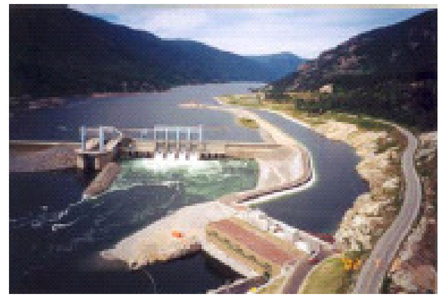

Key Issues:
5- Water Quality
1-Biological Diversity
2- Hydrological Regimes
14-Development of Regional Industries

Climate Zone:
Cfb: Mild with warm summers, cool winters and precipitation

Subjects:
- Diversion of flow through new powerplant at existing dam

Effects:
- Reducing dissolved gas supersaturation downstream
- Preventing increases in downstream temperatures
- Preventing sedimentation during construction
- Preserving downstream and upstream fish habitat
- Increasing reservoir nutrient levels and fish population
- Offset production of greenhouse gases
- Reclaiming previously disturbed land and shoreline areas
- Public participation in project planning
- Regional development
- Involvement of minority groups in project

Project Name: Arrow Lakes Generating Station
Country: Canada

Implementing Party & Period
- Good Practice: Arrow Lakes Power Company
1996 - 2002

Key Words:
Dissolved gas supersaturation, Fish, Sedimentation

Abstract:
Operation of the spillways at an existing dam has resulted in increased dissolved gas supersaturation (DGS) levels downstream. High DGS levels cause symptoms in fish similar to the bends in human divers and is recognized as the major water quality issue on the river. DGS levels downstream have frequently exceeded lethal levels. The addition of a powerplant to the dam has significantly reduced the use of the spillway and DGS levels downstream.

1. Outline of the Project

The 1964 Columbia River Treaty (the "Treaty") between Canada and the United States of America included a requirement for the construction of a storage dam on the Columbia River near the downstream end of Lower Arrow Lake in southeastern British Columbia. Arrow Dam (subsequently renamed the Keenleyside Dam) is located 55 km upstream of the Canada/USA border. The dam was constructed between 1964 and 1968 by B.C. Hydro, the "Canadian Entity" under the Treaty. At that time it was not economic to install generating facilities at the dam, or make provisions for the future addition of generation, given B.C. Hydro's other project alternatives on the Peace and Columbia River systems. While B.C. Hydro eventually developed plans for a 240 MW powerplant at the dam, these plans did not proceed beyond the preliminary design stage.

The Keenleyside Dam was completed in 1968 and raised the level of two natural lakes to form Arrow Lakes Reservoir, which has a live a storage volume of 8.8 x 109 m3, an area of 51 600 ha and extends 235 km upstream.

The dam consists of a concrete gravity section and an earthfill section. The concrete structures are founded on bedrock and have a total length of 360 m and a maximum height of 58 m. The 450 m long earthfill dam has a maximum height of 52 m and is founded on pervious sands and gravels over 150 m deep. It is a zoned embankment constructed from sand and gravel with an upstream sloping impervious core constructed from glacial till. The core extends 670 m upstream and across the full width of the reservoir forming an impervious blanket to limit seepage under the earthfill dam.

The reservoir is operated in accordance with the terms of the Treaty and is drawn down each fall and winter to provide water for generation at downstream hydroelectric projects. The reservoir reaches the minimum level in the spring providing flood control storage and refills during the late spring and summer. The mean annual flow at the dam is 1160 m3/s. Discharges from the dam typically vary from 142 m3/s to about 850 m3/s during the refill period; and from 1000 m3/s to 2700 m3/s in the summer, when the reservoir is full and passes basin inflow, and through the fall and winter while the reservoir is drafted. The available head at the dam varies from a maximum of about 22.5 m in the summer to as low as 2.5 m in the spring.

The discharge facilities through the existing concrete dam consist of four spillway bays controlled by 15.2 m wide by 16.8 m high vertical lift gates and four submerged low level outlets located on each side of the spillway. The low level outlets are 6.1 m wide by 7.3 m high rectangular downward sloping conduits controlled by vertical lift gates. A short, deep impact basin dissipates energy from the flows discharged through the spillways and low level outlets. The basin has a vertical dentated end sill that induces a high degree of turbulence with a corresponding high energy loss. After many years of operation it was found that the spillways entrain air which is taken to depth in the energy dissipator. Some of this air enters solution resulting in high levels of DGS downstream. Operating rules at the dam have been changed to maximize the use of three low level outlets

Table 1

Overburden excavation	3 620 000 m^3
Rock excavation	640 000 m^3
Rockfill in CFRD	390 000 m^3
Approach channel:	
• length	1500 m
• depth	25 m
• top width	104 m
• concrete lining	0.25 m thick
• concrete lining	23 500 m^3
Powerhouse:	70 800 m^3
• length	60 m
• height	63 m
• width	90 m
Kaplan turbines:	
• Number of units	2
• Capacity	96.4 MW
• Number of blades	4
• Runner diameter	8.1 m
Generators:	
• Capacity	92.5 MW
• Power Factor	0.9
• Type	Umbrella
• Rotor weight	300 tonnes
• Rotor dia.	11.4 m
Upstream earth plug	30 000 m^3
Tailrace rock plug	30 000 m^3
Land reclamation	50 ha

located to the left of the spillway to mitigate DGS downstream (Nunn et al. 1993, Ref. 1). Operation of the low level outlets at heads greater than their design head of 10.7 m has increased the risk of cavitation damage and they cannot be used at heads greater than 18.5 m or with partial gate openings at heads greater than 10.7 m due to the risk of significant cavitation damage. Therefore water quality guidelines were still exceeded for a significant part of the year. It was recognized that diversion of flow from the spillways by the addition of a powerplant would further mitigate the DGS problem.

In 1994, Columbia Power Corporation ("CPC") was established as a Provincial Crown corporation and acquired the rights to develop a powerplant at Keenleyside Dam. The objective of CPC in making power project investments is to support the employment, economic development and resource management objectives of the Province of British Columbia (the "Province") and the Columbia Basin Trust ("CBT"), within the constraints of a commercial corporation.

CBT is a regional corporation established by an Act of the Province's Legislature in 1995 to work with residents of the Columbia Basin to promote social, economic and environmental well-being in the region most affected by the Treaty. Two-thirds of CBT's 18-member board of directors is appointed by the local governments of the Columbia Basin region, with two directors being appointed by each of five regional districts and two directors being appointed by the Ktunaxa-Kinbasket Tribal Council. The remaining six directors are appointed by the Province. All directors must be Basin residents. The directors govern according to the Columbia Basin Management Plan, which is developed and updated through a process of broad public consultations.

Under the terms of a 1995 Financial Agreement between the Province and CBT, the Province is providing $500 million over 10 years for the construction of three powerplants by CPC and CBT, on a 50/50 joint venture basis. The addition of generation at the Keenleyside Dam (subsequently named the Arrow Lakes Generating Station) is the first of three power projects constructed by CPC and CBT, through a new joint-venture company, Arrow Lakes Power Corporation ("ALPC"). The net revenue from the powerplant will be divided 50/50 between CPC and CBT. CBT will use its share of the net revenue to fund socio-economic and environmental initiatives throughout the Columbia Basin region. Environmental assessment of the project commenced in 1995 under the new British Columbia Environmental Assessment Act, pursuant to which a project committee composed of federal, provincial, local government and First Nations representatives was established to steer the environmental assessment and review the project application.

The arrangement of the project is shown in Figure 1 and salient data are provided in Table 1. A 1500 m long approach channel bypasses the existing dam and blanket and conveys flow to a two unit, 185 MW powerhouse located in an outcrop of massive bedrock 400 m downstream of the dam, with a 70 m long tailrace to conduct the power flows back to the river.

Figure 1

A Project Approval Certificate (PAC) was issued pursuant to the BC Environmental Assessment Act in April 1998; a conditional Water License was granted pursuant to the BC Water Act in January 1999; and a Fisheries Authorization pursuant to the Federal Fisheries Act was issued in March 1999. Construction commenced in March 1999 and the project entered commercial operation in February 2002.

2. Features of the Project Area

The Columbia is the fourth largest river in North America, exceeded in length and flow only by the Mississippi, Mackenzie and St. Lawrence rivers. It drains an area of 670 520 km² of which 102 260 km² are in Canada. The main stem of the river rises in Canada some 772 km from the Canada/US border and then continues for about 1191 km to join the Pacific Ocean at Portland, Oregon.

The Columbia River valley is typical of river valleys in British Columbia that were formed by several glacial advances and retreats. It has a complex mix of deep glacio-fluvial and alluvial soils overlying bedrock in the valley floor and steep valley walls of rock.

The climate in the project area is strongly influenced by high mountains to the west and east. The mountain ranges to the west force moisture laden air from the Pacific Ocean to rise, causing precipitation before reaching the project area and creating a partial rainshadow. The Rocky Mountains to the east restrict westward movement of cold continental Arctic air masses, moderating the winter climate. As a result, summers in the area are warm while winters vary from cool to cold. The annual mean daily temperature is 8.5°C, ranging from a mean daily temperature of –2.4°C in January to +19.8°C in July.

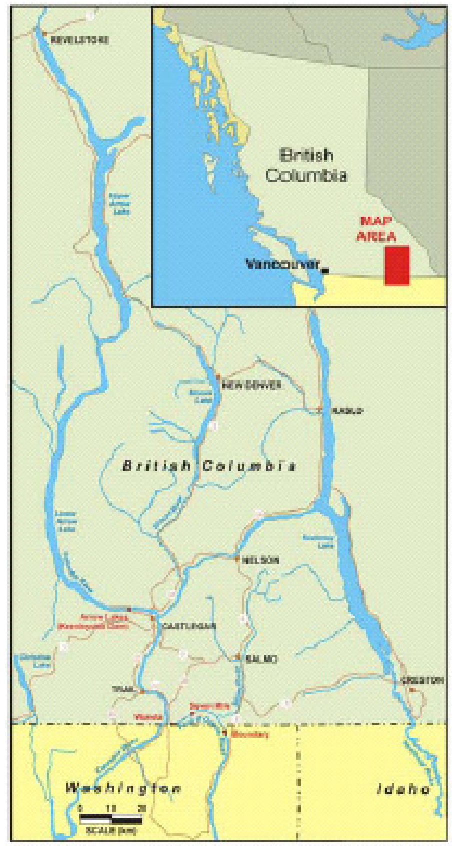

Figure 2

The Columbia River Basin experiences large snowpack accumulations through the winter with snowmelt runoff during the May to August period. Occasionally heavy, short duration rainfall events also occur during the May to September period, which can produce high peak flows when coinciding with extreme snowmelt conditions. Precipitation occurs throughout the year with an average annual precipitation at the project site of approximately 600 mm. Approximately 480 mm falls as rain and the remainder as snow, the majority of which falls between November and February.

There are a number of small population centres near the project and the total population within 65 km of the site is about 55,000. Lead-zinc smelting, forestry, tourism and power production are the primary economic activities in the area. The potential for agriculture in the area is low due to topographic and pedologic constraints.

Twenty-four fish species have been recorded in the lower Columbia River system between the Keenleyside Dam and the Canada-USA border. Several fish species in this reach of the Columbia River have been identified as species of concern and are listed by the Council on the Status of Endangered Wildlife in Canada (COSEWIC) as being “Vulnerable” or “Threatened”.

3. Major Impacts

For many years it was recognized that adding a powerplant would increase the benefits from the existing dam by harnessing some of the spilled energy (Nunn, 2002, Ref. 2). The region had suffered from the negative effects of the construction of the dam (for example some of the rare agricultural land on the shores of Lower Arrow Lake, the fruit orchards at Renata, had been submerged by the raising of the lake) and most residents felt that they had not benefited from the operation of the dam. The local community supported the construction of a powerplant by ALPC at the dam for the economic, social and environmental benefits that would accrue to the region, not only during construction but throughout the life of the project due to the regional mandate of the Trust.

Since the majority of new generation projects in the Pacific Northwest of North America are combined cycle gas turbine ("CCGT") projects fueled by natural gas, a powerplant at the dam would offset the production of greenhouse gases and conserve fossil fuels. Natural gas is extensively used for domestic heating and modern domestic furnaces have a thermal efficiency of about 85%, whereas the current generation of CCGT has a thermal efficiency of about only 55%. Output from the Arrow Lakes Generating Station was estimated to displace the production of 350,000 tonnes per year of CO_2 from CCGT.

Water diverted from the spillways through the powerplant will not entrain any air and thus will not create DGS. The powerplant has a hydraulic capacity of 1115 m^3/s, equal to the mean annual flow but less than the peak summer flows, therefore the spillways will still be used some of the time. Studies indicate that a significant benefit of the powerplant project will be a reduction in the average number of days that the water quality guideline for DGS will be exceeded downstream from 132 days per year t less than 49 days per year. As discussed above, the low level outlets are being operated at heads significantly greater than their design head to mitigate DGS. The addition of the powerplant will significantly reduce the annual operating hours of the low level outlets, reducing the wear and tear on the concrete. With the powerplant operating there will now be times of the year when all of the flow can be passed through the powerplant, allowing the low level outlets to be taken out of service for repairs of cavitation damage without compromising DGS levels downstream.

With the offset of CO_2 production and the reduction of DGS levels downstream the addition of a powerplant at the Keenleyside Dam is truly a "green power" project. Despite these obvious benefits it was still necessary for the environmental effects of the project to be assessed in accordance with the provincial and federal legislation.

The potential major impacts of the project identified in the environmental assessment were:

- fluctuations of reservoir and river levels due to daily load shaping;
- increase of downstream water temperatures;
- changes to downstream flow patterns;
- sedimentation and siltation during construction; and
- entrainment of fish through the powerplant.

4. Mitigation Measures

Daily load shaping was deleted from the scope of the project to eliminate the potential environmental effects from daily fluctuations of reservoir and river levels. Operation of Arrow Lakes Reservoir and releases from the dam and powerplant will continue to be dictated by Treaty requirements.

The Arrow Lakes Reservoir thermally stratifies in the summer and regulatory agencies were concerned that the approach channel would "skim" a higher proportion of warm water from the surface, cooling the reservoir and increasing downstream water temperatures with resulting adverse effects on cold-water fish species. Extensive studies demonstrated that the project would likely have little or no effect on downstream water temperatures. The design of the project was optimized to minimize the potential withdrawal of warmer surface water by setting the invert of the approach channel more than 20 m below the maximum normal reservoir level and maximizing the width of the inlet. A monitoring program conducted prior to the powerplant commencing operation has established a statistical relationship between downstream water temperatures, the discharge from the dam, the reservoir level and thermal stratification parameters of the reservoir. Downstream temperatures monitored during operation of the project will be compared to those calculated using the statistical relationship and measured reservoir thermal stratification parameters to confirm that no statistically significant increases in downstream temperatures of more than 0.5ºC have occurred. In the event that statistically significant increases in downstream temperatures are incurred, some mitigation may be required.

A large eddy downstream of the earthfill dam and several smaller eddies along the beaches on the left bank are important habitats for fish including white sturgeon, a species listed by COSEWIC as threatened. Flow patterns were measured using acoustic Doppler current profiling techniques for a range of flow conditions prior to the powerplant entering operation. A numerical model calibrated against both the results of physical hydraulic model testing and the field measurements was used to predict the effects of the project and optimize the orientation and size of the tailrace to mitigate effects on the existing flow patterns. Over the first few years of operation flow patterns will be measured to determine whether there have been any adverse effects on the downstream habitats. If adverse effects are identified on the small back eddies along the left bank of the river just downstream of the tailrace, which are used for spawning by one of the resident fish species, rockfill groynes will be installed to create appropriate backwater habitat.

The potential for siltation and sediment release during construction of the project was a particular concern due to an important rainbow trout spawning area located seven km downstream of the dam. During the early stages of project planning the major potential source of sedimentation was identified as the construction of cofferdams to isolate the powerplant construction area. One of the major advantages of the layout shown in Figure 1 is that cofferdams could be eliminated. Instead, an earthfill plug of in-situ material left at the upstream end of the approach channel and a solid rock plug left at the downstream end of the tailrace were removed after the powerplant had been completed.

The removal of the upstream plug took place during the low reservoir period so that the minimum amount of material would be dredged. A silt curtain was installed to prevent silty water from entering the reservoir during dredging. The first releases from the powerplant were scheduled to allow time for the suspended sediment to partially settle out into the coarse rock riprap lining. The initial discharges from the powerplant were controlled so that the powerplant discharge would be diluted with flow from the existing facilities so that the total discharge from the dam would meet the water quality criterion at the water quality monitoring station one km downstream.

Prior to the removal of the downstream rock plug a berm of clean rockfill was placed in the river to isolate the rock plug. This berm served two purposes: 1) containment during drilling, blasting and removal of the excavated rock, thus avoiding siltation; and 2) protection of fish from over pressures due to blasting. Once the rock plug had been completely excavated the rock berm and the river bed gravel between the plug and the berm were excavated by a clamshell and dragline. The excavation rate was controlled so that the suspended sediment levels downstream did not exceed the water quality criterion. In addition, planned dredging of gravel bars downstream to lower the tailwater level and increase generation were abandoned to avoid siltation and sedimentation.

A number of large trees had to be removed at the commencement of construction. Where feasible the trees were replanted in local parks. Hardwood trees too large for replanting were cut and donated to local colleges for use in carving.

An informal beach use area had developed upstream of the dam. Construction of the project eliminated this beach and in compensation $75 thousand Cdn was donated to each of two local parks to improve facilities and compensate for the loss of the informal area.

Sound environmental management practices were implemented throughout the project to protect water quality and in particular to control siltation and sedimentation through the use of sedimentation ponds and drainage control measures.

It was not considered feasible to mitigate the potential for fish entrainment through the powerplant. Even though fish have been entrained through the Keenleyside Dam discharge facilities for years, likely with high mortality in the very turbulent flow conditions in the energy dissipator, ALPC committed $175 thousand Cdn per annum (index linked) for increasing the productivity of the reservoir starting in the same year that construction started so that the fish population increase would more than offset any entrainment by the time operation commenced. Low nutrient levels in the reservoir due to the trapping of sediment and nutrients in the upstream reservoirs is believed to be the cause of the declining fish population in the reservoir; therefore the funds are initially being used to help support a reservoir fertilization program. The Fish Fertilization Program involves increasing the nutrient levels of the lake to provide food for juvenile fish. In 1999, following two years of pre-program study, the five-year fertilization experiment began. The project was undertaken by the Columbia Basin Fish & Wildlife Compensation Program, a joint venture between BC Hydro and the Ministry of Water, Land and Air Protection.

Fertilization takes place between April and September. A specialized blend of agricultural fertilizer is applied on a daily or weekly basis to a pre-determined zone in Upper Arrow Lake. The fertilizer, about 300 tonnes per year, is dispensed from a tanker truck on a scheduled ferry that crosses Upper Arrow Lake. The truck’s tank hose is attached to a diffuser pipe that discharges the fertilizer directly into the propeller wash from the ferry. Although the program benefits all species of fish, the monitoring portion of the program focuses on kokanee (landlocked salmon) as an indicator of overall success.

In addition to the compensation program the design of the Kaplan turbines used in the Arrow Lakes Generating Station incorporates a spherical discharge ring to minimize mortality.

The land adjacent to the Keenleyside Dam, both above and below the maximum normal reservoir level was disturbed during construction of the dam in the late 1960s and most of these borrow pits were not reclaimed. Overburden and rock excavated from the approach channel and powerhouse have been placed in these borrow pits. Land reclamation measures include creation of varied terrain features favourable to ungulates, planting of native tree and shrub species and the creation of wetlands to improve habitat value. Some relatively poor fish habitat in the reservoir margin has been lost as a result of the disposal of excavated material. Therefore, a series of small rockfill groynes and benches planted with sedges have been created to provide superior fish habitat.

A 49-km long, 230 kV transmission line connects the project to the Selkirk Substation owned by B.C. Hydro. The transmission structures are typically guyed wood pole structures. Approximately nine kms of the line are double circuited on an existing 230 kV line owned by B.C. Hydro as well as a two km section of single circuit narrow configuration line to reduce the clearing requirements. At the Selkirk Substation the transmission voltage is stepped up to 500 kV for transmission to the Vancouver area.

The project was implemented through a collective labour agreement through which all workers other than professional and management staff were employed. This agreement includes provisions for maximizing the hiring of workers from the Columbia Basin region and for the hiring of minorities. In addition to the provisions in the collective labour agreement, the design-build contract for the powerplant included provisions for regional economic benefits and First Nations involvement in the project.

Contractual commitments were made for regional economic benefits totalling $50.4 million Cdn, consisting of $35 million Cdn in labour and $15.4 million Cdn in purchases from regional suppliers and businesses. In addition to employment, the First Nations benefits included training & skills development. The contract included provisions giving the owner recourse against the contractor if the regional economic and First Nations benefit goals were not achieved.

5. Results of the Mitigation Measures

Monitoring of water quality in the reservoir and river downstream during construction demonstrated that there were only a few minor exceedances of the 25 mg/L water quality criterion for total suspended solids. These few exceedances were promptly rectified by the contractor.

Monitoring over the first two or three years of operation (2003 on) will continue to measure the improvement in DGS and whether there have been any adverse effects on flow patterns or water temperature.

Preliminary spot measurements of DGS undertaken in 2002 have confirmed that the discharge from the powerhouse are the same as the background level in the reservoir. Therefore it is expected that the predicted DGS benefits will be achieved.

Preliminary statistical analysis of the results of continuous temperature measurements taken upstream and downstream of the project during 2002 will be undertaken in the winter of 2002 to determine if the project has increased downstream temperatures. The summer of 2002 was long and warm and no unusually high downstream temperatures were measured.

Following the 2001 fertilization program, sonar surveys in the fall of 2001 conducted by the Columbia Basin Fish & Wildlife Compensation Program showed an estimated total of 20 million kokanee in the reservoir, a 72 percent increase over 2000 and a 228 percent increase over 1999. An aerial survey of spawning kokanee in 28 reservoir tributaries counted 670,635 spawners, an increase of 48 percent over 2000.

The fertilization program has resulted in the re-opening of the Upper Arrow Lake kokanee fishery with a daily catch limit of five fish. In addition to conserving fish populations, the fertilization has benefited the local sport fishery and provided increased food sources for wildlife predators such as bears, eagles and osprey.

Under provisions of the program, if fertilization requirements of the reservoir decline after several years as nutrient levels increase, then program administrators may target the annual compensation to other measures, such as the enhancement of spawning grounds in reservoir tributaries, or other habitat enhancement directly related to increasing the fish population in the reservoir.

During construction of the project the contractor actually expended $31 million Cdn in the region on labour and $24 million Cdn on procurement of supplies, materials and services from regional businesses, for a total of $55 million Cdn, nearly 10% above the contractual commitments. Approximately 85% of the workers employed on the project through the collective labour agreement were long-term residents of the region. Total regional expenditures equaled 26% of the contract price of $210 million Cdn.

The First Nations program was equally successful. A working group of First Nations advisors and a program coordinator position were established and maintained throughout construction. Eighty-four of the 1150 workers (7.3%) employed through the collective labour agreement claimed First Nations status. A First Nations apprenticeship board found and provided training for qualified workers for entry-level union positions. The contractor allocated $8 thousand Cdn, as part of a $450 thousand Cdn economic development and training program, to each of three Tribal Council/Nations to support advanced education in the building trades. Equipment supplier, GE Hydro, invested $200 thousand Cdn in existing and new First Nations businesses in the program area and/or in financing commercially viable First Nations projects such as local parks and recreational/tourism facilities.

Throughout construction and into the future, CPC and CBT have provided for a continuing audit of the First Nations and regional economic development programs. The audit ensured that contractual provisions for the various economic development programs were followed.

6. Reasons for Success

CPC works with its joint venture partner, CBT, to develop power projects that will benefit all residents of the region. The partners work hard to develop and maintain good relationships with individuals, organizations and communities across the region. CPC staff regularly attend trade fairs and community group meetings to ensure residents understand its mandate and are aware of upcoming and ongoing projects. A resource library is available to the public and the website provides comprehensive information. CPC communicates regularly with residents in the Columbia Basin through local and regional media and ensures that information on key projects is widely available and addresses community information needs.

CPC prepared a detailed scale model to help explain the Arrow Lakes Generating Station. This model was used in the public consultation process and was displayed at trade fairs, community meetings and similar forums.

CPC has established a history of working with interested and affected groups and individuals to ensure projects are undertaken in the most sensitive and inclusive manner possible. For the Arrow Lakes Generating Station, a community-based Impact Management Committee was established to ensure there was a forum to raise community issues related to construction of the project. In addition, considerable pains were taken to ensure that no lands were expropriated for either the powerplant or its 49-km transmission line. This is particularly important given the bitter legacy from large-scale expropriations and lengthy court battles associated with development of the Keenleyside Dam in the 1960s.

CPC and CBT are sensitive to traditional land uses and common concerns with First Nations people in the Columbia Basin. Various First Nations groups are involved in many aspects of the joint venture's power project activities. Keeping these groups involved and informed regarding the planning of the project was a priority for the joint venture partners. While CPC and CBT do not address issues related to aboriginal title, they do ensure that First Nations are involved early in all aspects of planning related to proposed joint venture projects. CPC and CBT are involved with First Nations issues such as traditional use and archeological studies.

CPC and CBT share in the region's concern regarding environmental issues. For this reason, great care was taken in every stage of the project - from planning to completion and beyond. Working closely with Fisheries and Oceans Canada, the Ministry of Sustainable Resource Management, and the Ministry of Water, Land and Air Protection, CPC and CBT work to minimize impacts to the environment. In most instances habitat improvement is sought and implemented following the principal of no net loss of fish or fish habitat. This goal mirrors Fisheries and Oceans Canada in their vision to provide "Safe, healthy waters and aquatic ecosystems, for the benefit of present and future generations, by maintaining the highest possible standards to Canadians."

The success of the Arrow Lakes Generating Station project is due to several important factors:

1) The residents of the region, including First Nations, were involved in the project from concept to

commissioning. As a result of this consultation and the obvious benefits to the region, there was strong public support for the project.

2) A comprehensive environmental assessment was undertaken in consultation with all federal and provincial agencies. With the exception of fish entrainment, all potential adverse effects of the project were mitigated by modification of the project design and by the implementation of sound management practices during construction. By the time the powerplant entered commercial operation the compensation for fish entrainment had already significantly increased the fish population in the reservoir, demonstrating that the program is producing orders of magnitude more fish than are entrained through the powerplant. The compensation program has therefore become an enhancement.
3) Contract provisions were designed to ensure the maximum involvement of the community and protection of the environment.
4) The project generates significant ongoing environmental and socio-economic benefits.

7. Outside Comments

The environmental assessment of the project included a cumulative effects assessment (CEA) of the project as required by the Canadian Environmental Assessment Act. The project CEA was ranked highest in a recent critical evaluation of 12 Canadian cumulative effects assessments (Baxter et al. 2001, Ref. 3) indicating the high standard achieved in the environmental assessment of the project.

A former Team Leader of the World Bank sponsored World Commission on Dams Secretariat recently wrote to the Chairman of CBT. His letter (Ref. 4) reviewed the progress of the World Commission on Dams (WCD), and said:

"…the CBT provides an essential purpose in linking project proponents to the Basin population, and a meaningful forum for discussing basic issues of power project desirability, setting requirements for impact minimization, and then mobilizing public support for the project or its variants to support community and regional development. In particular, it provides the resources for stakeholders and community groups to participate meaningfully in the necessary research, project study and other dialogue processes needed to resolve the inevitable tradeoffs and optimize mutual benefits that are to be derived from specific projects in an equitable manner."

"There are many other instances where CBT programmes reflect what the WCD considers to be "best or good practice", and which characterize programmes dealing with incremental and cumulative impacts of Basin development activities, which many countries are now seeking to establish and fund directly, and sometimes with innovative provisions for cost-recovery where appropriate and feasible. In many cases, the specific approaches that the CBT has adopted are becoming prerequisites for other countries in order for them to gain access to international funding support. The position established by the Committee on Appropriations in the USA, which I cited earlier, is just one illustration of the growing consensus to commit public resources for sustainable management of water and energy resources…"

The significant fisheries benefit due to the reduction of DGS has resulted in the project receiving strong endorsement by eight U.S. agencies, including the Environmental Protection Agency and the U.S. Fish and Wildlife Service, plus the Colville Confederated Tribes (Ref. 5).

8. Further Information

8.1 References

1) Nunn, J.O.H., Fidler, L.E. and Northcott, P. 1993, "Investigation of Changes to the Operation of Keenleyside Dam to Reduce Supersaturation of Dissolved Gases Downstream", CSCE Annual Conference, Fredericton NB.
2) Nunn, J.O.H. "Evolution and Challenges of the Keenleyside Powerplant Project", Canadian Dam Association 2002 Annual Conference.
3) Baxter, W., Ross, W.A. and Spaling, H. 2001, "Improving the practice of cumulative effects assessment in Canada", Impact Assessment and Project Appraisal, volume 19, number 4, December 2001.
4) Lawrence J.M. Haas, private communication to CPC, October 18, 2001.
5) Private communication from U.S. agencies to Columbia Power Corporation, March 7, 2000

8.2 Inquiries

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