glacier committed to providing a boat lock and boat launch facility at the headworks structure to accommodate these user interests. These users will be consulted with again to confirm their support.

3. PROJECT DESCRIPTION

3.1 Location and Access

The Dunvegan Project site is located on Peace River approximately 2 km west of the Highway 2 Bridge 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. Airline service is available to Grand Prairie or Peace River. Access from Highway 2 to the Project site will be along gravel site access roads along both sides of the river. The Dunvegan Bridge provides access to both sides of the river. Figure 3-1 show the layout of the Project.

3.2 Design Concept

Conceptually, the Dunvegan Project is a multi unit hydro facility utilizing a low head in the range of 6 m. The powerhouse will consist of forty 2.5 MW turbine units. The overall length of powerhouse is 285 m. A 110 m long spillway with crest gate will provide the primary flood control facilities. The development will incorporate a boat lock for river traffic and fishways for upstream and downstream fish migration.

Power will be transmitted along a 144 kV line that interconnects with ATCO Power's 144 kV line approximately 4 km southeast of the Project. The proposed operating regime and the key hydraulic parameters are presented in Tables 3.1 and 3.2.

The hydro power capacity and configuration of the project was determined based on a number of key factors described below.

3.2.1 Gross Head

The gross head at the plant may vary between 5.5 and 7.6 m depending on the flow in the river, plant operation and ice regime.

3.2.2 Plant Capacity

The plant capacity for the nominal 6 m head and 1800 m^3/s design flow is 100 MW. The 100 percent available flow is 390 m^3/s, which corresponds to a minimum output capacity of 19 MW. The operable turbine flow for each unit is between 42.5 m^3/s and 46.25 m^3/s. The units will typically operate at full capacity at a flow of 45 m^3/s each.

N
W E
S

FLOW

SAFETY BOOMS

SPILLWAY AND POWERHOUSE

ROCKFILL RAMP FISHWAY

NORTH ACCESS ROAD

HINES CREEK

BOAT LAUNCH & DOCK

LAYDOWN AREA & BOAT PARKING

ROCKFILL RAMP FISHWAY

BOAT LOCK

CONTROL BUILDING AND SUBSTATION

EXISTING TRAIL ACCESS

FORMER BORROWS

SOUTH ACCESS ROAD

TRANSMISSION LINE

PEACE RIVER

FLOW

HWY #2

DUNVEGAN PROVINCIAL RECREATIONAL AREA

EXISTING DUNVEGAN BOAT LAUNCH

FORMER BORROWS

EXISTING TRAIL ACCESS

TRANSMISSION LINE

DUNVEGAN CREEK

LEGEND

- EXISTING ROAD/TRAIL
- EXISTING HIGHWAY
- NEW ROAD
- NEW TRANSMISSION LINE
- LEGAL LOT BOUNDARIES

SCALE 1:10 000

0 100 200 300 400 500

METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
A	04	02	20	FOR DISCLOSURE DOCUMENT	RJS	CPB	RJS

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DUNVEGAN PROJECT
GENERAL ARRANGEMENT
SITE LAYOUT
PLAN

PROJECT NUMBER 1001-002
CADD NUMBER 4.3.157
DRAWING NUMBER FIG. 3-1

Table 3.1

Proposed Hydro Plant Hydraulic Regime

Headwater and Tailwater Levels During Flood Events

Flood Event	Flow (m^3/s)	Headwater Elev. (m)	Tailwater Elev. (m)	Head (m)	Turbine Flow	Spillway Crest Gate Elev(m)
MAFlow	1,482	347.9	341.2	6.7	Yes	347.9
1:2	3,490	349.7	343.1	6.6	Possible	344.4
1:5	4,870	350.5	344.1	6.4	Possible	344.4
1:10	5,950	351.1	344.8	6.3	Possible	344.4
1:20	7,710	351.9	345.7	6.2	Possible	344.4
1:50	8,820	352.4	346.3	6.1	Possible	344.4
1:100	10,300	353.0	347.0	6.0	Possible	344.4
1:200	11,900	353.6	347.7	5.9	Possible	344.4
1:500	14,300	354.5	348.6	5.9	Possible	344.4
1:1000	16,400	355.2	349.4	5.8	Possible	344.4

Table 3.2

Proposed Hydro Plant

Key Hydraulic Parameters

River	
River Valley Width	420 m
Powerhouse	
Combined Powerhouse Width (40 units) including fish sluices	285.7 m
Top of Powerhouse Elevation	348.4 m
Spillway and Boat Lock	
Total Spillway Length	110.3 m
Lock Width	8.5 m
Fixed Spillway Crest Elevation	344.4 m
Maximum Movable Spillway Crest Elevation	347.9 m
Turbine Flow	
Turbine Flow per Unit	45 m^3/s
Total Turbine Flow	1800 m^3/s

3.2.3 Turbine Generator Units

The forty turbines selected for the project are ECOBulb^{TM} turbines. The product was developed by VA Tech Hydro and represents an important contribution to clean and reliable energy generation for low head plants worldwide.

The ECOBulb™ is a fish friendly bulb turbine generator unit designed to minimize fish mortality. Due to innovative technology, it offers high efficiency for Compact generating sets with low maintenance requirements.

3.2.4 Powerhouse Configuration

The powerhouse will contain the 40 modular turbine units. The powerhouse will be constructed on the riverbed at elevation 337 m and has a top elevation of 348.4 m giving the structure a total height of 11.4 m.

3.2.5 Powerhouse Overtopping

The powerhouse will be designed to overtop if flows exceed about the 1 in 2 year flood, an average of 1.3 days/year varying between zero and 9 days under normal historic Bennett Dam operating conditions. It is anticipated that the turbines may need to be shutdown once significant overtopping occurs.

The facility is designed pass extreme floods including the probable maximum flood (PMF) estimated at 28,000 m^3/s without failing. A concrete and riprap apron extends 38 m downstream of the structure to prevent riverbed scour in the turbulent flow regime zone.

3.2.6 Spillway

The spillway will be a concrete overflow structure with an adjustable crest gate installed on the ogee. The gates are lowered during flood events so that they impede flow. This is ideal for this application, given the size of the river, the trees and other large debris it carries, and the significant ice flow at this site.

3.2.7 Boat Lock

Provisions for maintaining navigability of the river will likely be required. Provisions for maintaining navigability of the river will be provided by means of a boat lock located on the

south side of the river. Final design and operational parameters of the lock will be determined based on discussions with the Canadian Coast Guard.

3.2.8 Power Line

The energy produced at the Dunvegan Project will be carried by a 144 kV power line from the powerhouse on the south side of the river where it will join an existing 25 kV line at NW/NE 31-79-4-W6 some 4 km from the site. The existing 25 kV line will be upgraded to accommodate both 25 and 144 kV to the east for 4 km to the interconnection point with ATCO Power's 144 kV line at NE 34-79-4-W6.

3.2.9 Access Roads

As much as possible, access roads will be routed along existing roads to minimize new road construction. Permanent roads will be required to access both the south and north sides of the headworks to accommodate ongoing maintenance of the facility. The permanent access road on the south bank will cross the Dunvegan Creek near the confluence with the Peace River, and then follow the Peace River bank to the facility. The road on the north bank will cross Hines Creek.

3.3 Construction

3.3.1 Construction Timing and Sequencing

The timing of the commencement of construction will be dependent on receipt of approvals and authorizations. Glacier anticipates that detailed engineering and equipment procurement would commence in 2006. Site preparation work could commence as early as mid to late summer, 2006. Construction of the Project components could be completed by the fall of 2008 with commissioning of the plant in late 2008.

Overall the main construction work will take 2 ½ years. The key scheduling issue is construction of the major instream closure works. The sequencing of construction will be critical so that the extent that the river is blocked is minimized while structures are partially completed especially during periods when ice formation and movement is occurring.

In order to meet the construction schedule construction will commence from both abutments.

3.4 Operations

3.4.1 Powerhouse

The operation of the powerhouse will be continuous throughout all seasons. As a run-of-river facility, no water is diverted during operation of the Dunvegan Project - all water in the river remains in the river and flows through the turbines and/or over the spillway structure. The headpond formed behind the powerhouse and spillway structures will be 6 m deeper just upstream of the structures under mean annual flow conditions. This is equivalent to roughly 0.6 m above the normal (pre-Bennett Dam) 1 in 100 year flood level. The water depth eventually reduces to the original water level approximately 14 km upstream of the headworks. Under flood conditions, water levels increase and the effect will extend approximately 26 km upstream. The headpond will not operate as a storage reservoir, nor will flows be regulated. River flows entering the headpond will equal river flows below the structure. The area flooded along the river banks upstream of the structure will vary between 50 and 160 ha over the full length of the headpond depending upon river flow conditions. This equates to flooding an average of less than 20 m on each side of the river along the headpond.

3.4.2 Spillway

The gate on top of the fixed crest spillway will be raised or lowered depending upon flow conditions in the river (dependent upon releases from Williston Reservoir and contributions

from tributary streams). At high flow or flood conditions, the spillway gate will not be raised. During lower flow conditions, which occur about 10% of the time, such as late summer and fall, the spillway gate would be fully raised. In this case, water would be flowing through the powerhouse units with none going over the spillway. During freeze-up, a portion of frazil ice moving downstream will continue through the turbines and spillway, while some will begin to build up along the edge of the river behind the headwork structure. Eventually, the headpond will freeze over and the plant will continue to operate utilizing under-ice flow.

3.4.3 Boat Lock

As the project progresses, the design and operation of the boat lock will be determined based on the needs of river users (i.e. volume of traffic, type of vessels using the river, and safety considerations) and discussions with the Canadian Coast Guard with respect to meeting the requirements of the *Navigable Waters Protection Act*.

3.4.4 Debris Management

The Peace River during flood stage carries a variety of Large Woody Debris (LWD) that has entered the river upstream of Dunvegan. The LWD contributions come either from river bank erosion and slumping along the mainstem or tributaries, from high bank slides that enter the mainstem, or from re-floating old material deposited during previous flood events. During operations, floating booms will be used to direct the LWD towards the spillway portion of the structure. Canadian Hydro has had successful results passing LWD over the spillway at other operating plants. Occasionally, the LWD gets hung up on the channel bottom or fringe areas and will require assistance from the operational staff in moving the material over the spillway, allowing it to continue downstream.

3.4.5 Accidents and Malfunctions

Potential accidents or malfunctions would be primarily restricted to the risk of failure of the instream structural components (powerhouse, spillway, or boat lock). The powerhouse, spillway, and boat lock are designed to withstand the anticipated ice jamming and flood events, so the potential for failure is extremely low. In the event that structural failure did occur, preliminary estimate is that the resulting flood wave would have a 3 m high crest at Dunvegan that would attenuate to a 2 m high crest at the Town of Peace River. The structures themselves would not be carried downstream and would not likely cause property damage, although, additional channel bed and bank scour could occur. Recreational boaters could be affected depending upon the time of year.

The potential for fluid spills is minimal because the turbines and associated equipment use very small quantities of hydraulic fluids, plus the hydraulic fluids used in the powerhouse are not hydrocarbon-based fluids, rather they are biodegradable vegetable-based fluids. These plants will be well maintained and designed with drains and sumps capable of retaining more than the full volume of 200 litres contained in each unit. Drums of hydraulic fluids would be stored in a secure, properly designed building located on shore well back from the 1 in 500 flood level.

3.4.6 Waste Materials Management

Waste material generated at hydroelectric facilities during operations are typically limited to office supplies, low quantities of vegetable based hydraulic fluids, and minor quantities of solid waste material (i.e. metals, wood etc.).

3.4.7 Closure and Abandonment

The Dunvegan Project has an indefinite life span, as the Project design concept allows for each of the components to 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. Many of the machine components such as the turbines, hydraulic lifts for the lock, and the spillway crest gate will be salvaged. The concrete structures will be hauled to an approved landfill site.

4. ENVIRONMENTAL MATTERS

Each of the Project components has been planned with environmental management and contingency options built into the design, construction, and operation of the main project components including the powerhouse, spillway, boat lock, power line and road access.

4.1 Biophysical Setting

4.1.1 Physiography

The Peace River in Alberta is in the Alberta Plains physiographic unit of Alberta characterized by broad, gently sloping prairie, deeply incised by steep sided river valleys. The Peace River Valley was carved by a series of glaciers and meltwater channel flow and downcutting into marine and non-marine bedrock of Cretaceous age. Valley slopes along the headpond are dominated by steep interbedded sandstone and shales of the Dunvegan Formation, overlain by variable thicknesses of the silty Kaskapau Formation. In the Dunvegan section, the upper slopes in the valley have a hummocky appearance caused by slumping of the upper valley walls. The lower slopes have exposed bedrock walls interspersed with veneers of the slumped material from the upper slopes. The valley has an average width of 1.5 to 3 km at the top, is 0.4 km to 0.8 km wide at the river water level and has a depth from 150 m to 275 m below the upland prairie.

4.1.2 Climate

The regional climate is described as moderate continental with short moderately warm summers and long, relatively cold winters. The May and August mean daily temperatures

are higher than the surrounding boreal forest and similar to those found south of the Athabasca River. July is the warmest month (mean daily of 16°C, maximum of 36.1°C). The coldest month is January (mean daily of –17.8 °C, extreme minimum of –48.3°C). The majority of rainfall occurs during the summer months of July (highest record of 77.7 mm) and August. Snowfall is greatest from November through February (range 24.9 to 33.2 cm).

4.1.3 Hydrology

The Peace River is a major tributary within the MacKenzie River Basin and has a drainage area of $3x10^7$ ha from its headwaters to the confluence with the Slave River at Lake Athabasca. The headwaters are formed by the confluence of the Finlay and Parsnip River systems, which is now Williston Reservoir formed by Bennett Dam built between 1967 and 1972 in north-central B.C. The Bennett Dam regulates flow, altering the physical characteristics of the river as far downstream as the Peace-Athabasca Delta in northeastern Alberta. The main tributaries found along the Dunvegan Reach include the Hamelin, Dunvegan, Hines, and Boucher creeks and the Ksituan, Saddle (Burnt), and Leith rivers. Numerous unnamed tributaries are also present. The only named tributary with its confluence located within the proposed Project headpond is the Ksituan River, whereas the Dunvegan and Hines creeks join the mainstem immediately downstream of the proposed facility.

There are 40 years of flow records (no winter flows) for the Dunvegan site since the commissioning of Bennett Dam. The regulated mean annual flow is 1,482 m^3/s, the 10% and 90 % exceedance flows being 2,160 and 864 m^3/s, respectively.

4.1.4 Sediment

The sediment load in the B.C./Alberta border to Dunvegan reach is supplied by drainages downstream of Williston Reservoir, since virtually all of the upstream sediment is trapped by

that reservoir. The primary sources of sediment downstream of the reservoir originate from erosion of unconsolidated glacial lacustrine deposits and the shale, siltstone, and sandstone bedrock formation located in the mainstem and tributary valleys.

4.1.5 Ice Regime

The Peace River generally ices over through a process of upstream ice formation. The Town of Peace River (TPR), located partly on the floodplain approximately 80 km downstream of Dunvegan, has been plagued by ice jams and related flooding for many years. The Bennett Dam has had a major effect on the thermal and ice regimes of the Peace River. The Alberta/B.C. Joint Task Force on Peace Ice was formed in 1982/83 by members of BC Hydro, Alberta Environment, and the B.C. Ministry of Environment (now the Ministry of Water, Land and Air Protection) to maintain the safe outflows from the Peace Canyon Dam during the period required for a solid ice cover to form at the TPR. This period is generally considered to last while the ice front moves past the TPR until it reaches Dunvegan, plus several days good measure, after which BC Hydro may return to normal operating output.

At break-up, the combination of longer daylight and warmer ambient air temperatures thermally melts the ice front in the downstream direction. It is possible for more dynamic break-ups to occur locally where a tributary to the Peace River breaks up prior to the Peace itself, resulting in a rush of stored water and ice entering a still intact ice cover on the Peace River. This occurrence can forcibly break up the Peace River ice, potentially causing an ice jam. This kind of dynamic break-up has been observed in the past at the confluence of the Smoky River with the Peace River, approximately 10 km upstream of the Town of Peace River.

4.1.6 Aquatic Resources

Aquatic resources of the Peace River in Alberta have been studied over the past two decades, although not in a continuous or coordinated manner. Habitat features included backwaters, snyes, shoals with submerged coarse substrate, and tributary confluences. Several fish sampling programs have been conducted over the past decade. Fisheries studies specifically related to the Dunvegan Project were conducted as baseline work in 1999 and fish migration studies in 2002/2003. These studies identified 25 fish species, the main sport fish species being goldeye, walleye, northern pike, mountain whitefish, burbot, and bull trout. Longnose suckers were the most abundant coarse fish species and were captured at all sample sites.

4.1.7 Vegetation

The local and regional Project area falls mostly within the Dry Mixedwood Boreal Forest Natural Subregion, part of the Boreal Forest Natural Region of Alberta. This area is characterized by upland aspen forests with diverse understories, interspersed with grasslands, shrublands, and riparian vegetation communities. Most stands in the local Project area are either deciduous, or deciduous-coniferous mixedwoods in earlier successional stages of development, due to the relative frequency of fire in the past century. Upland areas fall within the Peace River Parkland subregion, dominated by stands of aspen and white spruce, with balsam poplar occurring on wetter sites. Forests intergrade with grasslands and shrublands; most grasslands in the subregion have been cultivated or grazed and only scattered remnants and steep-sided valley walls remain in native cover. Because the Peace River flow is regulated, vegetation has also been altered along the river banks and foreshore. Other developments such as highways, roads, bridges, power lines and grazing of cattle have also had an effect on vegetation communities along the river. Three rare plant species were identified in the local project area but none were found in conflict with any Project components. No restricted weeds were encountered in previous studies within the local project area but noxious or nuisance weeds were found primarily on grazed lands.

4.1.8 Wildlife

Historically, bison, elk, and moose utilized the slopes of the Peace River valley between Dunvegan and the B.C./Alberta border. Moose remain in large numbers, however few elk remain along the river having moved into the Clear Hills and Saddle Hills areas. Mule deer entered the valley upstream of Dunvegan in 1910 and have become fairly abundant. The non-agricultural tablelands are the most important winter habitat for ungulates, whereas valley bottoms are prime areas for calving and summer range. The most common large carnivores found along the Peace River valley are wolf and black bear. Sightings of coyote are fairly regular. The Dunvegan area is also within grizzly bear and cougar ranges, however, there have been no reports of either in recent years. The river does not contain particularly good furbearer habitat. Transient bank beaver may utilize the poplar along the banks of the mainstem but in low numbers. Small populations of muskrat, mink, ermine, weasel, lynx, fisher and red fox have also been reported in the area.

The mosaic of grassland, shrubland, forests, and riparian vegetation communities provides habitat for a variety of passerine birds. The absence of emergent aquatic vegetation, variability of flows in the mainstem and tributaries (high in spring, minimal during summer) does not provide suitable habitat for waterfowl. The mainstem does provide open water that is used heavily by spring migrants and stopover areas during fall staging and migration periods. Upland game is not abundant in the river valley. The diverse habitat found along the river support a variety of raptorial birds including bald eagles, golden eagles, and pigeon hawks. Raptor nests have been recorded along the Peace River in the vicinity of the proposed Project but are located near the headworks or road and powerline alignments. No amphibians or reptiles were observed by Rintoul (1985) in the Dunvegan Study Area.

4.2 Potential Effects and Mitigation

As a developer of low-impact, green power projects Canadian Hydro strives to minimize the environmental impacts of all of its Projects from the outset. The Dunvegan Project is no exception. The headworks occupy a relatively narrow band across the river channel, the abutments, fishways, boat lock, and boat ramp are located mostly outside the present river channel and as such can be constructed in off-channel ground, the road access and powerline routes have been aligned to follow existing roads and trails to minimize disturbance, and the headpond formed behind the headworks lies within a narrow, confined, steeply banked section of the river to minimize flooding of adjacent land.

The potential effects and potential mitigation measures that have been identified to reduce or eliminate each effect are discussed below. These will be considered and assessed in the environmental impact assessment for this project.

4.2.1 Flow Regime

The Project is a run-of-river hydroelectric plant and will not affect the flow regime in the river but will raise the water levels at the headworks structure by approximately 6 m. No mitigation measures are required.

4.2.2 Ice Regime

The Project will change the ice formation and break-up process in the river. Modeling is used to predict and quantify these potential changes. Glacier Power has engaged a local expert on Peace River ice, as well as an international expert on river ice from Clarkson University in New York State, to work collaboratively to develop a very accurate model for Peace River ice. Modeling previously completed by Glacier Power indicated some of the following effects on ice processes as a result of the Project:

- a reduction or elimination of the potential for secondary consolidations, which have historically resulted in flooding that has plagued downstream communities and land owners located on the floodplain;
- a reduction in the flow control period presently limiting production from the Bennett and Peace Canyon dams upstream;
- may increase the potential for seepage flooding at the community of Lower West Peace, and/or affect the TPR storm drainage system;
- may increase the potential for ice jam flood events near the TPR cause by early break-up of the Smoky River: and,
- may affect the winter ice bridge at Shaftesbury Ferry crossing.

Glacier Power, Alberta Environment, and BC Hydro have worked collectively to collect physical ice data, which can be difficult to obtain but is important in maximizing modelling accuracy. Glacier has conducted a seepage study at the community of Lower West Peace and has developed a mitigation strategy for that community. Glacier has also entered into an Agreement in Principle with the TPR designed to increase the capability of TPR to respond to and mitigate all future flooding events. Glacier is working towards verification of the Project's effects on the Shaftesbury ice bridge as well as potential mitigation solutions.

4.2.3 Aquatic Environment

The Project will affect upstream fish migration and may affect populations due to trash rack impingement and turbine mortality. The benthic invertebrate community may change in the headpond. The effect of the Project on fish habitat is primarily restricted to the footprint of the headworks structure and changes to key habitat features within the headpond. The Project is not expected to have an adverse effect on water quality.

Glacier will mitigate the fish passage and mortality issues by providing fishways on both banks of the river for upstream fish passage, fish sluiceways at several points across the face of the headworks structure to provide for safe downstream passage, properly designed trash racks to minimize impingement and entrainment of adult fish, and has developed an adaptive management strategy that provides contingencies and flexibility in plant operations to optimise fish passage conditions. The turbine generators are also designed to minimize fish mortality, particularly of smaller fish that may be entrained. Effects to fish habitat will be mitigated to some extent by minimizing the plant footprint and the residual balance will involve compensation measures that are presently being discussed with the regulatory agencies.

4.2.4 Terrestrial Environment

The Project headpond may cause minor bank sloughing but is not likely to cause any major landslides based on current assessments. Bank vegetation will be affected around the perimeter of the headpond as well as vegetation cleared for the access roads and powerline. Any rare plants encountered will be relocated above the headpond level or outside any clearing limits. Potential effects of a changed ice regime on wildlife will be included in the environmental impact assessment for the Project.

4.2.5 Historic Resources

Several archaeological sites considered to be of low significance were identified near the headpond and other Project components but all have been avoided except one site that may be flooded by the headpond. This site will be catalogued and any artifacts removed prior to flooding.

4.2.6 Navigation

The Project headworks structure will block river traffic. However, the headpond will improve navigability on the river for approximately 15 – 20 km upstream of the headworks. Glacier plans to mitigate the navigation blockage by incorporating a boat lock into the headworks structure.

5. COMMUNITY INFORMATION

5.1 Employment

Glacier estimates the Project will provide 300 worker years during the 2 ½ year construction period. Locally, the Project will provide employment opportunities for skilled and unskilled labour which will likely come from Grande Prairie, Fairview, Grimshaw, Peace River, Rycroft, Spirit River, and Woresely. According to the Alberta Construction Workforce Supply/Demand Forecast 2003-2007, no trade shortages are expected, and in particular not in northwestern Alberta, by the year 2006/07. Due to the relatively small size of the Project, the local communities and support systems should not be stressed, nor will there be a major influx of people and problems that go with larger Projects. Since there will not be a camp at the headworks site, construction workers will stay in nearby communities. This translates into increased revenue for the hotels, restaurants, and merchants in the area. During construction, most building materials will be purchased locally. The Project will require heavy equipment, timber, sub-contract construction, and transportation of material to and from the site. Glacier Power anticipates that these services can be provided by the local economy.

The operational phase will be dependent upon support services from local communities in the form of transportation, communication, and mechanical and electrical trades. The Dunvegan Project plant will require 3-6 full and part time staff to operate the plant. This will not place undue stress on the housing, schools, municipal services, or medical services in

Fairview or Rycroft. Glacier Power would contribute to the local economy through direct purchases of local goods and services during Project operations. It is estimated that an additional 4 indirect jobs will be created during operations and maintenance activities.

During operations, the Project is estimated to contribute approximately $1,000,000 per year to the MD of Fairview in property taxes. This is a major benefit to the community with a relatively small tax base. In addition, the Project will pay provincial water rental, and provincial and federal income tax. Over the life of the Project, these other benefits are approximately equal to the property tax payment.

5.2 Consultation

Glacier is developing a public consultation plan. The plan will include directly affected parties, landowners and leaseholders, local and regional communities and governments, First Nations, and other interested parties. The public consultation plan will include a process that will allow for the effective consideration and resolution of stakeholder concerns. Glacier plans to build on the relationships it has already developed with communities and interested parties. Consultation and agreements previously accomplished with several First Nations, including the Duncan's First Nation, the Athabasca Chipewyan First Nation, and the Mikisew Cree First Nation, will further facilitate the consultation process.