BC hydro
FOR GENERATIONS

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During Stage 2 of the Site C Project, studies are underway to update many of the historical studies and information known about the project.

The potential Site C project, as originally conceived, will be updated to reflect current information and to incorporate new ideas brought forward by communities, First Nations, regulatory agencies and stakeholders. Today's approach to Site C will consider environmental concerns, impacts to land, and opportunities for community benefits, and will update design, financial and technical work.

PEACE SITE C
SUMMARY STATUS REPORT

A 900 MW ELECTRICAL GENERATION FACILITY
AND TWO 500kV TRANSMISSION LINES
AT SITE C ON THE PEACE RIVER IN BRITISH COLUMBIA

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B.C. Hydro and Power Authority

March 1991

SECTION 1.0 - INTRODUCTION

B.C. Hydro previously made application for an Energy Project Certificate (EPC) for the Peace Site C Project pursuant to the Utilities Commission Act. The application was made in 1980 and reviewed by the British Columbia Utilities Commission (BCUC) in public hearings from November 1981 to November 1982.

BCUC recommended that an EPC not be issued until two conditions were met: that the load forecast be acceptable and demonstrate the need to begin construction of Site C in order to avoid supply deficiencies; and that Site C be demonstrated as the best project based on a comparison of total engineering, construction, environmental and other social costs of alternative projects. The B.C. Cabinet refused the issue of the Certificate in 1983.

In 1989 B.C. Hydro was forecasting the possible need for new supply by just before the turn of the century and therefore undertook preparatory work on the Peace Site C Project. The objective was to shorten the project lead time so that Site C would be a viable contingency option to meet any early supply need. The circumstances which would require an early addition to B.C. Hydro's Electrical System have not transpired. Nonetheless, B.C. Hydro wishes to maintain Site C as a viable option for the future.

This report outlines B.C. Hydro's current state of preparedness on Site C, organized in accordance with the Guide to the Energy Project Review Process. It includes:

- a description of the project and a proposed construction schedule

- a summary of the rationale for Site C as an option for the future

- a summary of public consultation carried out to date and to be continued

- a summary of the engineering and environmental studies carried out to date

The report is accompanied by copies of reports generated during the current preparatory phase for Site C. These reports generally update earlier material, submitted during the previous application process, much of which is still relevant. No environmental issues have been identified which, in the opinion of B.C. Hydro, would negate the BCUC finding set out in the 1983 Site C Report at page 268.

"In sum, while the Commission recognizes that major impacts will result from the Site C project, the Commission concludes that they are not so large as to make them unacceptable. Provided that appropriate conditions are placed on Hydro and that the government responds to the special needs created in the region, the impacts can be successfully and acceptably managed."

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SECTION 2.0 - PROJECT DESCRIPTION AND SCHEDULE

2.1 GENERATING STATION

2.1.1 GENERAL

The Site C dam and power station, proposed to be located 62 km from the B.C.-Alberta border, would be the third facility in the B.C. Hydro system to utilize the Peace River. The W.A.C. Bennett Dam is located about 177 km upstream of the British Columbia-Alberta border. The associated Williston Lake reservoir has the capacity to regulate the flow in the Peace River, which powers two generating stations at present. The G.M. Shrum Generating Station, located at 183 m high W.A.C. Bennett Dam, houses 10 generating units with a maximum continuous generating capacity of 2730 megawatts (MW). The Peace Canyon hydroelectric facilities, located 22 km downstream of the W.A.C. Bennett Dam, comprise a 50 m high dam and a four-unit powerplant with maximum generating capacity of 700 MW.

The Peace Site C Project would be a hydroelectric installation converting the potential energy of the flow of the Peace River at Site C into electrical energy in a 900 MW capacity power station. Energy studies of the combined operation of the upstream stations, G.M. Shrum and Peace Canyon, and of the potential Site C plant have demonstrated that Site C would have an annual average long-term production of 4710 GWh.

2.1.2 PROJECT SETTING - SITE SPECIFIC

Site Geology

The proposed Site C damsite and reservoir are located where the Peace River has carved a valley a few kilometres wide and 190 to 230 m deep in a relatively flat to slightly rolling plain. The damsite is located about 7 km southwest of the city of Fort St. John

and 0.8 km downstream of the mouth of the Moberly River (Fig. 2-1). The site of installations was chosen as the most favourable of a series of alternatives studied along the course of the Peace River downstream from Peace Canyon.

Base rock at the site consists of relatively soft horizontally bedded shale which has an upper surface at elevation 460 m and which has been eroded to a depth of approximately 60 m to form a wide flat valley. Across the valley floor the rock is overlain by some 10 m of alluvium which contains the meandering flow channel of the river. Above the rock surface on both sides of the valley are interbedded overburden deposits of clay, silt, sand and gravel which have an overall thickness of 140 m and an upper surface at approximately elevation 600 m. The eroded surface of the rock is exposed in the lower 50 m on both banks, and a gravel covered mid-slope terrace occurs on the south bank at the approximate level of the dam crest. To be addressed in the design of the dam and associated works is a series of weak flat seams present in the bedrock.

The valley slopes and terraces are wooded. Many shallow slides have occurred in the overburden material, particularly on the north bank.

Hydrology

Detailed analyses have been made of meteorological and hydrological records from sub-basins forming the Site C drainage area. This includes the Williston reservoir basin as well as the local tributaries below Williston which contribute to the flow at Site C. An estimate of the Probable Maximum Precipitation for the basin has been developed and from this the Probable Maximum Flood (PMF) for Site C has been calculated. With the allowance for the regulatory effects of the Williston Reservoir, the peak flow of the PMF at Site C will be approximately 18,200 m^3/s. Taking into account historical floods and the extremes in operating conditions of Williston reservoir, the Project Design Flood (PDF) has been

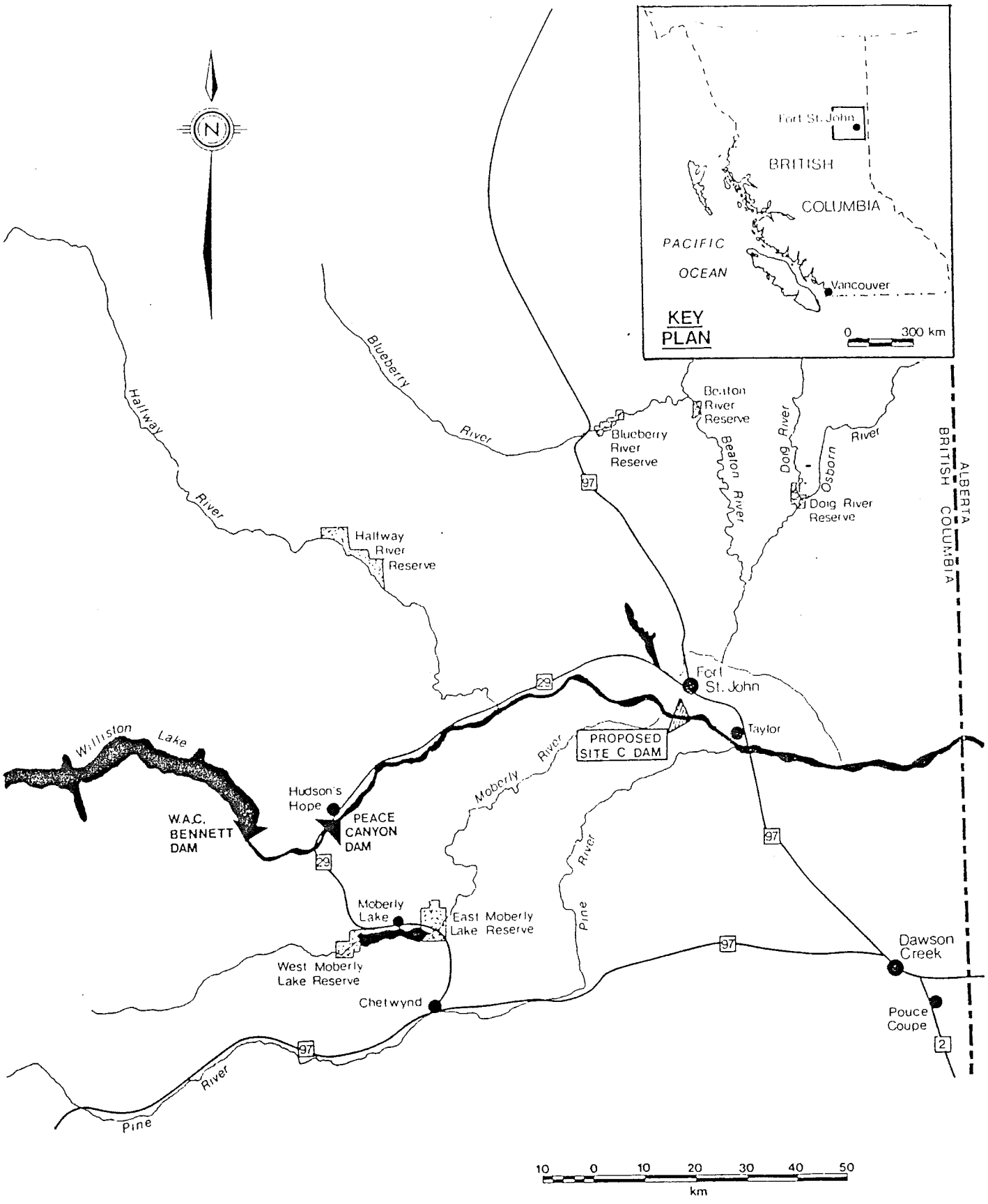


Figure 2-1

REGIONAL CONTEXT OF SITE C PROJECT

calculated at 11,900 m^3/s. This measurement has been used to determine the proportions of the spillway. The reservoir and discharge facilities have been designed to accommodate both the PMF and PDF. During the early years of construction and until the dam embankment has reached the level of the cofferdam, the diversion works would be capable of passing a flood which has a return period of 50 years.

2.1.3 PROJECT FEATURES

The project would comprise a zoned earthfill dam across the river with a gated spillway, a power intake structure, a powerhouse and switchgear facilities on the south bank. A project road from the north bank is planned to cross the river by bridge 4 km downstream from the site, and would provide construction period access and permanent access to the powerstation and spillway (Fig. 2-2). The main project components are described below.

Earthfill Dam

The dam would be designed as a zoned embankment consisting of a central impervious core with outer shells of sands and gravels. It would extend about 1100 m long at the crest and 60 m high above river level. The cofferdams, which form part of the temporary river diversion works, would be incorporated into the upstream and downstream toes of the main embankment. The base of the impervious core would be set in a trench excavated through the alluvium and into the base rock to provide a water tight cut-off. The dam embankment, including the cofferdams, would be constructed of materials obtained from excavations for the works and from selected borrow areas. The design will ensure that the structure and foundation rock would accept all loads with complete safety.

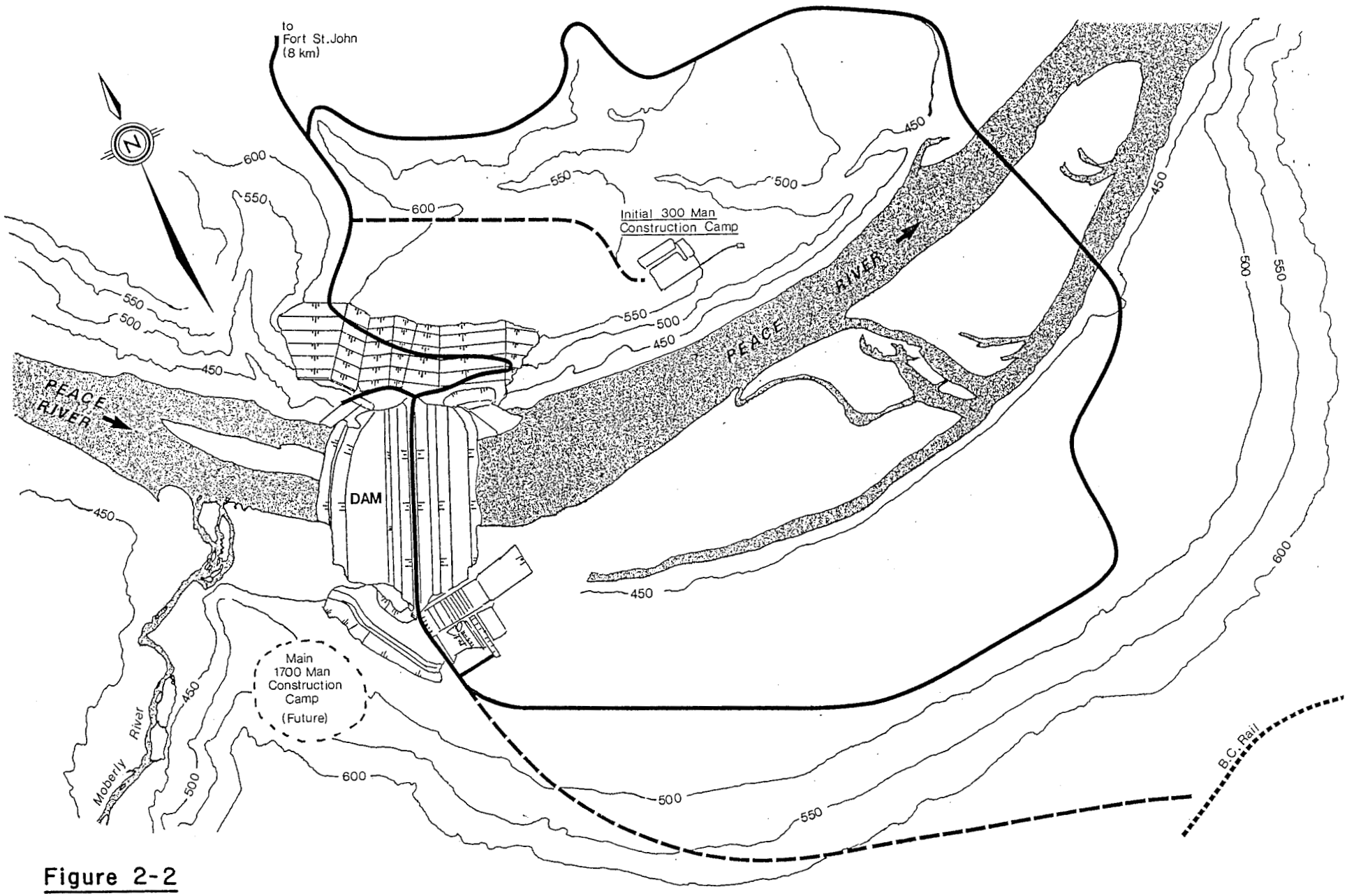


Figure 2-2

CONSTRUCTION ACCESS AND PERMANENT ROADS TO THE DAM SITE AT SITE C

LEGEND

permanent road

temporary road

200 0 200 600 1000 m

Elevations in metres ASL.

Diversion Tunnels and Low Level Outlet

During construction of the dam, spillway and power installations (at least until the first turbine is ready for testing), the river would be diverted through two 9.8 m diameter concrete lined tunnels in the north abutment. Each tunnel would be about 650 m long and have a gated concrete intake structure at the upstream end. Embankment cofferdams near the tunnel intakes and outlets would protect the dam working areas during the diversion period. When storage is to commence, one tunnel would be closed using the intake gate and permanently blocked with a concrete plug. During filling and until the reservoir reaches the spillway crest level, water would be released through the second tunnel to satisfy downstream requirements. Subsequently this tunnel would also be closed and plugged.

Reservoir

The reservoir would flood 46 km^2 of land to create a total water surface of 94.4 km^2 with a maximum normal operating level of 461.8 m. It would extend upstream for a distance of 83 km to the outlet of the Peace Canyon generation station. At the Site C dam, the water depth would be 52 m and the gross volume of the storage would be 2310 million m^3/s. (See Section 2.1.7 for Operation of Site C Reservoir).

The reservoir created by a dam at the Site C would inundate approximately 23 km of Highway 29 between Hudson's Hope and Bear Flats. The major affected sections of the highway would be near Lynx Creek, Farrell Creek, Cache Creek and the Halfway River (Fig. 2-3). Preliminary studies by B.C. Hydro and the Ministry of Highways have resulted in the proposed re-alignment of Highway 29. This realignment and construction would impact surrounding landowners, 23 known heritage resource sites, as well as recreational use and access along the reservoir.

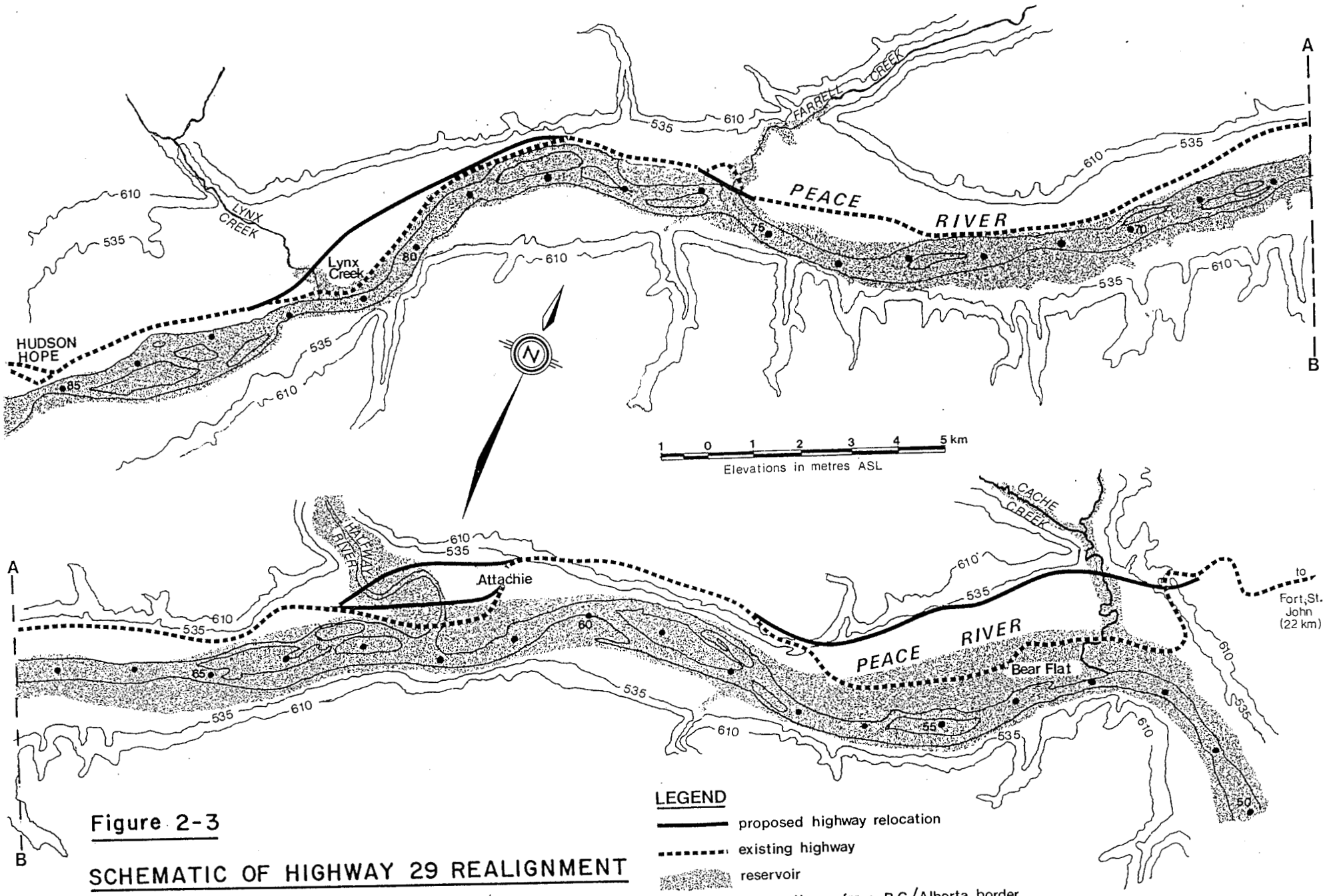


Figure 2-3

SCHEMATIC OF HIGHWAY 29 REALIGNMENT

Spillway

The spillway would be adjacent to the dam on the south abutment. It would have a gated crest structure with an inclined concrete-lined chute leading to a submerged "hydraulic jump" type energy dissipator near the downstream toe of the dam. The dissipator would be designed to absorb sufficient energy from the spillway discharge to ensure that downstream erosion would not endanger the dam or powerstation.

The spillway, with sill at elevation 446.5 m, would be fitted with six radial gates. It would be designed to pass the design flood of 11,900 m^3/s with the reservoir at elevation 461.8 m and would be capable of passing the probable maximum flood with the reservoir at elevation 466.3 m, 4.5 m above normal maximum operating level. Due to the control exercised by the Williston Reservoir upstream on the Peace River and the adoption of flood forecasting procedures, operation of the Site C spillway would be an infrequent event when the power plant is fully commissioned.

Powerplant and Switching Facilities

The intake structure for the powerplant would be in line with, and adjacent to, the spillway structure. The intake channel would be common to the intake structure and the spillway. The intake structure, approximately 400 m long and 45 m high, would consist of six separately gated openings each connected through a steel penstock to the scroll case of a Francis turbine housed in the powerstation downstream. The 9.35 m diameter penstocks would be encased in concrete and partly buried in granular backfill behind the intake structure. The surface powerstation would contain six units rated at 150 MW each (total 900 MW) under a head of 48.4 m. The total discharge under this head would be approximately 2200 m^3/s.

Although the station would be operated remotely from the G.M. Shrum generating station upstream, or from the Burnaby Mountain System Control Centre near Vancouver, a control room for local control would be provided in the service bay. Following transformation to 138 kV, power from the generators would be delivered by cable to the switchgear building located on a platform excavated in the overburden slope above and to the south of the power station. From here the output from the plant would be delivered to the Peace Canyon Switchyard by two 500 kV transmission lines and to Fort St. John by the existing 138 Kv line.

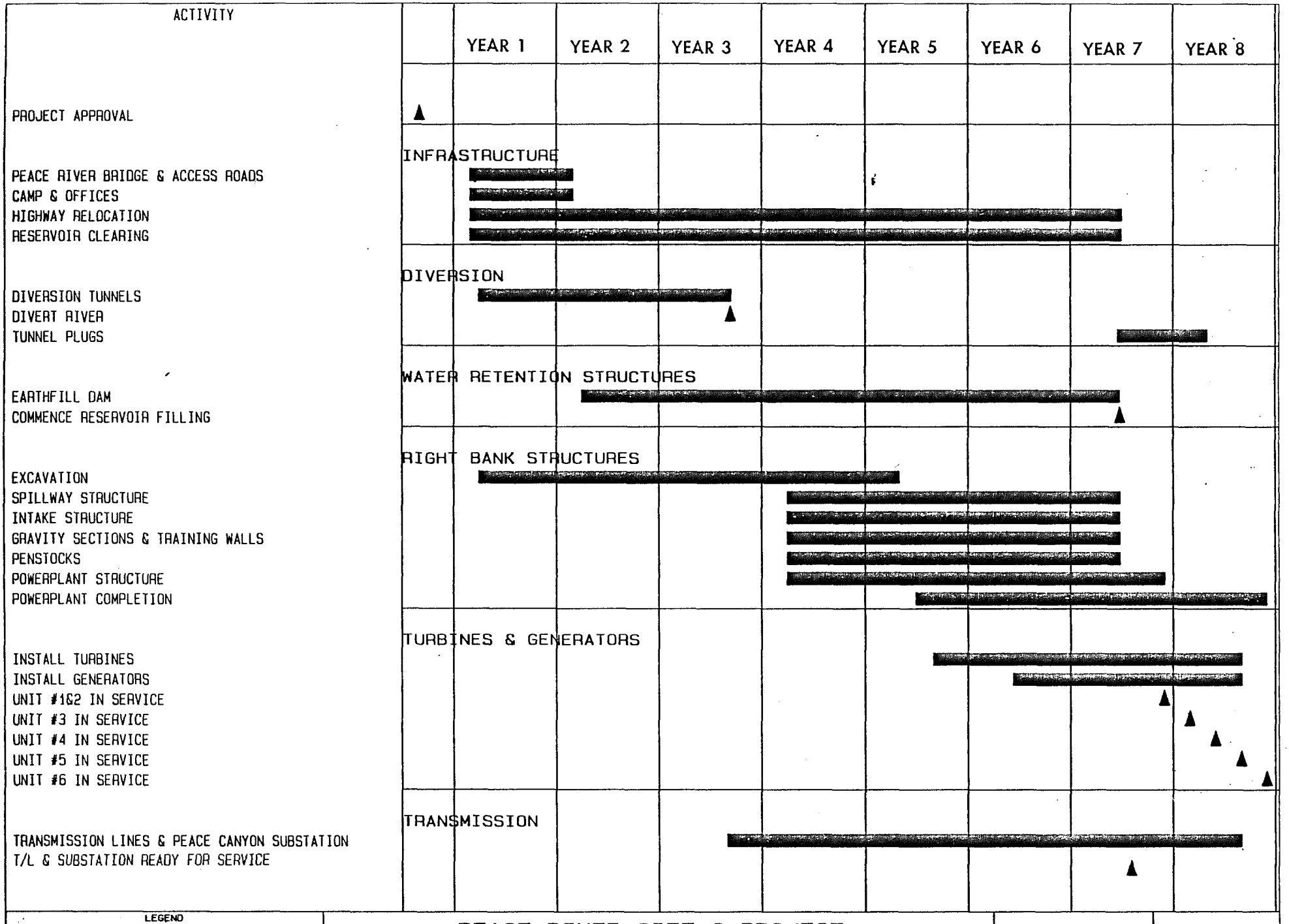
2.1.4 SIGNIFICANT CHANGES SINCE 1980

No significant changes to the project have been introduced since 1980, although the accumulation of additional hydrological and geological data in the intervening period has led to some design refinements. For example, the diversion tunnels have been reduced in size and the configuration of the cofferdams to be used for construction has been modified. There would also be adjustments in the alignments of some of the access roads in the site area as well as the siting of some of the construction facilities.

2.1.5 PROJECT SCHEDULE

Current scheduling studies still to be completed, indicate that an 86 month period (7 years, 2 months) would be required from the date of issue of tender of the first site construction contracts to the in-service date of the first two units (Fig. 2-4).

B.C. Hydro resource planning anticipates an in-service date for the project of 1 December in the year that energy is forecast to be available. Given the anticipated construction period, a 1 December in-service date would require that the first site construction contracts be issued for tender on 1 October, 7 years and 2 months earlier than the in-service date. This would allow about six months time for submission of tenders, award of contracts and mobilization



PEACE RIVER SITE C PROJECT
SUMMARY CONSTRUCTION SCHEDULE

BCHydro

Fig. 2.4

Report : BCH03
Project : C-WSS-03
Date : 06MAR91

over the winter so that commencement of on-site construction work could take place in the spring, approximately 1 April, and the use of the full construction season of the first year would be assured.

2.1.6 CONSTRUCTION

The first major construction activities would be creation of access to the project site, construction of the labour camp and excavations on the north and south banks of the river. Initial excavations on the north bank would establish upstream and downstream portals for the diversion tunnels to permit a start on underground excavation. The intake and outlet channels would be isolated from the river by local cofferdams. Excavations on the south bank would remove a large volume of bulk excavation before award of the final construction contracts to complete the excavations and build the concrete structures.

Initial on-site construction contracts and turbine and generator design, supply and installation contracts would be simultaneously tendered. Closure of the cofferdams to divert the river to allow construction of the earthfill embankment would take place in the fall of the third year of construction. The completed diversion tunnels would be opened and the river channel blocked with upstream and downstream cofferdams. After excavation of the riverbed and preparation of the foundations, the main earthfill dam would be built. The construction period for earthfill would be restricted by seasonal weather variations but would be completed by the start of summer of the seventh year. One diversion tunnel would then be closed to permit reservoir filling while required river flows are maintained through the other tunnel. When the reservoir level reaches the spillway overflow level the other diversion tunnel would be closed and the river flows would be maintained through the spillway or through the generating units.

Following excavations on the south bank of the river, starting in spring of year four, the major powerplant and spillway concrete

structures would be built. Progress would be scheduled so that installation of the turbines could begin at the end of year five. The first two units would be available for testing in the fall of year seven when water is available from the reservoir. The unit testing would be completed and commercial operation could start by 1 December of year seven. Work areas and borrow pits used during construction would be graded and seeded in an appropriate manner when these areas are no longer required.

Although a weighted average life of 70 years has been used as the cessation of economic viability of such dams it is estimated that the actual project life may be many times greater. Even if substantial sedimentation occurs in the reservoir over a few hundred years, the project could continue in operation.

2.1.7 OPERATIONS AND MAINTENANCE

The Site C plant would be operated to meet B.C. Hydro system load requirements in a manner consistent with the upstream plants, G.M. Shrum (GMS) and Peace Canyon (PCN). These plants are expected to continue to provide a significant amount (40%) of the system energy generation and have sufficient flexibility and capacity to meet a variable system load with fluctuations over periods ranging from hours to years. These changes in generation to meet system loads would mean that the Site C outflows would similarly change.

Since PCN and Site C have limited storage available for the re-regulation, or modification, of upstream plant outflows, or for the regulation of inflows from tributaries, and in order to prevent or reduce spill at these projects, the reservoir levels at PCN and Site C are expected to fluctuate. The amount of the reservoir fluctuations would vary in response to upstream discharges, local inflows, and available generating units. The fluctuations could be daily, weekly, and seasonally. The expected daily operating range of fluctuation for Site C based on past experience at PCN and Revelstoke, would be two meters or less for 80% of the time.

However, drawdowns up to six meters or more could occur for emergency or unusual system conditions (e.g. loss or restriction of generating units at one of the projects, restrictions on system generation or transmission facilities, etc.) or prior to the freshet, but with an expected frequency of less than 1% of the time. Infrequently, the Site C reservoir could be surcharged above the normal maximum reservoir level due to unexpected rainfall runoff from the local basin.

The Site C tailwater levels would vary with plant discharges. The magnitude, fluctuations, and distributions of plant discharge between generation releases and spill releases, would depend upon available generating units, allowable reservoir fluctuations,including reservoir surcharge, emergency or unusual system conditions, and local basin inflow conditions. During the freshet it may be necessary for plant discharge to increase significantly to pass floods on the Halfway and the Moberly rivers.

Reservoir filling would be carried out under the direction of the B.C. Hydro Engineering Department to ensure that controlled filling occurred with all the necessary monitoring.

Consistent with other hydroelectric generating units of similar size and design in B.C. Hydro's system, the maintenance on the Site C units would probably be carried out as follows for each unit: six weeks for major maintenance work in the first year,and two weeks for minor work and warranty inspection in the second year, and four weeks alternate years thereafter.

2.2 SITE C 500 kV TRANSMISSION LINE

2.2.1 GENERAL

The two proposed 500 kV transmission lines would run from the proposed Site C hydroelectric development near Ft. St. John to the existing B.C. Hydro hydroelectric development at Peace Canyon near

Hudson's Hope. This connection would accommodate the transmission of electrical power generated at Site C to the existing B.C. Hydro transmission system.

2.2.2 PROPOSED ROUTE

Two 500 kV lines are proposed to follow an established B.C. Hydro transmission line corridor (Fig. 2-5). From Site C, the route runs south-west parallel to the B.C. Rail line for approximately 28 km. It then continues south-west crossing the Moberly River Valley just south of Boucher Lake and crosses Highway 29 between Hudson's Hope and Chetwynd before crossing the Peace River and entering the Peace Canyon Switching Station. The route length is approximately 76 km, most of which is forested Crown land with some cultivated private parcels.

B.C. Hydro has a 118m right-of-way that runs from the Site C area to Peace Canyon and can accommodate both of the 500 kV lines in place of the existing two 138 kV lines (Fig. 2-6). The existing right-of-way would be used for most of the route with the possible exception of short lengths at the Peace Canyon and the Site C terminations. The existing right-of-way is presently cleared to a width of 65 m to accommodate the two 138 kV lines. This would be increased to approximately 140 m requiring removal of some trees outside of the existing right-of-way that threaten the security of the new lines. As such, minimal property acquisitions and easements are anticipated.

2.2.3 TRANSMISSION

The proposed lines would be single 500 kV AC transmission lines physically similar to the existing 500 kV lines running south from G.M. Shrum Generating Station and Peace Canyon. The basic tower design (Fig. 2-7) would be a single-circuit lattice steel structure supporting three electrical phases in a horizontal (flat) configuration. Each phase would consist of four sub-conductors arranged in a square bundle.

The relatively flat rolling terrain traversed by the route would allow use, for approximately 90% of the route, of the guyed type towers. Self-supporting structures would be used only for line terminations, long spans, and large line deflections.

The distance between the structures would vary depending on the terrain; however, in most cases it would be between 400 and 500 m typical of B.C. Hydro's 500 kV lines. The average structure height would be approximately 28 m. The conductor to ground clearance would vary but the minimum would be 11 m. B.C. Hydro designs for transmission lines, including their ground clearances, meet or exceed Canadian Standards Association (CSA) requirements.

2.2.4 CLEARING, CONSTRUCTION AND RIGHT-OF-WAY ACCESS

There is existing road access along portions of the route as a result of the construction and maintenance of the two existing 138 kV lines. Some additional access would be required from the existing roads to new individual structure and work sites. Due to normally wet soil conditions, some winter construction techniques for winter roads and clearing were utilized for the installations of sections of these 138 kV lines. It is, therefore, anticipated that due to both technical and environmental factors, similar line clearing and construction and road construction techniques would be necessary for the two proposed 500 kV lines.

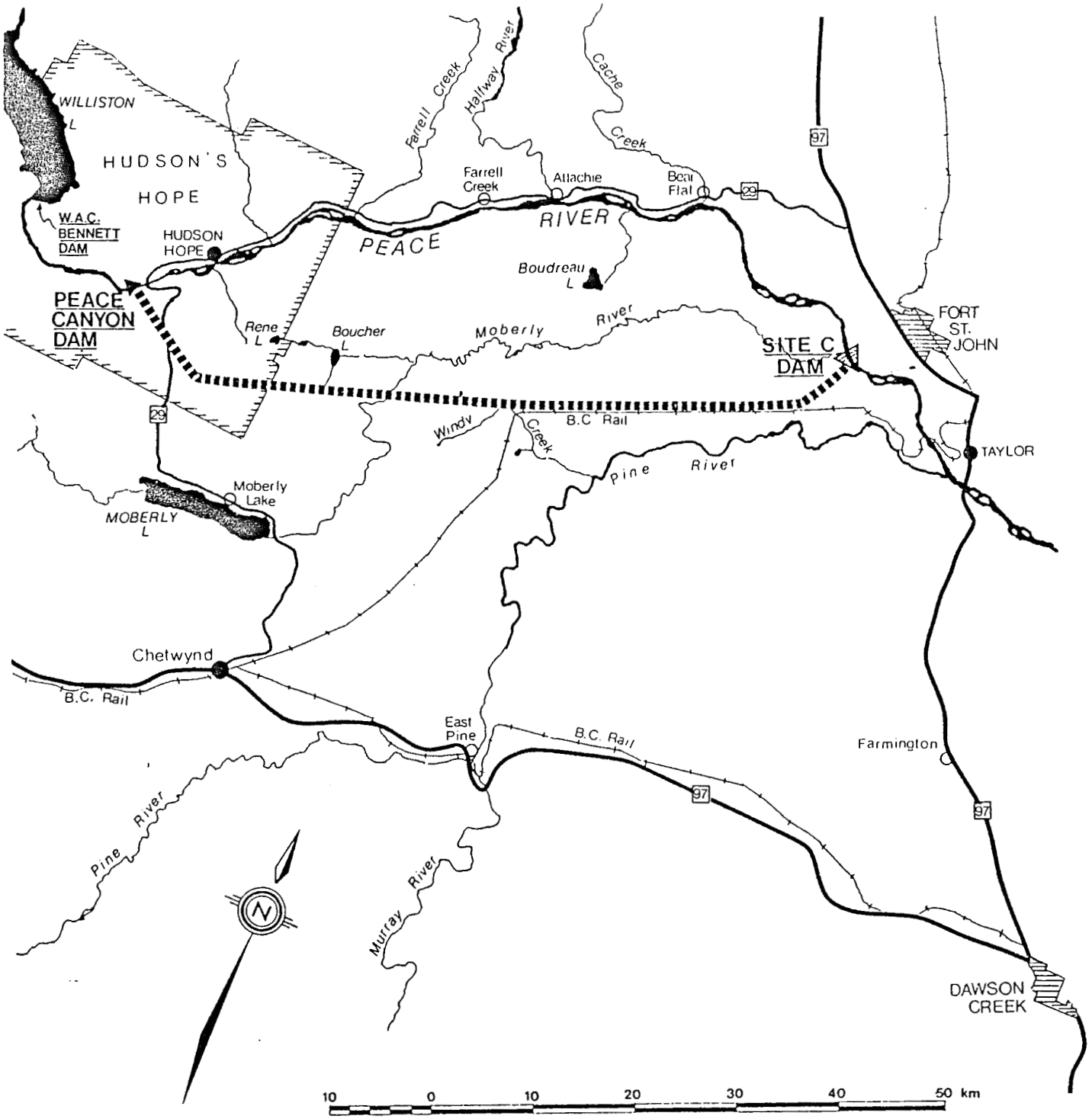
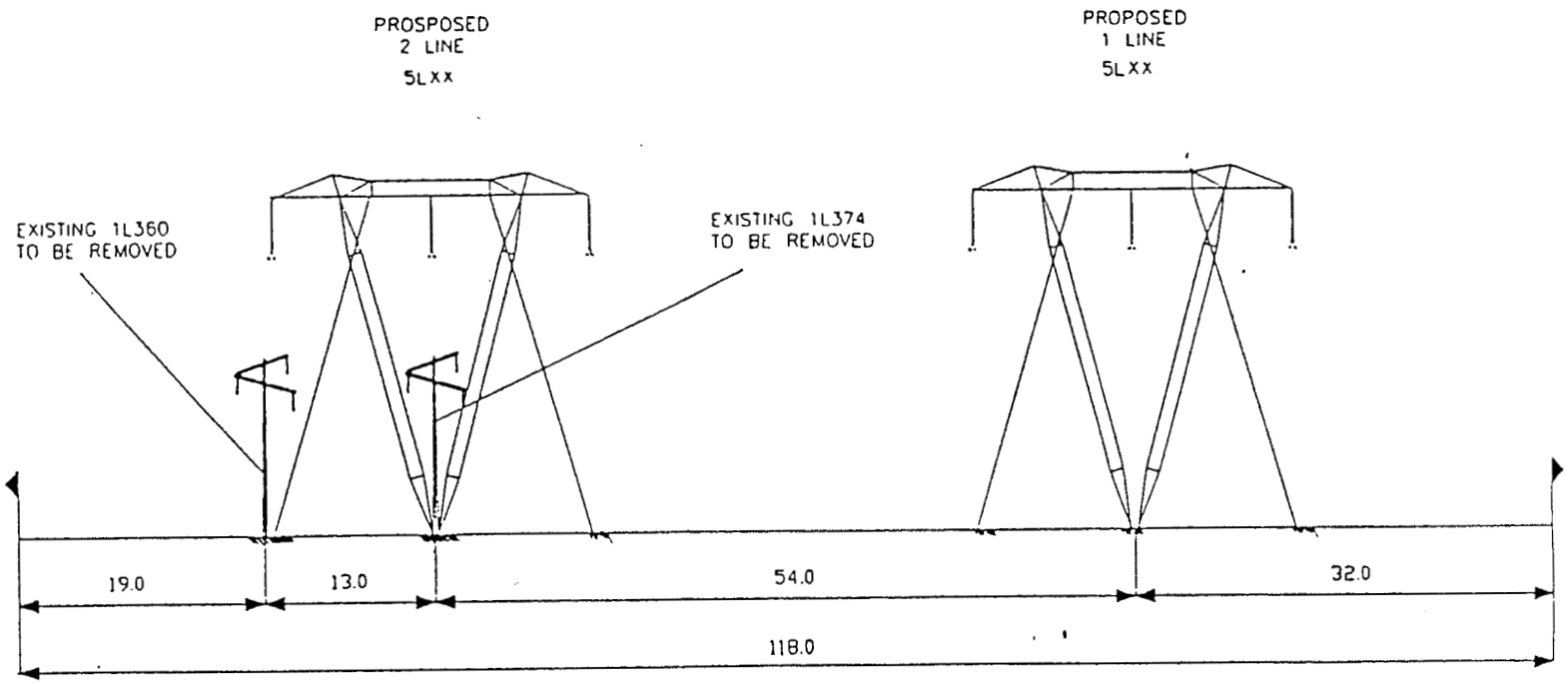


Figure 2-5

PROPOSED ROUTE FOR 500kV TRANSMISSION LINE – SITE C/PEACE CANYON

Figure 2-6

SITE C - PEACE CANYON
500 kV TRANSMISSION LINE PROJECT
TYPICAL RIGHT-OF-WAY CROSS SECTION



VIEW LOOKING FROM SITE C TOWARDS PEACE CANYON

NOTE: DIMENSIONS IN METRES

2.2.5 ANCILLARY FACILITIES

Line terminations and associated switching facilities would be installed at both Site C and Peace Canyon. This equipment could be accommodated within the existing station boundaries at Peace Canyon and within the development area at Site C.

SECTION 3.0 - PROJECT RATIONALE

In its 1990 Electricity Plan, B.C. Hydro established the following resource development priority, based on criteria such as cost-effectiveness, availability, public acceptability, socio-economic and environmental impacts, uncertainty and transmission impacts;

1. Power Smart -- increased efficiency of electricity end-use
2. Coordination and Major Purchases
3. Resource Smart -- increased efficiency of B.C. Hydro's existing facilities
4. Private Sector Generation, Self-generation and Load Displacement
5. New hydroelectric generation in developed river basins
6. New hydroelectric generation in undeveloped river basins

The current outlook for the quantity and price of resources available in categories 1 to 4 is such that these resources appear to be sufficient to meet forecast electricity demands until almost the turn of the century, when the Canadian Entitlement of the Columbia River Treaty Downstream Benefits begins reverting to British Columbia. Under current demand projections and on the assumption that these resources (plus the return of the Canadian Entitlement of the Columbia River Treaty Downstream Benefits) will be available in sufficient quantity, it appears that no major new hydroelectric generation facilities requiring construction of dams, either in developed or undeveloped basins, would be required to be in-service until early in the next century.

Because of the uncertainties involved in forecasting future demand for electricity and in predicting the degree of success of the various initiatives in categories 1 to 4, preliminary studies were carried out for a number of potential contingency options, including the Peace Site C Project. These studies are currently being finalized and documented in a manner which will maintain the project as a viable option for future supply and will facilitate reactivation of the project when required.

B.C. Hydro's resource development planning includes a risk management strategy to protect against the risks of over-supply and under-supply in the event of significant demand/supply imbalances during the forecast period. Over-supply risks occur when projects are built too early, potentially causing energy surpluses. Under-supply risks occur when projects are not built in time and higher cost options must be utilized to meet demands.

The Site C Project plays a vital role in B.C. Hydro's risk management strategy for responding to higher than expected growth in electrical demand. By having brought the Site C studies to an advanced stage of licence application readiness, B.C. Hydro's ability to reactivate the project quickly, if required, is enhanced.

In the event that a significant long-term trend indicating a future under-supply situation were to emerge, measures involving substantial commitments such as advancement of new generation facilities, would be required. For example, some of the higher than expected load growth scenarios suggest that a major project or additional IPPs could be required in the early 2000's. Alternatively, the unavailability of other resources, such as the Canadian Entitlement of the Columbia River Treaty Downstream Benefits, could result in a similar requirement in the early 2000's.

The Site C Project would not be suitable for meeting short-term under-supply situations, in view of the size of the project and the relatively lengthy lead time required to bring it into service. Short-term variations, which may balance out over the longer term, can be addressed by measures such as appropriate reservoir management (e.g., deliberate filling or drafting of reservoirs), variations in non-firm energy purchases, adjustment of interruptible electricity exports, and adjustments of existing thermal plant use.

SECTION 4.0 - PUBLIC CONSULTATION PROGRAM

4.1 INTRODUCTION

4.1.1 History and Update of Public Consultation Program

The public information and consultation program for the Site C project began in 1975 with public discussion initiated by B.C. Hydro about the alternatives (Sites C and E) for developing the Peace River between the Peace Canyon development and the Alberta border. Between 1975 and 1977 several information bulletins were published and meetings were held with the Regional District, property owners, interest groups, Indian Bands and the public.

Detailed studies on Site C were distributed in 1979 throughout the Peace River area and to Government, public interest groups and libraries throughout the province. B.C. Hydro's information program was focused in the region with the opening of a Site C Information Centre in Fort St. John in 1980, followed by open house meetings and the dissemination of information through displays, films, fact sheets and summary documents.

Upon submission of the EPC application in September 1980, B.C. Hydro halted active consultation except for providing information as requested, since it did not wish to be perceived as lobbying the public or BCUC.

Since the 1983 decision by BCUC, no further action was undertaken by B.C. Hydro until 1989. Once the new Site C project mandate was initiated in May 1989, B.C. Hydro commenced preparations for a possible new application for conditional approval of an EPC as a contingency measure, and began a new public consultation program. In this program, numerous project fact sheets, project newsletters and reports were distributed in the study area and throughout the

province. Letters were sent to 123 people in response to requests for information, or comments about, the project.

Meetings were held with special interest groups and the public during 1989. These included:

- over 30 special interest group meetings;
- four public information meetings in communities in the region;
- four open houses in communities in the region.

The consultation process involved identification of issues and concerns related to Site C, a review by the public of the degree to which the issues and concerns were properly stated and described, and inclusion of these issues and concerns in a new round of environmental studies commencing in mid 1990.

More detail on this program is provided in the "Peace River Site C Public Consultation Program, Final Report" published as a separate document.

Positions with regard to the project were provided to B.C. Hydro in a "Position Paper of the District of Hudson's Hope" and by letter dated May 3, 1990, with attachment, from the Peace River Regional District.

4.1.2 Study Area and Participants

The study area for consultation on the Site C project was structured to incorporate both local/regional concerns and province-wide concerns. The regional study area included all interest groups, the public, and communities potentially affected by, or with an interest in, the proposed Site C dam. Specific communities in the region included:

- Fort St. John
- Taylor
- Dawson Creek

- Pouce Coupe
- Hudson's Hope
- Chetwynd

In all, over 35 interest groups were identified ranging from environmental groups (e.g. The Peace Valley Environmental Association), to business interests (e.g., Chambers of Commerce and labour organizations). A full list of interest groups is provided in the "Peace River Site C Public Consultation Program, Final Report".

The focus of the current program was on regional stakeholders (communities, interest groups, native groups and the public). Local governments were active in the consultation program. These included one regional district, six incorporated municipalities, and various Indian bands within the Treaty 8 Tribal Association and the Peace Tribal Alliance. Contacts were also established with provincial MLAs, federal MP's, school boards, hospital boards, the R.C.M.P., major industries, citizen's committees, wildlife associations, several other provincial and local interest groups, local newspapers, radio stations and interested individuals.

4.2 METHODOLOGY

The public consultation program has been conducted consistent with the requirements of the "Utilities Commission Act" (1980), as outlined in the provincial government's "Guide to the Energy Project Review Process" (1982). The expectations of the federal government agencies with an interest in the project were also addressed.

4.2.1 Internal Organization

B.C. Hydro's Public Information and Consultation Program is the responsibility of its External Relations Department (Government and Public Affairs Division). The 1989/1990 Site C Public Consultation Program was designed and conducted by a consultant, the DPA Group

Inc., commissioned by B.C. Hydro, External Relations department, under the direction of the Site C project manager. Interaction with the consultant was coordinated by the External Relations coordinator and included a team drawn from the Site C project team, B.C. Hydro's Environmental Resources department, and other B.C. Hydro representatives as required. The consultant assumed primary responsibility for the consultation program and was assisted by various members of the project team and other B.C. Hydro staff.

4.2.2 Operational Principles for Public Consultation

The approach adopted in the current program was designed to be a constructive, open and interactive planning process providing local and provincial interest groups and individuals the opportunity to participate.

Operating principles adopted by the public consultation team and the B.C. Hydro participants in the program, and the results achieved, include:

- commitment to meaningful public involvement where the public feels some ownership over the process; characterized by an open exchange of information;
- recognition that public involvement requires provision of information, however incomplete, to participants; even when final answers were not known, it was better to give the public draft and incomplete information to demonstrate commitment to an open process;
- recognition of the importance of public input in the design of the public involvement program itself; local representatives were requested to help design the public involvement program;
- sensitivity to the public consultation process and the role of the consultant as an independent facilitator; the consultant's role was clearly established as a facilitator, working with the public to help identify and express issues, concerns and

suggestions; and working with B.C. Hydro to provide responses to these in a way which was easily understood by the public.

4.2.3 Consultation Program Objectives

The overall goal and objectives established for the public involvement program are:

Goal:

- To identify issues and concerns about the Site C project, and to assist B.C. Hydro in finding ways to resolve these concerns.

Guiding Principle:

- To identify and respond to community concerns in a pro-active and open manner.

Specific Objectives

- To foster an understanding of the project, the project planning process and the potential implications of the project;
- To provide ongoing opportunities for residents and B.C. Hydro to exchange information and views;
- To achieve some measure of public consensus on the issues and on how best to address them;
- To provide useful input to B.C. Hydro regarding appropriate mitigation, compensation and enhancement strategies;
- To demonstrate B.C. Hydro's commitment to responding to community concerns in an open, honest and straight-forward manner.

The public was fully informed of these objectives through meetings with interest groups, public meetings and open houses, and newsletters.

4.3 CONSULTATION PROGRAM DESIGN

The basic design for the consultation program involved several activities as follows:

- identify the study area and its various communities, political structures, and public interests;
- contact the various community interests and cooperatively develop an information and consultation plan;
- inform the public of the project's requirements through published information, meetings, displays, telephone information "hot-line", and other means;
- develop dialogue through various forums, e.g., written or telephone response to publications, informal meetings, open houses, drop-in centres, as appropriate;
- facilitate interactions of the communities and other stakeholders with B.C. Hydro;
- identify, define, and document the concerns raised by the public;
- respond to public concerns and resolve problems where possible;
- identify and incorporate potential mitigation strategies, compensation, and other options in the project's design to address issues raised by stakeholders;
- prepare a summary report on public consultation.

Within this general framework, the consultation program included two general components:

- formation of a local public consultation committee;
- the consultation process itself.

4.3.1 The Local Site C Public Consultation Committee

A Consultation Committee was formed in 1989 to provide advice to the consultant regarding the design and execution of the Public Consultation Program. Its membership included representatives from the following communities/organizations:

- Chetwynd
- Dawson Creek
- Fort St. John
- Hudson's Hope
- Peace Liard Wildlife Association
- Peace River Regional District
- Peace Valley Environmental Association
- Taylor
- Treaty 8 Tribal Association

The objectives for providing advice to the consultation team, agreed to by the Committee, were to:

- work with the consultant to devise a consultation process which would maximize the amount of meaningful and useful input from the community;
- communicate with the community and the consultant to ensure that all members of the community had access to the public consultation process;
- attend the public meetings and open houses in individual members' respective communities;
- work with the consultants to ensure that all issues, concerns, and resolutions were fully and accurately documented and communicated in such a way that the community understood;
- provide feedback to the consultant on the effectiveness of the Public Consultation and to provide recommendations for improvements to the process on an ongoing basis.

The Committee met with the consultant 4 times between September 1989 and January 1990. Details of the Committee's input is provided in the Public Consultation Report accompanying this application. The Committee was instrumental in helping to refine the design for the consultation program. Suggestions which they made ranging from venue selection for open houses to advertising were incorporated into the program.

4.3.2 Public Consultation Process

Following review of the proposed consultation process with the Site C Consultation Committee, adjustments were made to reflect their suggestions on how to maximize public access to, and participation in, the process.

In summary terms, the general structure of the process is as follows:

- information meetings to introduce the Site C Project to the public, describe the proposed consultation program, and begin to identify their comments;

- meetings with interest groups to assemble focused information on their concerns;
- a comprehensive statement of suggestions, comments, issues and concerns reviewed with the public to ensure that all areas are covered;
- preparation (by B.C. Hydro) of responses; (not completed)
- review of responses by the public (not conducted).

The consultation program was generally accepted by local groups and members of the public. The consultation team was able to develop a comprehensive list of the issues and concerns to which B.C. Hydro has made a commitment to respond.

B.C. Hydro is designing a program of ongoing communication within the region which, primarily through its local offices, will continue to interact with the community groups.

4.4 PUBLIC CONCERNS

4.4.1 Project Related Concerns

4.4.2 General Public Concerns

These are presented in the Peace River Site C Public Consultation Program, Final Report.

4.5 PUBLIC INPUT TO ENVIRONMENTAL STUDIES

The next step in the process was for B.C. Hydro to prepare a response document which would then be reviewed by the public. The issues and concerns documented to date were used in the preparation of Terms of Reference for the environmental studies. B.C. Hydro intended to use these study results to prepare the response document. This document would then be presented to the public for their review and input.

The 1990 public consultation program associated with the environmental studies consisted of the following main activities:

- ongoing communication with the public
- review of Terms of Reference
- communication between the environmental consultants and the public;
- ongoing meetings with the consultation committee

4.5.1 Communication with the Public

To inform the public of the environmental studies, a newsletter was prepared by B.C. Hydro and distributed in September 1990 to all

households in the region by mail drop. The newsletter provided a status report on Site C, notice of Hydro's intention to undertake the environmental studies, and brief summaries of each study.

4.5.2 Review of Terms of Reference

The consultation committee was asked to advise on the best method to obtain public review of the Terms of Reference, and it recommended that the Terms of Reference be mailed to the interest groups for their input. A letter was sent inviting interest groups to review the Terms of Reference and provide comments to the public consultation consultant. Follow-up phone calls were made to ensure that the interest groups understood the material and the process for review. Written comments were received from 5 of the 45 interest groups and local governments which were invited to comment.

The interest groups which received an invitation to comment on the Terms of Reference are listed in Table 4-1.

Comments received on the Terms of Reference suggested additional emphasis on the following study disciplines:

- Socio-economic Studies
- Heritage Resources
- Climate
- Downstream Studies

Details on comments submitted by interest groups are presented in the "Peace River Site C Public Consultation Program, Final Report."

4.5.3 Communication with the Environmental Consultants

To ensure that the conduct of the environmental studies was consistent with the principles and objectives of the public consultation program, the public consultation consultant conducted a workshop with all the environmental consultants. The objective of

the workshop was to inform all consultants of the results of the public consultation process, highlighting the issues and concerns obtained to date, discussing areas of overlap between studies, and ways to reduce the demands on the public (i.e. combining meetings). DPA sent a bi-monthly report to all consultants informing them of all study activities, and helped to coordinate meetings held in the region.

SECTION 5.0 - ENGINEERING STUDIES

5.1 INTRODUCTION

By 1982, when previous engineering studies were suspended, extensive site explorations had been carried out and the designs and planning for Site C had advanced to the stage where drafts of technical specifications and tender drawings had been prepared for:

- the majority of the infrastructure works including the left and right bank access roads the main construction camp and a bridge across the Peace River;

- the turbines;

- a single civil package (PC-1) including the entire diversion works, the first stage left bank stabilization works, the first and second stage cofferdams and the dam embankment; and

- supply of the gates, gate hoists and stoplogs for the diversion tunnel portal structures including the associated embedded parts.

In 1988, B.C. Hydro load forecasts indicated that it would be prudent to resume engineering activities on Peace Site C as part of a contingency plan to reduce the project lead time. At the same time it was decided to transfer engineering design to the private sector and, following a thorough competitive selection process, Klohn-Crippen Consultants Ltd. were hired to carry out the engineering. Extensive review of the existing designs was carried out and subsequently Klohn-Crippen assumed professional responsibility for the design of Site C, with some minor modifications, and advanced engineering and technical specifications for the critical early contracts.

5.2 PROCUREMENT

Consistent with B.C. Hydro's objective of maximizing potential benefits to the economic development of BC, a review of contract packaging was undertaken and is described in Report No. KC03[1] "Preparatory Engineering Activities for the Site C and Keenleyside Projects - Contract Packaging", which is included with this submission.

The general conclusion from this review was that, while significant benefits should accrue to the Province from small contracts, these should be assessed against the potential increased costs and risks to a project before determining the specific contract packaging.

The review of Site C contract packaging resulted in subdivision of many of the contracts originally envisaged in the early 1980's. A list of the currently proposed contracts is contained in Table 5-1.

The following tender documents for the early critical contracts have now been prepared to an advanced draft stage (shelf ready), whereby they could be quickly finalized and issued.

PC-1A	Clearing - Left Bank
PC-1B	Campsite - Grading and Access Road
PC-1C	Diversion Tunnels and Tunnel Cofferdams
PC-1F	Clearing - Right Bank
PC-1G	Right Bank Access Roads
PC-2	Turbines and Governors
PC-10A	Campsite Services
PC-11	Peace River Bridge
PC-13	Prefabricated Camp Buildings
PC-30A	Diversion Gate Embedded Parts
PC-30D	Diversion Outlet Stoplog Embedded Parts

5.3 DESIGN STATUS

5.3.1 Introduction

Klohn-Crippen commenced engineering activities on Site C at the end of 1988 and, with the exception of completion of a study on the Probable Maximum Flood (PMF), ceased design activities by June 1990 at B.C. Hydro's direction.

Report No. KC73[2] "Peace River Site C, Shelf Ready Design Status Report", included with this submission, has been prepared to document the status of engineering activities as of November 1990 and to provide information required to permit an efficient start up of engineering work in the future. A detailed schedule for the recommencement of design activities is included in the report.

Engineering activities were coordinated under B.C. Hydro's project management requirements which are described in Section 5.4, adopting the Work Breakdown Structure as the project management framework.

5.3.2 Accomplishments

During the course of the engineering activities Klohn-Crippen issued 53 reports, their subconsultants 11 reports and B.C. Hydro two related engineering reports. These provide a comprehensive record of the status of engineering on the project and are listed in Table 5-2.

The primary objectives of Klohn-Crippen's work program were met. Professional responsibility for design of Site C was transferred to Klohn-Crippen, they became familiar with B.C. Hydro's design practices and engineering and technical specifications for the early contracts were completed.

The following are some of the significant accomplishments achieved as well as the engineering and technical specifications for the early contracts listed in Section 5.2.

- A field investigations program was carried out in 1989 to provide additional information on foundation conditions and construction materials. One result was a reduction in required overburden excavation on the north bank from the early 1980's estimate of 15.2 million m^3 to 8.6 million m^3.

- Due to changed operating conditions at G.M. Shrum Generation Station upstream, the diversion tunnels diameters have been reduced from 11.2 m to 9.8 m.

- It was decided to locate a construction camp on each bank of the river, as compared with the original concept of one camp on the north bank.

- Joint studies (Klohn-Crippen/B.C. Hydro) on the Probable Maximum Flood (PMF) for the project were undertaken. These studies have extended over a lengthy period due to involvement of key personnel in other activities. This basic design parameter is expected to be satisfactorily defined by mid-1991.

- New computerized digitized mapping was prepared for the damsite and reservoir area.

- A review of the stability, of the reservoir shoreline was initiated. Existing instrumentation was rehabilitated and some new instrumentation was installed. A monitoring program was implemented and is ongoing.

5.4 PROJECT MANAGEMENT SYSTEM

5.4.1 Introduction

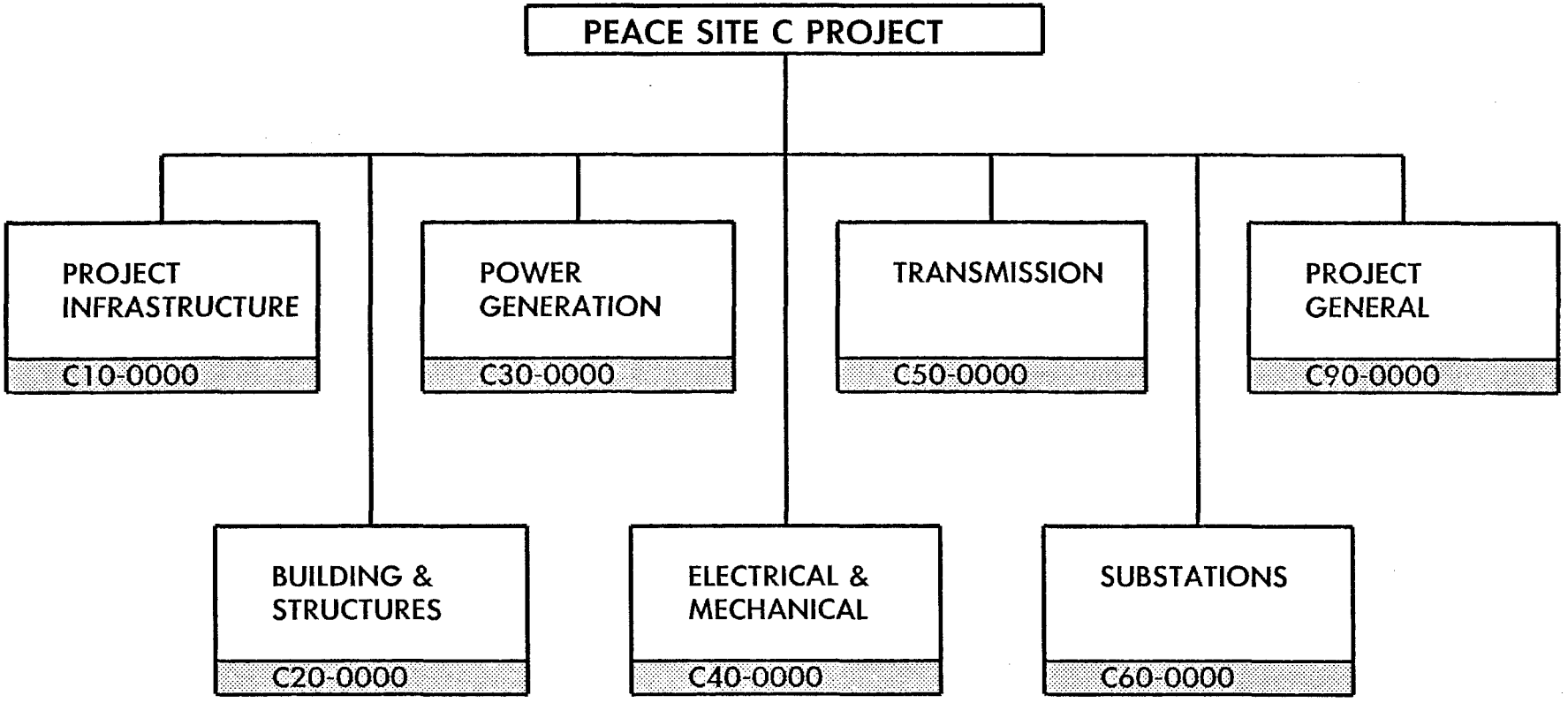
In response to some concerns expressed at the BCUC hearings on B.C. Hydro's 1980 application for an Energy Project Certificate for the Site C Project, B.C. Hydro advised that it was in the process of modifying its traditional approach to management for large hydroelectric projects from a functional management system to a project management system. B.C. Hydro's commitment was emphasized in 1985 with the formation of a Project Management Division. Formal policies and procedures for project management together with operational requirements were compiled in manuals issued in 1989.

In early 1989 a further initiative was introduced to develop a Work Breakdown Structure (WBS) as a fundamental management tool for the Site C Project in accordance with current project management philosophy.

5.4.2 Work Breakdown Structure

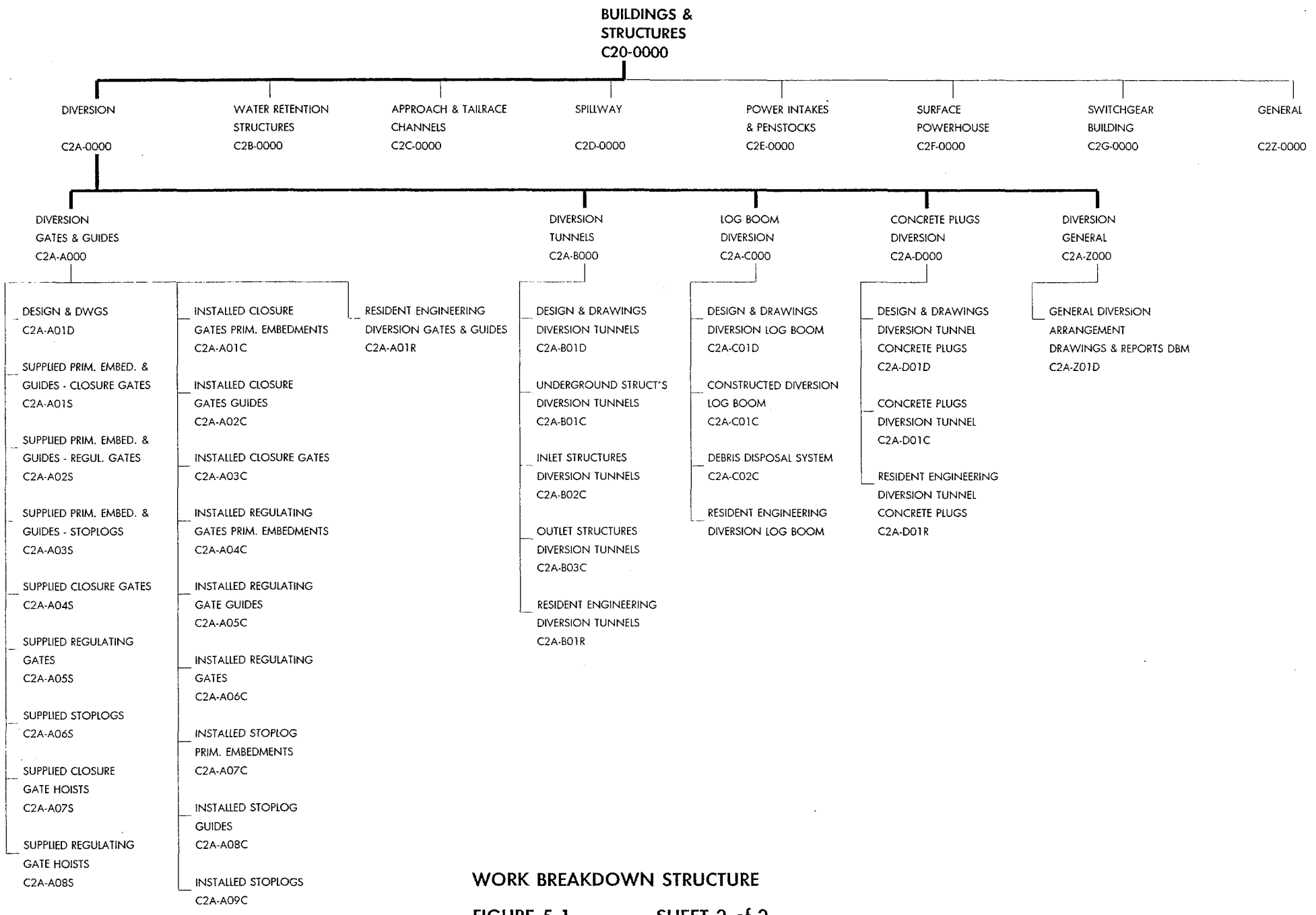
The WBS is a hierarchal information classification system, typically described or displayed in the form of a tree diagram (Figure 5-1). Each box in the tree is described as an element of the WBS and the elements portraying the final breakdown are unique, each with a precise scope and a distinct set of specified results to be delivered.

The WBS is, foremost, a tool for subdividing the scope of a project into manageable portions. The topmost element in the WBS tree contains the entire project scope. In subsequent development of the detailed description, the total scope is systematically subdivided into facilities, then into features, sub-features and finally to elements classified as work packages. Work packages are defined such that a single party is responsible for achieving the specified results or deliverables and each work package can stand alone.



WORK BREAKDOWN STRUCTURE

FIGURE 5-1 SHEET 1 of 2



WORK BREAKDOWN STRUCTURE

FIGURE 5-1 **SHEET 2 of 2**

Numbers of work packages are combined to provide the supply, construct and service contracts which are finally awarded to deliver the entire project.

The breakdown is also used to illustrate increasing detail for project estimating and cost reporting throughout the project lifecycle. Costs applicable to individual elements can be estimated with increasing accuracy as the design is developed. The WBS facilitates the roll up to individual structures for capitalization or taxation purposes.

Each work package is assigned a start and completion date determined from the project schedule allowing the reporting and summarizing of schedules similar to costs and scope.

The WBS is used as the central management tool for achieving the assigned project objectives for scope, cost and time. The principal applications are:

Linking performance standards.
Scope and design management.
Cost estimating and reporting.
Activity scheduling.
Assigning scope to individual contracts.

A unique code consisting of letters and numbers is assigned to each element of the WBS. This code becomes the predominant information discipline for the Project. The WBS code must be used for, or included as an identifier in:

Scope Statements
Drawings
Project Budget
Task Assignment Documents
Files
Reports and Other Deliverables

Early in the development of the WBS, Walter A. Wawruck, Project Management Services, a Consultant on Project Management was hired to assist with the development of the tree and to be the Principal Author of the Guidelines for the WBS Manual.

Within the Manual there are two types of guidelines. General guidelines covering policy, management policies and description of processes. Secondly specific guidelines contain detailed instructions for carrying out a specific operation or step in a large operation. Typically they deal with the preparation of a form or document.

WBS Directory

The scope management process includes the development of a WBS directory. The WBS Directory is the project baseline document.

The basic content of the directory is the documentation of B.C. Hydro and other stakeholder requirements for the project and the description of how these requirements will be achieved.

Scope statements have been and are currently being prepared to reflect the current status of the design of the Project.

To aid the user in a search for items whose WBS code identifier she or he does not know, the Directory contains listings of WBS element code numbers and titles. These listings follow the hierarchal code sequence, and include a listing segregated by work package type.

TABLE 5-1

LIST OF FORESEEN CONTRACTS

(a) Civil Contracts

Contract Number	Description	E&M Input	Supply	Construction	Possible B.C. Firm
PC-1A*	Clearing - Left Bank			X	X
PC-1B*	Campsite - Grading and Access Road[1]			X	X
PC-1C*	Diversion Tunnels and Tunnel Cofferdams	X		X	?
--	Main Earthfill Dam with Cofferdams and Excavations on Left Bank			X	
PC-1F*	Clearing - Right Bank			X	X
PC-1G*	Right Bank Access Roads			X	X
PC-10A*	Campsite Services[1,3]	X		X	X
--	Asphalt Paving - Campsite and Approach Road[1,2]			X	X
PC-11*	Peace River Bridge			X	X
PC-13*	Prefabricated Camp Buildings[1]		X		X
--	Campsite Construction - B.C. Hydro Offices and Buildings[1]			X	X
--	Camp Catering and Housekeeping[1,2]		X		X
--	Petroleum Products Storage Depot				
--	Campsite Services[2,3]	X		X	X
--	Prefabricated Camp Buildings[2]		X		X
--	Campsite Construction - B.C. Hydro Offices and Buildings[2]			X	X
--	Bulk Excavation on Right Bank with Cofferdam for Outlet Channel			X	

(a) Civil Contracts (continued)

Contract Number	Description	E&M Input	Supply	Construction	Possible B.C. Firm
--	Powerplant and Spillway - Main Contract	X		X	
--	Penstocks and Couplings (Design, Supply and Install)	X		X	
--	Powerhouse Superstructure	X		X	X
--	Powerplant Completion[4]	X		X	X
--	Spillway Bridge			X	X
--	Switchgear Building	X		X	X
--	Reservoir Clearing			X	X
--	Environmental Reinstatement			X	X

Legend

* Denotes advanced draft contracts as of June 1990. It is considered that engineering has advanced sufficiently on these packages that tenders could be issued within about thirty days of approval to proceed, provided that the relevant outstanding issues listed in Section 3.0 and Section 5.0 could be resolved prior to tender issue.

Notes:

1 Denotes Left Bank Campsite
2 Denotes Right Bank Campsite
3 "Campsite Services" include supplying and installing underground services (water, sewer, gas), water storage tanks, water pumping system, sewage treatment plant, buildings to house such services and electrical power and lighting distribution systems.
4 "Powerplant Completion" would be a general contract including civil, mechanical and electrical works. Civil works would include the latter stages of secondary concrete and miscellaneous structural, building and architectural finishes in the powerhouse and elsewhere for the powerplant. See separate lists for details of mechanical and electrical works.

(b) Mechanical Contracts

Contract Number	Description	Electrical Input	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
PC-2**	Turbines and Governors (Design, Supply and Install)	X		X		X		
SUPPLY OF DIVERSION TUNNEL EQUIPMENT								
PC-30A*	Diversion Gate Embedded Parts		X		X		X	
--	Closure and Regulating Gates		X		X		X	
--	Regulating Gate Hoisting Equipment	X	X		X			
PC-30D*	Diversion Outlet Stoplog Embedded Parts		X		X		X	
--	Outlet Stoplogs and Lifting Beam		X		X		X	
SUPPLY OF DRAFT TUBE GATES								
--	Guides and Embedded Parts for Draft Tube Gates		X		X		X	
--	Draft Tube Gates		X		X		X	
--	Draft Tube Gate Crane (Design, Supply & Supervise Instn.)	X		X	X		X	X
SUPPLY OF POWER INTAKE EQUIPMENT								
--	Intake Gate Guides and Embedded Parts		X		X		X	
--	Intake Gates		X		X		X	
--	Intake Gate Hoists	X	X		X			
--	Bulkhead Gate Guides and Embedded Parts		X		X		X	

(b) Mechanical Contracts (continued)

Contract Number	Description	Electrical Input	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
--	Bulkhead Gates		X		X		X	
--	Intake Gantry Crane (Design, Supply & Supervise Instn.)	X		X	X		X	X
--	Intake Trash Racks		X		X		X	
SUPPLY OF SPILLWAY EQUIPMENT								
--	Seal Plates and Embedded Parts for Spillway Gates		X		X		X	
--	Spillway Gates with Post-tensioning Equipment		X		X		X	
--	Spillway Gate Hoists	X	X		X			
--	Guides and Embedded Parts for Spillway Stoplogs		X		X		X	
--	Spillway Stoplogs and Lifting Beam		X		X		X	
POWERPLANT EQUIPMENT								
--	Powerhouse Cranes (Design, Supply & Supervise Instn.)	X		X	ps			X
--	Equalizer Beam (Supply)		X		ps		X	
--	Pumps (Design and Supply)	X		X	pc			
--	Air Compressors (Design and Supply)	X		X	pc			
--	Fire Protection Systems and Equipment (Design & Supply)	X		X	pc			
--	Tanks and Receivers (Design & Supply)			X	pc		X	

(b) Mechanical Contracts (continued)

Contract Number	Description	Electrical Input	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
--	Water Treatment Equipment (Design & Supply)	X		X	pc			
--	Sewage Treatment Equipment (Design & Supply)	X		X	pc		X	
--	Workshop Equipment (Design and Supply)			X	pc			
--	Material Handling Equipment (Design and Supply)	X	X		pc		X	
--	Elevators (Design, Supply and Install)	X		X		X		
--	Auxiliary Power Generation Equipment	X		X	?	?	X	
POWERPLANT COMPLETION INCLUDING:								
--	Installation of above supplied powerplant equipment:					I		
	Supply and installation of:							
	- piping and valves (non-embedded)					D		
	- air handling equipment					D		
	- air ducting					D		
	- air conditioning units; and					K		

Contract Number	Description	Electrical Input	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
	other general finishing work to complete auxiliary mechanical systems.					X		

LEGEND

* Denotes advanced draft contracts as of June 1990. It is considered that engineering has advanced sufficiently on these packages that tenders could be issued within about thirty days of approval to proceed, provided that the relevant outstanding issues listed in Section 3.0 and Section 5.0 could be resolved prior to tender issue.

** It is considered that tenders for this contract could be issued within six months of a decision to proceed.

Notes:

I - Installation Only
ps - To be installed under the Powerhouse Superstructure Contract
pc - To be installed under the Powerplant Completion Contract
D - Conceptual design and selection of key equipment by Klohn-Crippen
K - Selection only of key equipment by Klohn-Crippen

(c) Electrical Contracts

Contract Number	Description	Input from Other Disc.	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
PC-3**	Generators (Design, Supply and Install)	M&E		X		X		X
--	Generator Transformers 13.8 to 138 kV			X	X			X
--	System Transformers 512.5/138 - 12.6 kV			X	X			X
--	Excitation Systems			X	X			X
--	Turbine Governor Actuators	M&E		X	X			X
--	Generator Terminal Equipment			X	X			
--	100 kV C.G.I. Switchgear			X	X			X
--	138 kV C.G.I. Switchgear			X	X			X
--	12.6 kV Metalclad Switchgear			X	X			
--	12.6 kV-600 V Main Station Service Switchboard			X	X		X	
--	AD/DC Distribution Switchboards			X	X		X	
--	100 kV Surge Arresters			X	B			
--	100 kV and 138 kV Line Termination Towers (Supply)	T&S	X		X		X	
--	100 kV Capaciter Voltage Transformers			X	B			
--	12.6-12.6 kV LTC Transformers			X	X			
--	138 kV Cable Circuits (Design, Supply and Install			X		X		X
--	138 kV Surge Arresters			X	B			

(c) Electrical Contracts (continued)

Contract Number	Description	Input from Other Disc.	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
--	138 kV Capacitor Voltage Transformers			X	B			
--	Protection and Control - Printed Circuit Boards (Supply)		X		X		X	
--	Protection and Control - Switchboards, Consoles and Cabinets (Supply)		X		X		X	
--	Protection and Control Sub-assembly Equipment (Supply)		X		X		X	
--	Fault Recorder			X	X			
--	Monitoring Equipment			X	X			
--	Transformer Fire Protection Controls (Supply)	M&E	X		X		X	
--	Station Service Air Compressor Controls (Supply)	M&E	X		X		X	
--	125 and 24 V Station Batteries			X	X		X	
--	125 and 24 V Battery Chargers (Supply)		X		X		X	
--	125 and 24 V DC Supply Cubicles (Supply)		X		X		X	
--	Powerplant Completion including:							
	- installation of above supplied equipment					I		
	- grounding				H	I		
	- conduits & ducts					X		
	- cable trays and supports					X		

Contract Number	Description	Input from Other Disc.	Prescriptive Specifications	Performance Specifications	Supply	Supply & Install	Possible B.C. Firms	Installation Supervision
	- lighting fixtures					X		
	- receptacles and switches					X		
	- wires and cables				H	I		
	- motor starters				H	I		
	- motor starters - heating and ventilation					X		
	- other general finishing work to complete ancillary electrical systems					X		

LEGEND

** It is considered that tenders for this contract could be issued within six months of a decision to proceed.

M - Mechanical Input
T - Transmission Line Input
B - Bulk Order by B.C. Hydro
I - Installation Only
E - Electrical Input
S - Structural Input
H - Other Direct Supply by B.C. Hydro

TABLE 5-2

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29. Report KC35 - Summary of Information for Advisory Board Meeting No. 6, 2 to 6 October 1989, Report on Status as at 31 August 1989, September 1989.

30. *Report KC36 - Switchgear Selection, Task CF10, Incomplete Draft Report, not Finalized.

31. Report KC37 - Geotechnical Database Recommendation Report, Task CG20, November 1989.

32. Report KC40 - Slope Stability Analyses of Preliminary Earthfill Dam Sections, Task C2C-B01D, March 1990.

33. Report KC42 - Investigations of Temporary Riprap, Task CG50, January 1990.

34. Report KC43 - 1989 Investigation Program Report on the Left Bank Trough, Task CG50, March 1990.

35. Report KC44 - Construction Materials Impervious Fill, Preliminary Search for Glacial Till, Task CG50, January 1990.

36. Report KC45 - Hydrotechnical and Meteorological Reference Information, Task CD50, December 1989.

37. Report KC46 - Tailwater Studies, Task CD71, April 1990.

38. *Report KC47 - Hydraulic Model Studies, Instructions for Submitting Proposals and Conditions for Providing Consulting Services, Task CH70, Draft Report, not Finalized.

39. Report KC49 - Diversion Design Flood, Risk Analysis Optimization, Task CH40, November 1990.

40. Report KC50 - Preliminary Layout of the Right Bank Structures, Task CH70, July 1990.

41. Report KC51 - Instrumentation and Data Evaluation for a Proposed Test Embankment, Task C2C-B01D, March 1990.

42. Report KC52 - Report on Preparatory Engineering Activities (PEA) - 1989 (Site C and Keenelyside), Task CP10, July 1990.

43. Report KC53 - Assessment of Upper Left Bank Overburden Deposits, Task C9B-B03D, April 1990.

44. Report KC54 - Assessment of Lower Left Bank Overburden Deposits, Task C9B-B03D, July 1990.

45. Report KC55 - Comparison of Cofferdam Schemes, Task C2C-Z01D, April 1990.

46. Report KC60 - Evaluation of Concrete Aggregates for Left Bank Structures, Task C2Z-Z01D, June 1990.

47. Report KC61 - Penstock Optimization and Turbine Characteristics, Task C2E-Z01D, July 1990.

48. *Report KC62 - Switchgear Building, Task C2G-A01D, Draft of Geotechnical Section only, not Finalized.

49. Report KC63 - Powerhouse Standby Generating Units, Task C2Z-Z01D, April 1990.

50. Report KC64 - Diversion Tunnel Design, Task C2A-Z01D, July 1990.

51. Report KC69 - Construction Materials Investigations, Task C9B-B03D, July 1990.

52. Report KC73 - Advance to Shelf Ready Design Status Report, Task C9A-B02M, Volume 1 of 2, March 1991.

53. Report KC85 - Rebound of Excavations in Shale, Task C2Z-Z01D, December 1990.

54. *Report KC93, Local Basin Design Floods, Task C9B-A03D, Draft February 1991.

SITE C REPORTS
ISSUED DURING 1989/90
BY KLOHN-CRIPPEN SUBCONSULTANTS

1. Reclamation Criteria, Shale Slope Revegetation, Site C Dam Project, by Polster Environmental Services, October 1989.

2. Evalution of Aggregate Sources for Supply of Concrete Aggregate - Site C Left Bank, by Levelton and Associates Ltd., March 1990.

3. Site C Project, East Bank Alkali Aggregate Reactivity of Mortar Bars Made with Island Aggregate NBRI Test Method, by Levelton and Associates Ltd., March 1990.

4. Peace River Site C Project, Degradation Studies, by Northwest Hydraulic Consultants Ltd., March 1990.

5. Peace River Site C Project, Review of Erosion Protection Works, (Task C2Z-Z01D) by Pildysh & Associates Consultants Ltd., May 1990.

6. Laboratory Testing Report on Shale Bedrock Testing for Site C, by Golder Associates Ltd., May 1990.

7. Laboratory Testing Report on Soils and Concrete Aggregate Testing for Peace River Site C Project, 3 Volumes, by Golder Associates Ltd., June 1990.

8. Cross-Sections for Site C Project, CS1, CS2, CS3, CS4, Peace River, Data Report by McElhanney Associates, 1989.

9. Site C Peace River Project, Access Road Profile, ASCII Profile Listings, Eastings, Northings, Elevations, Description and Chainage, Data Report by McElhanney Associates, 1989.

10. Site C Peace River Project, Access Road Cross Sections, ASCII Cross Sections Listings, Chainages, Eastings, Northings, Elevations, Data Report by McElhanney Associates, July 1989.

11. Site C Peace River Project, Diversion Tunnel Outlet Portals Cross Sections CS1A-CS1B, CS2A-CS2B, CS3A-CS3B, CS4A-CS4B, CS5A-CS5B, Data Report by McElhanney Associates, August 1989.

SITE C REPORTS
ISSUED DURING 1989/90
BY B.C. HYDRO

1. Report H2243 - Peace River Site C Project, Reservoir Slopes, January 1990.

2. Report H2299 - Peace River Site C PMP/PMF Review, April 1990.

SECTION 6.0 - ENVIRONMENTAL STUDIES

6.1 Introduction

The 1980 Site C EPC application was based primarily on environmental and socioeconomic studies undertaken from 1975 through 1978. The various study reports were appended to the application and were reviewed extensively by provincial, regional and local agencies and public groups. BCUC held extensive public hearings on Site C in 1981-1982 in which environmental and socioeconomic impacts were reviewed and discussed by numerous witnesses and intervenors. BCUC (1983) concluded from the evidence presented that the project would have numerous environmental impacts but these could be managed in such a way as to render them acceptable from a regional and provincial perspective.

The only major deficiency in environmental studies was identified as being in the fisheries area. The socioeconomic data was seen to be in need of updating at the time of the hearings, and since data in this subject area has limited shelf-life, many of the BCUC recommendations called for deferral of decisions on impacts and compensation until actual impacts could be detected via the proposed monitoring program.

In 1989 when there was an apparent need to prepare for the project as a planning contingency, an update of the fisheries impact assessment was initiated to address the previously identified deficiency. This assessment was to depend upon the results of a two year fisheries study program. No other new environmental field work was commissioned until 1990, when it became obvious that a new application for the project would be required to address both the provincial and federal regulatory processes.

B.C. Hydro, with help from a variety of consultants, compiled detailed terms of reference, which it felt would update all of the environmental work to a level sufficient to meet the needs of both provincial and federal processes. Some of this material was reviewed with government agencies and changes were made to the proposed programs. Work on the new "update studies" began for most subject areas about mid summer 1990.

At the same time that update studies were developing, B.C. Hydro was experiencing increased success with conservation programs, such as Powersmart, and alternate energy supply, such as that obtained through cogeneration and coordination agreements, looked more promising. The contingency requirement to prepare for a new Site C application diminished. Accordingly most of the new studies have been carried out to the revised inventory stage with deferral of environmental impact assessments until the forecast need for the project is more imminent. This deferral results from the uncertainty of how contemporaneous environmental studies should be with project application.

The following information summarizes the work accomplished to date and the major findings within each environmental subject area. Details are available in the reports accompanying this submission as listed in Table 6-1.

A geographic information system has been used to compile and display the updated environmental resource data. The information will be produced at a 1:50,000 scale. Databases from various sources, including those available from several provincial government ministries have been used. As well as the thematic information available from each of the environmental disciplines, there will be a presentation of updated land use information. The GIS report is being produced by Hugh Hamilton Ltd.

TABLE 6-1
PEACE RIVER SITE C PROJECT
RECENT ENVIRONMENTAL REPORTS

REPORT TITLE	AUTHOR
Fisheries Habitat and Tributary Surveys - Year 1 (January 1991)	Aquatic Resources Ltd.
Fisheries Habitat and Tributary Surveys - Year 2 (January 1991)	Aquatic Resources Ltd.
Peace River Site C Sport Fishing Survey (March 1991)	The DPA Group Inc. and Western Renewable Resources
Fish Movements and Population Status - 1989 Studies	RL&L Environmental Services Ltd.
Fish Movements and Population Status - 1990 Studies	RL&L Environmental Services Ltd.
Heritage Resources Assessment Status Report (February 1991)	Arcas Consulting Arch. Ltd.
Recreation and Tourism Assessment Site C Project - Draft Status Report (February 1991)	MacLaren Plansearch
Agriculture	Norecol Environ. Consultants Ltd.
Consumptive Wildlife - Volume 1	Keystone Bio-Research
Consumptive Wildlife - Volume 2 Review of Ungulate Inventories and Harvest and Trapping Returns	D.A. Blood and Associates
Initial Review of Site C Climate Impacts (September 1990)	Stanton E. Tuller
Environmental Resources Mapping	Hugh Hamilton Ltd.
Forestry	Industrial Forestry Services Ltd.

6.2 CLIMATE

6.2.1 Background

The climate of the Peace region is classified as being cold and relatively dry and clear. Temperatures typically range from an average minimum of -13° C in January to an average maximum of 22° C in July. Mean annual precipitation over the Peace valley is 398 mm, with November through March precipitation falling as snow. Wind speeds across the Peace valley average 7 km/hr near Hudson Hope and 10 km/hr near Fort St. John; the dominant directions are southwest in summer and southwest or northeast in winter.

Local climates within the confines of the Peace River valley below Peace Canyon differ slightly from those on the surrounding plateau due to lower elevations, protection from winds and south-facing aspects along some terraces. The differences are considered to be significant to the maintenance of ecosystems within the valley, such as grassland slopes. Growing degree days recorded near Bear Flat are 2190 along the lower terraces, 2380 along the intermediate terraces and 2040 on the plateau. The average frost free period is 111 days within the valley, and lower river terraces have a slightly higher risk of frost occurrence. Summer dew point temperatures are near 6° C, with the Peace River having very little effect on dew fall within the valley. Valley fogs are extreme from July through September.

6.2.2 Previous Studies and Impact Assessments

Potential climate changes due to reservoir formation were assessed by Thurber Consultants Ltd. (1979) based on data from several Ministry of Environment stations located on the upper and lower valley terraces and on data collected in 1976-77 from transects across the valley . A background review (Atmospheric Environment Services 1976) dealt with climatic changes resulting from the

formation of Williston Lake in 1968. Additional climatic assessments were made by the Ministry of Environment and presented to the BCUC during the 1981/82 public hearings regarding Site C. The low density of recording stations and the short lengths of record available were significant constraints on the precision of climatic impact predictions.

The proposed Site C reservoir would be relatively small in surface area and width. In general, any reservoir-induced climate modifications are considered likely to be measurable only within the confines of the valley and probably only within 600 m of the shorelines. Very small reductions (<0.5° C) in mean daily summer temperatures were predicted, with similarly small increases in daily minimum summer temperatures and mean daily fall and early winter temperatures. The number of growing degree days was expected to be slightly lower (possibly 5 percent less). Small increases in frost risk were anticipated during crop growing seasons, but could not be quantified. Evaporation was expected to be slightly lower from May through July, and slightly higher from August through October (magnitude of change ≈ 0.15 gm/cm² per day). Mean daily humidity was expected to decrease from May through October (magnitude of change ≈ 0.12 mb) although nighttime humidity in late summer and fall would likely be slightly higher (≈ 0.5 mb). Small increases in wind speed (≈ 10 %) were expected throughout the year. Fog frequency was expected to increase from April through December (by 4 to 24 days, depending on the mixing depths), and fog density from May through October was expected to be higher (by 0.15 to 0.4 gm/m², again depending on the mixing depths).

The main concerns with climatic changes in the Peace valley relate to:

- increased humidity and fog leading to a deterioration in crop drying conditions in late summer and early fall;

- decrease in summer temperatures leading to a reduced crop growing season;
- increased fog occurrence leading to visibility problems along Highway 29 and at Fort St. John airport; and
- an increased risk of icing along the highway and on bridges.

The BCUC concluded that climatic effects on agriculture would be uncertain and limited in extent; they could be significant to some farmers within the valley. They recommended that priority be given to crop drying in the agricultural compensation program.

6.2.3 Recent Studies

No further climate impact assessments have been carried out. A review of the climatic issues (Tuller 1991) indicates that the climatic data base for the Peace valley is still characterized by short periods of record, limited spatial coverage, missing data and a small number of data elements recorded. The lack of humidity data from within the valley is a particular obstacle to improved impact assessment. An additional 3 to 5 years of wind speed and temperature data have become available since the previous assessment and could be analyzed to improve some aspects of the previous impact predictions. However, no major improvements to the previous overall impact predictions can yet be made.

6.2.4 Study Status

Any climatic changes caused by the Site C project would be relatively small and limited in geographic extent. Any specific cases of impacts arising from climactic change, e.g. crop drying at locations within the vicinity of the reservoir could be dealt with through localized mitigation or compensation measures, such as provision of crop dryers.

An adequate network of climate recording stations would be required to obtain the necessary spatial coverage of the Peace valley for future meso- and microclimatic impact predictions and to monitor actual climate changes resulting from reservoir formation. Temperature, humidity, precipitation and wind speed and direction would have to be recorded at relatively high frequencies to obtain a meaningful data base.

6.3 LANDFORMS AND SOILS

6.3.1 Background

The Peace valley is a major feature of the Peace Lowlands, and is a deeply incised valley floored with active fluvial materials and bounded by glacio-fluvial terraces, river-cut benches and unstable valley walls. The valley is bordered by rolling plateau uplands and flat benchlands. The northern side of the valley is generally less steep, more densely vegetated and less geologically active than the south side.

The main Peace valley has reached a stage of relative maturity in terms of downcutting and bank erosion, but most tributaries, including the Halfway and Moberly rivers which would flow into the reservoir, are more active and unstable. Landslides are significant features of the Peace Valley. Four major slides have occurred within the past 80 years. Slides are of several types including surface erosion due to water in the bedrock or overburden, flowslides or rotations in overburden, and slides within bedrock.

The geological strata underlying the reservoir area are composed predominantly of interbedded Cretaceous shales and sandstones. At least 750 million m^3 of gravel are estimated to exist between Site C and Hudson Hope; use of these resources to date has been minimal. The Gething formation underlies the shales and sandstones and bears coal seams. The Wilder gas field lies at a depth of some 2100 m below ground surface and extends along both sides of the Peace valley upstream of the Moberly-Peace confluence. Five of eight wells are currently in production.

Soils in the valley bottom and along the lower terraces are mainly cumulic regosols and orthic eutric brunisols of alluvial origin and variable texture, depth and moisture- holding capacity. They are generally fertile with low amounts of organic matter. Soils along

the higher terraces are rego black and eutric brunisols of good to moderate drainage and high fertility. Soils adjacent to the valley rim but outside the inundation zone of the proposed reservoir are mainly of glacio-fluvial origin and are moderately well- drained and moderately fertile.

6.3.2 Previous Studies and Impact Assessments

Physical impacts related to geological conditions were documented for the previous EPC application by Thurber Consultants (1979). About 20 percent of the river valley between Site C and Hudson Hope is regarded as having no potential for instability, the remaining 80 percent has a high probability of overburden slides occurring within the next 70 years. Particular sites with major slide potential are located near Attachie (site of a major slide in 1973), at Tea Creek and on the Moberly River. Damage to surrounding areas and vegetation would occur in the immediate vicinity of such slides, but hydraulic model simulations indicate that waves resulting from such slides would not overtop nor endanger the physical integrity of the dam. Bank overburden deposits along the upper end of the reservoir near Hudson Hope have been identified as being unstable.

The reservoir would not affect any present mineral, natural gas or gravel extraction in the Peace valley. To date, no resource extraction has been directed at the coal deposits near Hudson Hope, part of which underlie the valley and proposed future reservoir. One existing gas well near Site C would be flooded, but other wells and the gas field itself would be unaffected. A gas pipeline above the dam site would require relocation.

The region has a low level of historical seismicity. Most of the catalogued earthquakes which occurred within an area bounded by 119°W and 123°W, and 54°N and 58°N are between magnitude 3.0 and 3.5 (richter scale). The largest event on record is 3.7 which was centred in the Rocky Mountains.

The potential for reservoir induced seismicity (RIS) at Site C is considered to be very low. This conclusion is supported by the lack of RIS at Bennett Dam which has a larger and deeper reservoir.

The dam structure would be designed to withstand a peak ground acceleration of 0.13g which is equivalent to an earthquake of magnitude 6.0 located at a distance of 50 km from Site C.

Earthquake risks to the dam were evaluated and considered insignificant.

6.3.3 Recent Studies

No additional studies have been undertaken on landforms and soils within the project area by B.C. Hydro. A revised soil survey of the area based on 1:100,000 scale mapping was published by Agriculture Canada in 1988. The main project and reservoir configurations have not changed since the previous studies and EPC application and the impact assessments are still valid. A refined revised application of the safeline concept to protect future development near reservoirs is being developed by B.C. Hydro.

6.3.4 Study Status

Some further detailed studies of soils and landforms will be required when the project reaches an advanced stage of design and is scheduled for development. Most of these will be related to reclamation of construction sites and borrow and spoil areas, and to specific requirements such as the identification of significant topsoil deposits which could be considered for removal prior to reservoir flooding.

6.4 AGRICULTURE

6.4.1 Background

Approximately 75 percent of the Peace River valley from Hudson Hope to the Alberta border is estimated to be suitable for cultivation and the production of a range of vegetable, cereal and forage crops. The agricultural land capability ratings are 1 to 4 with agricultural climate capability ratings 1 and 2. About 40 percent of soils in the valley are of recent alluvial origin, and a proportion of these soils on terraces and islands became part of the agricultural resource base following control of seasonal flooding by the upstream W.A.C. Bennett Dam. Because of the relatively more favourable climate and higher proportion of productive soil types, the Peace valley has a higher agricultural potential than the rest of the Peace River agricultural region.

As with the rest of the agricultural region, actual agricultural use of the Peace valley is less than its potential and is constrained by economic, marketing, land tenure and infrastructural factors. Cereals including wheat, barley, oats and canola are the major agricultural crops. Frost damage in early fall and a high incidence of precipitation during harvesting periods are regionally significant constraints to grain production and storage. Large areas are utilized for forage and forage seed production or for pasture. Relatively small areas are cultivated for vegetables. Beef cattle are the dominant livestock resource, and production is based on combinations of pasture, feed stall operations and extensive range grazing on crown land.

The south bank of the Peace valley is crown land with very limited agricultural use because of access limitations and steep terrain along the valley rim. Privately owned and leased lands extend along the north bank. All lands with soil capability ratings of 1 though 4 are presently included in the Agricultural Land Reserve.

Numerous agricultural development programs are under way within the Peace agricultural region. Most are directed at improvement of crop and livestock production through technological development, market development, training and information.

6.4.2 Previous Studies and Impact Assessments

For the previous EPC application, agricultural resource impacts were assessed and described by Canadian Bio Resources Consultants Ltd. (1979). The loss of land of agricultural capability ratings 1 through 4 from reservoir formation was estimated at 3200 ha, while inundation loss of all land of potential agricultural use (classes 1 through 6) was measured at 4130 ha. Of this total, only about 88 ha was then in agricultural use (including pasture). Construction and other site activities would have affected another 166 and 178 ha respectively. Total agricultural land alienation due to the project at that time was estimated at 18 percent of the Peace River valley. These numbers are currently being updated, but significant changes are not anticipated.

Project impacts on actual agricultural use were not quantitatively measured prior to the previous EPC application. Eight farming operations were identified as being potentially impacted by partial flooding or by having portions of the lands included within a safeline. Secondary impacts listed but not quantified included reduction of land parcels to agriculturally uneconomic sizes, effects of Highway 29 relocation, and changes to local water tables.

Changes to agricultural use within or close to the reservoir area since the previous studies have been limited in extent. Small areas have been brought under cultivation while other areas have been left fallow. Basic information on the agricultural resource base has been improved by soil surveys undertaken by Agriculture Canada. The flood reserve extending from Site C to near the B.C.-Alberta border was cancelled by a Cabinet Order-in-Council in May 1985 and this could affect agricultural resource use in the region.

6.4.3 Recent Studies

Additional studies of the agricultural resources in the project area were started in mid-1990 and are being wound down by March 1991.

The emphasis of this recent work is on:

- updating agricultural resource inventories;
- identifying and interpreting any significant trends in resource availability, quality and use;
- providing a forecast of the most likely trends in agricultural resource use within the region and study area; and
- evaluating the agricultural significance of the removal of the Site E hydroelectric flood reserves below Site C.

Major sources of new agricultural resource inventory are air-photo interpretation and information provided by regional agencies, agricultural organizations and local and regional agricultural experts. Agricultural inventory information will be available in report tables and text and as part of a GIS-based land resources inventory.

6.4.4 Study Status

An updated agricultural resource inventory will be available by March 1991. This is intended to be a major component of the basis for the development of an impact assessment. Since agricultural production in the impact area is in the hands of private land-owners, compensation for lost agricultural land would have to be addressed at two levels, firstly to land and secondly to the agricultural resource base.

A passive program of land acquisition by B.C. Hydro through responding to requests to sell within the future reservoir area was reinstated in 1989 and is expected to continue. If the project were to proceed, all privately owned and leased properties within the reservoir safeline would be acquired by B.C. Hydro, with full market

value being paid to the owners. Easements could be negotiated with owners of marginally affected properties. Management and use of lands adjacent to the reservoir have yet to be defined.

Compensation for lost agricultural resources could effectively be developed in cooperation with the Ministry of Agriculture and Fisheries. A number of possibilities, identified to date but not yet investigated in detail, include:

- development of new agricultural areas through provision of roads and other supporting infrastructure;

- enhancement of the agricultural productivity of existing lands within the Peace agricultural region through technological and research development.

Mitigation of impacts to agricultural land use and land-owners were extensively reviewed by BCUC during the previous EPC application and the recommendations remain valid, although these would be updated and reviewed with regional agencies and the agricultural community if and when the project is reinstated. These include:

- reclamation of sites disturbed by construction and their return to the agricultural land base;
- continued agricultural use of lands acquired by B.C. Hydro;
- consolidation and amalgamation of fractioned parcels to adjacent agricultural units;
- mitigation of impacts due to Highway 29 relocation;
- provision of crop drying facilities on lands near the reservoir;
- development of a land-use plan and participation by Hydro to minimize secondary impacts on remaining agricultural and other land: identification of areas where topsoil could be removed and conserved is an element of the plan.

6.5 FOREST RESOURCES

6.5.1 Background

The proposed Site C project lies within the boreal white spruce biogeoclimatic zone which extends across extensive areas of northern B.C. Dominant tree species are white spruce, lodgepole pine, balsam poplar and aspen. Periodic wildfires have influenced forest stand composition and successional status within the region. Within the Peace Valley, elevations, slopes, aspect, erosion, seasonal floodplain inundation (prior to W.A.C. Bennett Dam construction), local water tables and soil accumulations all affect forest composition and growing conditions. Forest composition is heterogeneous, with numerous small dispersed stands of spruce and lodgepole pine. Aspen and poplar stands are dominant at the lower elevations.

The Site C reservoir area lies along the boundary of two Timber Supply Areas - Fort St. John and Dawson Creek. Logging, along with agriculture and petroleum extraction, is a major economic activity in the region. Crown timber supply commitments for the two TSA's exceed 2 million m^3 per year and demand is expected to exceed supply within the near future. Current timber harvests are dominated by coniferous species, spruce and lodgepole pine, but deciduous timber is becoming increasingly more important with the development of pulp and processing mills at Taylor, Dawson Creek and Chetwynd. About 650,000 m^3/yr of deciduous timber are currently harvested in the two TSA's. Timber resources within close reach of the major milling centres at Fort St. John and Dawson Creek have been largely utilized during the first cut rotation, and licensees are having to harvest and transport logs over increasingly greater distances.

6.5.2 Previous Studies and Impact Assessments

Forest resource impacts described in the 1980 EPC application were based on studies and assessments undertaken from 1975 through 1978 (Reid Collins and Associates Ltd. 1979). No commercial logging of the forests within the proposed reservoir area had been undertaken up to that time (nor since) due to difficult access, relatively low merchantable coniferous timber volumes, and the availability of economically more attractive timber resources elsewhere in the region.

The total forested area which would be flooded was estimated to be 3824 ha, of which merchantable coniferous timber (predominantly white spruce) occupied 950 ha (27 percent) with a total coniferous volume of 272,390 m^3. This volume represented an 8-month timber supply for an average sawmill in the region. The average annual increment of coniferous timber in the whole reservoir area was estimated at 8373 m^3/yr, i.e. about one week's supply for an average sawmill. The Ministry of Forests (1981) reviewed the assessments and estimated that if potential agricultural areas and inaccessible and/or environmentally sensitive areas were excluded then only 1724 ha of land producing 4736 m^3/yr coniferous timber could be regarded as part of the normal timber resource base. About 13 percent of the area was estimated to have good coniferous growing conditions (good site index), about 52 percent was rated moderate and the remaining 35 percent was rated poor. No merchantable (coniferous) timber would have been impacted by dam construction activities. Highway 29 relocation would have affected about 5 ha containing an estimated 1580 m3 merchantable timber.

6.5.3 Recent Studies

In mid-1990 a new forest resource inventory of the reservoir area and the transmission right-of-way from Peace Canyon to Site C was initiated (Industrial Forestry Service Ltd, in preparation). The

source of the inventory is Ministry of Forests (MOF) air photo surveys and 1:20,000 forest cover mapping, site class indices and associated area-volume and mean annual increment estimates prepared from 1987 through 1989. Initially the multiple objectives of the forest studies included the development of a timber and vegetation clearing plan for the reservoir and construction site. A review of previous reservoir clearing programs in B.C. was to be undertaken to provide useful pointers for the Site C program. Also included were preliminary studies to establish the basis for a future compensation program for replacing impacted forest resources. These latter study elements were postponed when work on the project was deferred in late 1990. The requirement for a detailed impact assessment for forest resources was also postponed, but inasmuch as the inventory of the reservoir and construction areas represents most of the direct project impacts, a provisional impact assessment may be available. These initial studies are scheduled for completion by March 1991.

6.5.4 Study Status

The impact assessment would be completed when the project was close to an EPC application. It would include an assessment of the impacts of reservoir clearing and the availability of large volumes of timber within a short time frame on the local forest industry, as well as an assessment of the significance of the loss of part of the future resource base on long-term forest resource extraction in the two TSA's.

A set of clearing standards would be established for the reservoir. BCUC recommended that these be established by the Ministry of Forests. The chief goals of clearing standards would be to maximize resource extraction, minimize wastage and to remove as much organic material from the area as possible prior to flooding to protect water quality.

A reservoir clearing plan would be developed, preferably on a joint basis between B.C. Hydro and the Ministry of Forests with public input. The chief concerns would be to develop the necessary infrastructure and arrangements with licensees and contractors to ensure maximum clearing within the time frames imposed by construction scheduling and coffer dam closures. Agreement would have to be reached between the various parties on the extent of clearing beyond the actual reservoir floodline so as to address all concerns related to water quality, protection of fish and wildlife habitats, future recreational use and public safety.

6.6 WILDLIFE

6.6.1 Background

The Peace lowlands, including the Peace valley above Site C, have the mildest climate and lowest snowfall in the Peace region. Together with vegetation diversity and a large amount of land-water interface, these factors are responsible for the area having a relatively high abundance and diversity of wildlife.

Mule deer are presently the most abundant ungulate species in the region. This is a change since the previous assessment. White-tailed deer are increasing in numbers throughout the region, with highest numbers in the Peace lowlands and agricultural areas. Moose are the second most abundant ungulate in the region and valley, and use most habitats except intensive agricultural areas. Elk are increasing rapidly within the Peace Lowlands and are heavily dependent on montane shrub-grassland slopes for winter habitats.

A variety of furbearers occur throughout the valley and include beavers, muskrats, snowshoe hares, red squirrels, short-tailed weasels, martens, fishers, mink, wolverines and otters. Carnivores include coyotes, red foxes, lynx and wolves. The Peace valley is an important flyway for migrating waterfowl, and ducks, geese and swans move westward along the valley from mid-April to mid-May, and back again in late fall. Canada geese and shorebirds breed in the reservoir area. Boudreau Lake, near the confluence of the Moberly and Peace rivers, is a proposed ecological reserve and a prominent bird nesting area in the Peace region.

6.6.2 Previous Studies and Impact Assessments

Previous assessments were based on limited field data acquired in 1976 and 1977 (D.A. Blood & Associates 1978). Total loss of habitats within the Peace valley was predicted for 4625 ha. Reduction of moose carrying capacity was estimated at 125 to 250 but

up to 500 were judged to use the potential reservoir area in severe winters. About 50-250 deer would have been impacted by habitat loss. Impacts on the Moberly elk herd were not firmly established due to the lack of data. Significant reductions in available habitat would have occurred for beaver, weasels, martens, coyotes, lynx, snowshoe hares, red squirrels and black bears.

6.6.3 Recent Studies

The Ministry of Environment commenced a 1:50,000 scale biophysical mapping inventory of the lower Halfway River area in 1986 and subsequently extended the inventory to include the area south of the Peace River. In early 1991 the Ministry provided mapped and digitized data covering the Site C project study area to B.C. Hydro's consultants who established the biophysical data base on a Geographic Information System (GIS). The mapping provides a standardized, updated and quantitative basis for wildlife and vegetation studies within the project area.

Further wildlife studies were initiated in July 1990 on the major wildlife species used consumptively for hunting and trapping. All available data on ungulates and the principle furbearers, including aerial survey and radio-tracking data and hunting and trapping statistics were provided by the Ministry of Environment to B.C. Hydro's consultants. Analysis of the data will be completed by March 1991 and is expected to provide a good basis for an assessment of regional and local population sizes and trends and the extent of hunting and fur harvests.

To provide more site-specific information for the reservoir area, a program of radio-collaring and tracking large ungulates was initiated in July 1990. By January 1991 a total of 13 moose, 8 elk and 9 deer had been provided with radio collars and were being tracked from the air on a twice-weekly basis. The radio-tracking program is scheduled to run to at least June 1991, and detailed analyses of ungulate movements will be provided at that time. Moose

tend to move frequently within and through the reservoir area, suggesting that a large population makes intermittent use of the areas to be flooded. Deer and elk have been found to be far more sedentary. A preliminary aerial census of the reservoir area in January 1991 revealed the presence of 342 deer, 142 moose and 2 elk.

Track counts of the major fur-bearing species are being conducted throughout the winter of 1990/91 and will provide more precise estimates of furbearer densities within the major biophysical habitats in the reservoir area. Aerial and river surveys in the late fall of 1990 indicated a total of 77 active beaver lodges twice the number recorded during the previous impact assessments in 1976/77.

6.6.4 Study Status

Radio-tracking of moose, deer and elk is scheduled for completion by June 1991. All wildlife study activity in 1990 and 1991, principally radio-tracking of ungulates plus seasonal surveys of furbearers, waterfowl and ungulates, has been directed at developing a better inventory of wildlife populations and movements within the project area. No impact assessments have been made.

Studies on biological communities and other wildlife species of non-consumptive value were considered for 1990/91 but were not undertaken. The main objectives of these studies would be to obtain a measure of the biodiversity of the project impact area, to determine how this would be affected by reservoir flooding and project development, and to determine the status of fauna and flora species of special concern due to their conservation status, rarity, aesthetic values, etc.

Close liaison has been established with the regional Ministry of the Environment on the wildlife studies. In future, attention would be directed towards the planning and eventual establishment of compensation programs. The scope and intent of such planning would

be influenced by progress on similar compensation programs now being developed co-operatively between the Ministry and B.C. Hydro for Williston and Mica reservoir areas. Compensation-related items which have been identified for discussion and eventual study include surveys of potential compensation areas, preferably near the reservoir and possibly including lands already acquired by B.C. Hydro, establishment of goals and techniques to be employed in habitat enhancement for ungulate species, identification of areas suitable for non-consumptive wildlife enhancement such as wildlife viewing areas.

Mitigation of expected impacts to wildlife were extensively reviewed during the previous EPC application and BCUC hearings. These measures would be continued, refined and expanded if the project were to proceed, based on the latest inventory data and on changes to project design and land use patterns, and would include:

- developing a reservoir clearing schedule so as to minimize wildlife impacts

- appropriate management of activities and waste disposal at construction camps; and

- minimizing construction of roads and public access.

6.7 FISHERIES

6.7.1 Background

A total of eleven species of sport fish are found in the Peace River Site C study area. Major species, in order of numerical importance, include mountain whitefish, Arctic grayling, rainbow trout, lake whitefish, and walleye. Low numbers of bull trout, kokanee, northern pike, goldeye, and burbot are also present. Mountain whitefish are very abundant upstream from Taylor. Densities of this species increase in most reaches during the open water season, which suggests the occurrence of an upstream movement. Arctic grayling and rainbow trout appeared to have sedentary populations. Bull trout are low in number but widespread throughout the river. Kokanee were also limited in number and concentrated in known areas. Warm water species such as walleye, northern pike, goldeye, and burbot exhibited very low catch rates but were most often encountered in the reach below the Pine River to the BC/Alberta border.

Four coarse fish species were encountered during fisheries surveys of the Peace River. Longnose sucker was the dominant species numerically, followed by largescale sucker, white sucker, and northern squawfish. Large spawning concentrations of suckers were observed at creek mouths, particularly at Farrell Creek during spring.

6.7.2 Previous Studies and Impact Assessments

An inventory of fish populations in the Site C area was conducted during the period 1974 - 1977, and the major impacts of the Site C development on the fisheries resource were described by Renewable Resources Consulting Services Ltd. (RRCS 1979). Alteration of the present riverine system into a standing water body and blockage of upstream fish movements at the damsite were the major impacts noted. The surface water area of the river in the reservoir location would

increase in area (from 48.4 km^2 to 94.4 km^2) due to the flooding. The increase in aquatic habitat will result in increased phytoplankton and zooplankton production.

Without enhancement, it was predicted that northern pike populations would increase in response to growth of aquatic vegetation in littoral areas of the reservoir, and mountain whitefish and Arctic grayling numbers would remain at present levels. Bull trout may increase although greater angling pressure may reduce their numbers. Rainbow trout numbers are predicted to be low in the reservoir due to the limited availability of suitable spawning habitat.

Based on limited data, a maximum sustainable yield of sportfish for the existing riverine system was estimated at 12,000 fish per year, and the Site C reservoir was predicted to support slightly increased angling (RRCS 1979). The Ministry of Environment (1981) concluded, based on the same limited data, that the sustainable yield of the riverine system would be 18,000 fish per year, and that without enhancement, angling use would drop to about 75% of the level expected without the project.

The potential exists for high total dissolved gas (TDG) levels downstream of Site C during periods of spillway discharge, which could cause gas bubble disease in fish. B.C. Hydro (1982) assessed the potential for problems during spillway discharge and predicted that at spillway flows of less than 2200 m^3/s, TDG levels should not exceed 120% saturation; however, above 2200 m^3/s, the predicted TDG levels increase rapidly. Discharge from infrequent spillway operation should be below 2200 m^3/s more than 99% of the time with five or six units in operation. According to project scheduling at least four units will be operational during the high flow period in the summer following startup. In conclusion, once Site C is in full operation, any problems associated with high TDG levels should occur infrequently; however, spillway discharge greater then 2200 m^3/s could result in mortality to downstream fish stocks even when the

high discharge is only for a short duration.

The BCUC concluded that there was insufficient information on the fisheries resource and its utilization in the project area on which to base a compensation value, and recommended that additional studies be undertaken as a condition of any Energy Project Certificate for the Site C development. It recommended that:

- B.C. Hydro conduct a detailed angling and creel survey;

- B.C. Hydro gather information on sportfish movements in the Peace River and tributaries to assist in determining the impacts of flooding and the prospects for survival of existing stocks. This included investigation of sportfish migration and life-history patterns related to habitat associations to allow identification of critical limiting factors and designing appropriate enhancement measures to provide compensation in kind;

- B.C. Hydro, in consultation with the Ministry of Environment, conduct studies to ascertain the most effective manner in which shoreline and tributary enhancement programs might be developed for the reservoir. Identification of potential spawning areas using existing maps, literature and follow-up field studies were recommended to determine suitability and feasibility of pre-impoundment enhancement methods;

- the appropriate government agency undertake the studies needed to provide information on the productivity of existing reservoirs, particulary northern ones, so that a body of knowledge be developed on the biological impact of the conversion of rivers to reservoirs. The levels of mercury in fish in existing reservoirs should be included in these studies to assist the Ministry of Environment in designing the appropriate enhancement program.

BCUC recommended mitigation measures as follows:

- minimize sediment loadings during construction;

- implement suitable handling of waste materials in order to minimize water pollution.

BCUC also recommended that when the above studies are completed, appropriate compensation measures be determined in the post-development monitoring program, using the evaluation parameters adopted by BCUC.

In 1985, the B.C. Ministry of Environment conducted an angling use and creel survey of the section of the Peace River between the Peace Canyon Dam and Farrell Creek (Hammond 1986). They found that rainbow trout were the most commonly caught sportfish, but, due to release of undersized trout, lake whitefish and mountain whitefish contributed most to the harvest. An estimated 8629 anglers fished for a total of 16 898 hours, and caught an estimated total of 7667 fish. This represented an average catch rate of 0.45 fish per rod-hour. Hatchery fish, stocked into Dinosaur Lake, made up 38% of the rainbow trout harvest, indicating that entrainment out of the reservoir is significant to the downstream sport fishery.

In 1988, B.C. Hydro undertook a mercury sampling program in 12 B.C. reservoirs and 2 control lakes. In this study, mercury concentrations in fish tissue, water samples, and sediments were measured. A limited number of fish samples were collected from within the Site C area.

6.7.3 Recent Studies

B.C. Hydro initiated a program designed to address the deficiencies identified in the BCUC report. After a review of the draft terms of reference for the first year of a planned two year study, in consultation with representatives of the B.C. Ministry of the

Environment, the scope of the studies was agreed upon. Meetings were held with local environmental groups and rod and gun clubs in Fort St. John, Hudson Hope, Chetwynd, and Dawson creek to outline the studies and to receive comments.

In 1989, B.C. Hydro commissioned pre-construction studies to update the pre-development database relating to the fisheries resource and its use, and to identify feasible mitigation and enhancement opportunities that exist in the development area. The studies were grouped into three components: a sport fishing survey (The DPA Group Inc.), fish habitat and tributary surveys (Aquatic Resources Ltd.), and fish movements and population status programs (R.L.&L. Environmental Services Ltd.).

6.7.4 Status of Study Components

The final report of the sportfishing survey is to be submitted by 31 March 1991. The report will document sportfishing use of the Peace River between the Peace Canyon Dam and Taylor. Activity is assessed by a combination access point and aerial overflight creel survey. Fishing activity is summarized by month, location and angler type and information on fishing method, angler residence, and age group is provided. Sportfish catches are summarized by size and age classes for each species and is broken down into harvested and released fish categories. Biomass of harvested fish is also provided.

Aquatic Resources Ltd. submitted a draft report of the 1989 studies in January 1991. A habitat map atlas (large format; limited distribution) will also be submitted in early March 1991. The report and atlas contain information on fish habitat in the Peace River tributaries in the area between Hudson Hope and Fort St. John. Also included in the report are descriptions of fish populations, assessments of tributary habitats removed by reservoir creation,and potential enhancement/mitigation opportunities. A draft report of the 1990 studies was submitted in February 1991. It contains

detailed information on habitat use by sportfish for spawning and rearing purposes in selected tributaries, as well as assessments of enhancement/mitigation potential. Final reports for the 1989 and 1990 studies and the habitat map atlas are expected by the end of March 1991.

R.L.&L completed a final report of the 1989 studies in March 1990. The final report of the 1990 studies will be available in early April 1991. The reports contain information on fish abundance, distribution and habitat use, life history data, feeding habits and macroparasites in the mainstem Peace and Halfway rivers. Population estimates were developed for major sportfish species and seasonal movement patterns were assessed using tag recoveries and an extensive radio telemetry program. Information on temperature regimes and water quality are also contained in the reports.

Sport Fishing Survey

The estimated effort over the 12 month (i.e., May 1989 to April 1990) period was 6485 angler-days for shore anglers and 1495 angler-days for boat anglers. Over half this effort was expended in the Hudson Hope region with less than 6% occurring below the proposed dam site. In total, 9782 game fish were caught by Peace River anglers - 6422 were kept and 3360 were released. Mountain whitefish were the most abundant species captured followed by rainbow trout and Arctic grayling.

Most anglers (90%) were local residents. The main types of gear used included lures (65%), bait (33%), and flies (38%). Rainbow trout were the most sought after species (75%) followed by Arctic grayling (36%).

Most anglers harvested trout in the 290 to 340 mm size-class with Arctic grayling and whitefish species being slightly larger. Rainbow trout and Arctic grayling ranged in age from two to five years. The majority of rainbow trout being captured were age three,

whereas Arctic grayling were equally comprised of age three and four year olds.

Fisheries Habitat and Tributary Surveys

In general, the loss of unique tributary habitat due to reservoir creation will be minimal.

Significant losses will include spawning habitats in the Moberly River and Lynx Creek.

Fish population densities were relatively low in all tributaries. Maurice Creek contained the highest densities of rainbow trout of all tributaries examined and appeared to be the most important spawning tributary for rainbow trout from the Peace River. Although Lynx Creek appeared to provide rearing habitat for rainbow trout, the habitat capacity was limited due to the high silt load. Cache, Wilder, Farrell, and Ground Birch creeks and Cameron River had very few sportfish and relatively high densities of suckers and minnows. Clear water tributaries of the upper Halfway River appeared to have extensive rearing habitat for several sportfish species, mountain whitefish being the most prevalent species sampled. The Moberly River appeared to be an important spawning area for mountain whitefish and Arctic grayling.

Spawning and rearing habitats within the Site C reservoir will probably be limited and species such as Arctic grayling, rainbow trout, or walleye would likely require hatchery support to maintain numbers. Enhancement opportunities may exist in tributary streams such as Lynx Creek (i.e., reduce silt loads by diverting springs in Brenat Creek) and Maurice Creek (i.e., provide spawning channels). Habitats in the upper Halfway system which do not appear to be near carrying capacity can be stocked with bull trout and rainbow trout to increase angling opportunities.

Fish Movements and Population Status

Major fish species encountered in the mainstem Peace River included mountain whitefish, lake whitefish, Arctic grayling, rainbow trout, longnose sucker, and largescale sucker. Low numbers of bull trout, kokanee, walleye, and northern pike also were present. With the expection of walleye and northern pike all species were most abundant upstream of the proposed dam site. Resident populations of sportfish species in the mainstem Halfway River were limited.

Mountain whitefish was the only species which appeared to spawn successfully in the mainstem Peace and Halfway rivers while others spawned outside the study area (i.e, walleye), or attempted to use small tributary streams. Radio telemetry results indicate that rainbow trout entered Maurice and Lynx creeks during spawning and bull trout undertook extensive migrations into the upper tributaries of the Halfway River system.

All fish populations appeared to be "sedentary", except walleye, which undertook post-spawning migrations from Alberta into the Site C study area. The proportion of the walleye population which passed the proposed dam site was suspected of being very small.

Population estimates were developed for mountain whitefish, lake whitefish, Arctic grayling, rainbow trout, and walleye.

Mercury concentration in muscle tissue samples were typical of background levels for the species examined and did not exceed federal guidelines for maximum allowable concentrations for human consumption.

6.8 SOCIOECONOMIC

6.8.1 Background

The Site C dam would be located approximately seven kilometres southwest of the City of Fort St. John. While impacts would be concentrated in Fort St. John and its immediate area, the study area for socioeconomic issues would also cover the nearby communities (and adjoining hinterland) of Taylor, Hudson's Hope, Dawson Creek, Chetwynd and Tumbler Ridge. These communities would be faced with managing a variety of socioeconomic, land use and municipal planning consequences related to the project's construction and operations effects. Dawson Creek, Chetwynd, and Tumbler Ridge are also of study relevance because of their roles as sub-regional business and labour market centres, and the fact that they fall within the project's natural commuting shed.

The primary area boundaries, therefore, correspond to the larger Fort St. John (Fort St. John, Hudson's Hope, Taylor) and Dawson Creek (Dawson Creek, Chetwynd, Tumbler Ridge and Pouce Coupe) sub-areas of the Peace River-Liard Regional District.

6.8.2 Previous Studies and Impact Assessments

Socioeconomic impact studies were prepared by Canadian Resourcecon Ltd. et al. (1979), Thurber Consultants Ltd. (1979) and Christine Latty and Associates (1980). The following is a summary of the impacts identified and the reaction of the regulatory agencies to this information.

Employment and Income

From the previous hearings, BCUC concluded that local hiring could well be the most significant compensation to the region for the adverse impacts suffered. Basic employment during the construction phase would increase sharply and induce employment growth in

non-basic sectors. The short-term effects on employment and income levels from project construction, with the majority of jobs concentrated in the vicinity of Fort St. John, would greatly exceed the long-term impact of plant operation. Project-induced stimulation of the regional economy would lead to the creation of service sector jobs which will be available to residents of Fort St. John and others in the region.

The principal employment effects of the project that were forecasted in 1980 by B.C. Hydro consultants were as follows:

- Manpower requirements for project construction, highway relocation, reservoir logging and clearing, and transmission line construction would total 5400 man-years over the eight year construction period; 1360 man-years would be required in the peak year of construction;

- Employment of regional residents on various aspects of the project would be a priority of the project, with as much as 45 percent of the total labour requirement coming from the region. This regional labour employment would be expected to peak in the fifth year of construction;

- It was estimated that 55 percent of the total construction work force would come from outside the region, and that approximately 1200 non-resident workers would move into the area. Of this total, it was estimated that 1000 workers would live in camps located at the project site, and that the remaining 200 construction workers and supervisory personnel would live with their families in the nearby areas, principally Fort St. John;

- Indirect employment generated through local expenditures by project contractors was forecast to total 50 jobs in year three of project construction.

- Net employment growth in regional service sectors, attributable to project related increases in population and income, was projected to peak at 150 jobs in years four and five of project construction;

- All short-term employment increases would disappear once construction of the project was completed, declining after the peak construction year;

- When operational, the project would employ a permanent workforce of 25 persons with primarily technical and managerial backgrounds, likely from outside the study region. This would lead to a total increase in local employment of nearly 40 jobs;

- It was expected that price levels in Fort St. John would rise due to buoyant economic conditions during project construction. Therefore, certain segments of the local population, such as those on fixed incomes and those dependent on various forms of social assistance and disability pensions, would experience a reduction in purchasing power;

- At the end of the Site C construction period, employment would decline sharply for the project and in businesses that had hired additional staff to cope with project-induced activity.

In its 1983 report, BCUC recommended that:

- B.C. Hydro and the Ministry of Labour and Consumer Services consult with relevant trade unions to facilitate increased local membership in unions, at least for the duration of the project;

- A procurement agreement to encourage hiring local residents and purchasing from local suppliers be reached between B.C. Hydro, the Ministry of Labour and Consumer Services and union

representatives. The Allied Hydro Council Agreement had previously enforced the following hiring sequence at B.C. Hydro construction sites:

- registered union members in the local areas;
- registered union members from outside the area;
- non-union workers from the local area;
- non-union workers from elsewhere.

- B.C. Hydro make it known whether the Allied Hydro Council greement would be renewed and Site C designated a closed or open site. If Site C was to be is designated a closed site, the provincial government, in cooperation with B.C Hydro, should work with union contractors to increase local membership as required, based on the conclusions of a labour market assessment. If Site C was to be designated an open site, B.C.Hydro should advise contractors of local hiring requirements, if any, perhaps through the inclusion of appropriate clauses in the tendering agreements;

- the need for a training program be established immediately before an EPC was issued, based on economic conditions prevailing at that time. If the need was established, B.C. Hydro should pay for and administer the training programs in consultation with the appropriate unions.

BCUC stated that the need for training programs would require knowledge of the labour market conditions at the time of project construction, and, therefore, could not be assessed until construction was about to commence. Both the region and the Province as a whole have a sizeable construction work force which would require minimal, if any, additional training to meet the needs of this project. The availability of skilled workers for project construction and, therefore, the need for training programs would be dependent on the level of construction activity in the province and on the degree to which local hiring for the project was to be required.

BCUC concluded that the magnitude of the impacts of the post-construction decline would depend on the extent of alternative employment opportunities available at the end of the project, both within and outside of the region. It agreed with B.C. Hydro that few mitigative measures could be taken with respect to any significant post-construction decline, except to advise the manpower and employment services as early as possible about the end of the construction phase in order to facilitate retraining and rehiring of local residents or relocation of those available to move to other projects.

Population

The trend in growth in the northeast B.C. region was upward in the early 1980's with dramatic growth until 1981. Thereafter, the rate of growth fell by 6% to 1986. The long-term outlook for the sector remains positive with current growth in the petrochemical and forest industries, and with potential for increased agricultural and tourism development.

Construction of Site C would create considerable additional employment in the Fort St. John area. Direct employment would be available on the project itself and employment opportunities in non-basic sectors would increase as well. While many of these new jobs would be taken by current residents of the region, the magnitude of the employment increase means that non-residents would fill a large number of the employment vacancies. The resultant in-migration would create a large yet relatively short-term increase in the area's population. This influx would consist of project workers living in the construction camp near the site, project workers relocating their families to the region and other non-residents who would fill jobs in the local service sector.

The project-induced population increase would add pressure on municipal services and infrastructure. Related financial impacts resulting from the anticipated additional costs to be borne by local

government, and the impact of transient construction workers on the community's social fabric and the quality of life, would require study during preparatory stages of the project.

Based on the impacts identified during the last application and review process, the present estimation of project impacts on the population has not changed and is:

- Approximately 55 percent of the total construction work force would come from outside the region, peaking at approximately 1200 non-resident workers;

- Of these, about 1000 workers would live in camps located at the project site during the peak year of construction. The remaining 200 construction and supervisory personnel would live with their families in the nearby areas, principally Fort. St. John;

- In-migration to the region of construction workers and their families and other non-residents filling vacant positions in local service sectors would increase the resident population of the Fort St. John area by 800 during the peak year of construction;

- The short-term increase in population attributable to project construction would largely disappear following completion of the construction stage. It is assumed that some of those who move to the area might choose to remain if employment opportunities are available in the region as work on Site C nears completion;

- It is estimated that the Site C project would directly contribute to a long-term population increase in Fort St. John of 80 people;

Land Use

Impacts predicted during the last BCUC review of the application related to land use, which are still relevant, include:

- Termination of private ownership in the area which would be affected by the reservoir through B.C. Hydro's responsive land acquisition program;
- Forced relocation;
- Alteration to property below the safeline of the reservoir;
- Termination of all types of land use in the flooded area of the reservoir;
- Relocation of Highway 29 and other facilities;
- Biophysical changes due to flooding and clearing;
- Additional planning costs for the Regional District;
- Alteration in land values due to perceived imminence of dam construction.

BCUC urged B.C. Hydro to make every effort to delineate a fair means of acquiring additional land if Site C proceeds, and in disposition of land not ultimately required for the project.

Land use planning which responds to biophysical capabilities and community aspirations, rather than to pressure for development, was deemed desirable. Sub-regional planning for agricultural, residential and recreational development was proposed and retention of public access to the Peace River was supported.

BCUC concluded that land use impacts, mitigation and compensation be referred to a monitoring program. In general, B.C. Hydro would be responsible only for definable, tangible impacts. Appropriate government agencies were requested to undertake development of a land use plan, and B.C. Hydro was required to pay for incremental project-induced costs, to participate in the plan development, and to comply with the practices prescribed in the plan regarding management and maintenance of lands not required for project

operation. Planning costs for the Regional District would be covered by additional revenues derived from a levy on the project.

BCUC recommended that the flood reserve on the Peace River valley from the Alberta border to Site C be removed.

B.C. Hydro announced a responsive land acquisition policy in 1977 which provided for purchase at fair market value of all private lands below the safeline, with an offer to lease back the land to each rancher or farmer at market rent. Sellers would be offered the right of first refusal to buy back the property at the original purchase price if the project were abandoned. This policy was withdrawn in October 1981.

A land acquisition program similar to the responsive program of 1977 - 1981 was reinstituted in September 1989. Owners of the property which would be required for the project have the option to sell to B.C. Hydro. The program will result in the acquisition of only minimal property rights required for safe operation of the project.

The flood reserve from the Alberta border to Site C was removed by Cabinet Order-in-Council in 1985.

Housing and Infrastructure

B.C. Hydro and its consultants estimated that accommodation could be needed in Fort St. John for project personnel and service sector workers and their families during the peak construction years. This could result in the need for up to 280 additional housing units. The influx of construction personnel to Taylor and Hudson's Hope would be small and effects minor. The flooding of properties in the Lynx Creek subdivision of Hudson's Hope could reduce tax revenue to the district. The pumphouse, water intake and initial part of the distribution system for domestic water in Hudson's Hope would also be inundated.

Since 1980, the population of the area has decreased slightly, therefore, the demand for housing and the related services in the City of Fort St. John and the Village of Taylor has remained relatively stable. Potential expansion resulting from several planned industrial projects could lead to an influx of population throughout the region, and would require an update of housing availability and suitability, as well as potential fiscal impacts in the affected areas.

The reservoir created by a dam at Site C would inundate approximately 23 km of Highway 29 between Hudson's Hope and Bear Flats. The major affected sections of the highway would be near Lynx Creek, Farrell Creek, Cache Creek and the Halfway River. Preliminary studies by B.C. Hydro and the Ministry of Highways have resulted in the proposed re-alignment of Highway 29. This re-alignment and construction would impact surrounding landowners, 23 known heritage resource sites, as well as recreational use and access along the reservoir.

BCUC did not endorse the compensation package agreed to by Fort St. John and B.C. Hydro. Numerous impacts were not seen as a legitimate expense of the project since the magnitude of social impacts was unknown. BCUC recommended instead that the matter of impacts, mitigation and compensation for the City of Fort St. John be referred to a monitoring program. Therefore, it was recognized that a negotiated agreement should not be made a condition of the Energy Project Certificate.

To satisfy concerns in Hudson's Hope, BCUC recommended that as a condition of the Water License, B.C. Hydro carry out such monitoring of bedrock banks as directed by the Water Comptroller. BCUC also recommended that the monitoring reports be made public, and that any corrective action required be carried out by B.C. Hydro.

With regard to the flooding of municipal land and properties, BCUC recommended that as a condition of the Energy Project Certificate,

B.C. Hydro negotiate financial compensation for the Corporation of Hudson's Hope in an amount equal to the estimated net decline in property tax revenue attributable to lost land plus the replacement or repair cost of municipal works, land and facilities that will be lost or damaged.

BCUC concluded that any costs to the Peace-Liard Regional District for additional planning be compensated through revenues from a levy on project construction facilities. Any remaining shortfall should be dealt with by the monitoring program.

BCUC recommended that B.C. Hydro not be required to pay for increased costs claimed by Taylor with respect to its water intake constructed prior to BCUC hearings.

Community Services

In 1980, B.C. Hydro estimated project-induced impacts on community services for the peak year of project construction and employment to include: additional ambulance attendants, doctors, hospital beds, dentists, one public health nurse, social services clerks and social workers, teachers, classrooms, and probation officers.

Social service issues identified in the BCUC hearings related to the magnitude of the impacts, the extent to which the Site C project would be responsible, the measures that should be undertaken, and who should undertake them.

Also in 1980 it was estimated that the project would affect Fort St. John most directly. This community had at that time already experienced the stress and disruption of rapid growth and a large transient population. The major social problems in Fort St. John, typical of rapid-growth, highly transient population centers, were alcohol abuse and the attendant increase in traffic accidents, a rising crime rate, a migrant school population with a high drop out rate, and under-financed transients seeking work in the area. The

effect of the project would be to exaggerate existing community problems and service gaps.

Little evidence was presented at the hearing on other social service impacts, such as human resources and education. However, intervenors were generally concerned that those impacts be monitored.

BCUC recommended that:

- the extent of B.C. Hydro's responsibility for health and hospital service costs be determined by the monitoring program;
- B.C. Hydro's responsibility in the matter be carefully limited to reimbursement for the extra health and hospital services required as a result of Site C; and,
- the assessment of other social service impacts be referred to the monitoring program.

When, and if, such impacts were identified and B.C. Hydro's share or responsibility determined, appropriate mitigation or compensation measures were to be taken at B.C. Hydro's expense.

Social Values and Community Stability

Early Site C hearings noted that the region has a stable core population, but has been subject to the "boom and bust" effects of external economic ventures. There is a high level of community cohesion and political effectiveness in each of the affected communities. There is a relatively low level of crime, alcohol and drug abuse, and other social deviation at the present time. Long-term residents value their physical environment highly, as well as wishing to retain the existing social values and quality of life.

The sense of community in the town of Fort St. John has increased during the slower growth phase of the 1980's. Community recreation,

cultural events, the arts community, ethnic associations and other organizations have grown and prospered. These values would be endangered by a radical change in the community composition or by events such as an increase in alcoholism and vagrancy attributable to non-resident workers and transients.

Flooding would require relocation of about 25 families in the valley and would cause stress, and a loss of "sense of place", familiarity and belonging.

The values of the river valley, including the aesthetics, traditional use and other non-tangibles, attributed to enjoyment of this natural environment would be lost by its replacement with a man-made reservoir.

BCUC was of the opinion that the social loss of private lands transferred out of the ALR could not be compensated, as there were no relevant guidelines.

Native Peoples

Issues raised by the Treaty 8 Tribal Association during BCUC hearings on behalf of the concerned Indian bands (the Blueberry, Doig, Halfway, Salteau and West Moberly) included:

- the survival of the native subsistence economy in light of Site C and other development projects in the region, since effects are cumulative on the lifestyle of the native people. The bands have experienced a great deal of pressure as a result of development projects in northeastern B.C. which endanger the traditional subsistence lifestyle. Increased recreational hunting pressure was cited as the greatest threat to the bands' resource base.

- the substance and status of Treaty 8, and the protection it affords to native hunting and trapping rights. The United Native Nations suggested that the land title and treaty status should be settled before any new development is allowed to proceed.

- the proposed mitigation and compensation measures, including matters related to the protection of wildlife.

Three project impacts that could affect native hunting are:

- the flooding of the reservoir which will result in the loss of some wildlife habitat;
- the loss of the valley as a wintering and calving range for moose, which is the staple of the native diet;
- the invasion of recreational hunters further into native hunting territories when they are displaced from the Site C area. This would be aggravated if there were a road across the dam, since new access would be provided to the south side of the Peace River.

BCUC concluded that the historical conflict between the native subsistence economy, Treaty 8 land resolution, and the development plans for the provincial economy were outside its terms of reference. However, BCUC concluded that the project impacts would be significant to the native population of the region and noted that the experience of the Ingenika people when Williston Lake reservoir was created was relevant in anticipating the social and economic impacts. BCUC agreed that there was a widespread subsistence economy in the Site C region which depends on hunting and trapping and that wildlife habitat would be lost, particularly moose wintering and calving grounds, if the dam were to be constructed. The Commission believed that the question of the cumulative impacts of development projects on the native economy should not be addressed by a Site C monitoring program or by any specific conditions in the Energy Project Certificate. It also believed that

it was not the appropriate body to interpret the true meaning of Treaty 8. That issue must be resolved in other forums since it affects all competing uses of land in the region.

BCUC recommended that the impacts on native hunting, trapping and fishing, and the social framework of native communities were to be dealt with by the monitoring program which would:

- identify what those impacts will be;
- put in place specific programs for monitoring results;
- take steps to see that negative impacts are offset and redressed;
- depend on native input to identify any adverse effects and remedies.

In order to ensure that the native population is compensated in kind, BCUC recommended that the compensation package for wildlife impacts be determined by the Ministry of Environment in consultation with the native people, and that the package provide for the Indians' consumptive use of wildlife.

BCUC recommended that neither B.C. Hydro nor the Ministries be required to make any direct payments to the native people. The Indians were to report impacts to the monitoring program, with suggestions for remedial measures. This was in accordance with the native people's expressed desire to be allowed to develop their own mitigation and compensation measures. BCUC further recommended that B.C. Hydro be directed to provide funds for those measures which are approved by the monitoring authority.

6.8.3 Recent Studies

A small amount of socioeconomic related work was completed in fiscal 1990-91 as part of the program intended to bring the project to "shelf-ready" status. The overall objective would be to present a socioeconomic inventory and impact analysis which would meet or exceed the requirements for a new EPC application,and for the federal government's Environmental Assessment and Review Process (EARP) for the project.

The uncertainty regarding the timing of the project and the time sensitivity of socioeconomic data, which must be current to be useful, has been a constraint to extensive research. Therefore, much of the baseline data which will eventually be necessary was not collected during this phase. Instead, the work was focused on defining a clearly-understood approach and responding to issues and concerns raised by the public consultation process. The approach was designed to address those concerns of government agencies and the public which were raised since the previous application. In addition, the input of related environmental studies is required and will be included as background to a Socioeconomic Impact Assessment (SIA).

The SIA is planned to occur in four phases: Phase 1, Scoping; Phase 2, Baseline and Impact Assessment; Phase 3, Review of Deficiencies; and Phase 4, Mitigation and Compensation Negotiations.

The overall objectives of the SIA are:

- to develop a comprehensive socioeconomic baseline profile for the area impacted;
- to project area conditions without the Site C development;
- to evaluate the economic and social impacts of project construction and operations;
- to examine mitigation and compensation options.

This Status Report is limited to Phase 1, Scoping, in response to the project requirements in 1990-91.

The following baseline profile data requirements were identified:

- Area and major centre historical and projected population series, with subseries classification characteristics, i.e., on migration and rates of natural increase and age/sex specific population cohorts.

  The availability of this data series was verified through the Central Statistics Bureau, Ministry of Finance, Victoria, which can provide the necessary information on a 20-year planning horizon, by local health area and major population centre.

- Area and major centre historical labour force and unemployment data series, with subseries classification characteristics by gender and occupation.

  The availability of this information was verified through Canada Employment and Immigration sources, including both the Vancouver office (covering British Columbia) and area Canada Employment Centres (CEC). The specific data series available (for example, unemployment rates, participation rates, numbers of UIC claimants, numbers of employable income assistance cases, duration of claims, etc.) can be supplemented on an industry and occupational basis through occasional labour market reviews and updates generated by the area CEC. Additional invaluable sources of information are major employers and trade union centres, on local labour

demand/supply conditions and skill availability, as well as other labour force information.

- Area economic, business and sectoral profile. A variety of sources were identified that could provide the background information necessary to construct such a profile. These include the Peace River-Liard Regional District offices and reports, the BC Regional Index, area regional and local economic development officials, and area business and municipal representatives; for example, Chambers of Commerce. In addition, more detailed sector-specific profiles can be prepared through the offices of the relevant provincial government ministries, specifically Agriculture and Fisheries; Forestry; Energy, Mines and Petroleum Resources; and Tourism. This study component would be coordinated with related environmental studies, i.e. agriculture, forestry and tourism.

- Area social and municipal infrastructure and services. The following specific areas are included:

  - educational and training facilities and loading;
  - health and social services facilities and loading;
  - area housing and land inventory;
  - municipal infrastructure and services, including social and recreational services and fire and police protection;
  - regional land use and land planning regulations.

This information base would be assembled through on-site interviews with relevant area authorities, i.e. local school district officials; the provincial Ministry of Education; local health district officials; hospital administrators, provincial Ministries of Health; Social Services and Housing; Canada Mortgage and Housing; and private property market representatives and municipal officials.

- The municipal fiscal profile of Fort St. John. This information can be assembled directly from Fort St. John officials, supplemented by provincial municipal statistics (the annual "Blue Book", published by the Ministry of Municipal Affairs, Victoria).

- A profile of the populations and services of native Indian reserves within the study area.

6.9 RECREATION/TOURISM

6.9.1 Background

More than a dozen Provincial Parks and Recreation Areas offer day and overnight facilities within the Site C study region. These opportunities are augmented by a number of additional sites maintained by the B.C. Forest Service, the Regional District, B.C. Hydro, Municipalities, the private sector and the Ministry of Highways.

Between the Peace Canyon dam and the proposed Site C damsite, there are approximately six roadside reststops, three river access points from Highway 29, seven informal boat launches, five recreation reserves and a municipal park.

Primary use of existing regional facilities involves fishing, boating, hunting and camping or a combination of these activities. Overnight use of Provincial Parks indicates a heavy transient component during July and August, particulary on or near the main Alaska Highway route.

It appears that the region serves largely as an interim destination for most visitors rather than a final destination.

Non-resident tourist use is generally of short duration and usually excludes river boating due to the specialized nature of the sport.

Recreational activities in the Peace River Valley are currently impeded by poor and infrequent access to the river, lack of publicly owned useable shoreline and absence of basic facilities for public use. These factors are not insurmountable which may indicate that there has not been a heavy demand for improvement.

Although the Peace River and its valley constitutes a valuable recreational resource, it competes with other water areas rivers in

the region. Existing evidence of public activity on the river appears to result from repeated use by a small group of riverboat enthusiasts.

6.9.2 Previous Studies and Impact Assessments

Impacts on the recreational resources and use in the Peace region were presented in Edwin Reid and Associates Ltd. (1979); DPA Consulting Ltd. (1981), and B.C. Hydro Properties Division (1981). Government position papers also reviewed this subject area (Ministry Lands, Parks and Housing 1981; 1982). A tourism impact study was prepared by Canadian Resourcecon Ltd. in 1980.

Site C would eliminate river-based recreational opportunities, including many attractive activities on the islands. The projected appearance of the Site C reservoir, analyzed from vantage points along Highway 29, would be a dramatic element in the landscape, but would lack the variety of the present watercourse. The reservoir would be closer to the highway than the river is at present and the water surface would be visible for almost 35 km, as compared to 16 km. The flooding of islands and small channels would cause the greatest loss of attractiveness. There would also be a net loss of attractive shoreline, and the recreation capabilities along the Moberly and Halfway arms of the reservoir would also be reduced.

The reservoir is expected to attract similar numbers of people from the surrounding area as previously used the river, but the relative importance of recreational activities would change. General boating, fishing and camping would be more popular, but hunting might decline somewhat in popularity depending on game management practices. River canoeing and river boating would be lost, but flat water canoeing might increase.

The quality of reservoir recreation might be reduced due to fluctuating water levels, floating debris and rough water

conditions, which have posed problems at other locations. There is also concern that safety on the reservoir would be reduced due to debris and an unstable shoreline.

BCUC recommended that as a condition of the EPC, B.C. Hydro pay an amount equal to the present value of the recreational loss, and that these funds should be used to develop programs that would contribute to enhancing recreation both on the reservoir and on remaining rivers in the region. Public access to the water would be increased by developing four areas on the north shore of the reservoir suitable for campground, picnic, boat launching or day-use facilities up to Provincial Parks Branch standards. Land use planning studies, including recreation capability, would be required after reservoir filling to determine the optimal location and design of facilities.

From the compensation package, BCUC recommended that the Ministry of Parks develop recreation programs that enhance river and reservoir recreation in consultation with local authorities. Further funds were to be set aside for the development of Alwin Holland Park by Hudson's Hope and for the development of wilderness campsites by the River Rats Club.

Canadian Resourcecon (1980) projected that there would be no loss in regional tourism as a result of the project as other regional opportunities would meet this demand. However, the attraction of the project may actually increase the number of tourists visiting this area of the region both during construction and after Site C is completed.

A Tourism Development Strategy was completed in late 1989 for the Peace River - Liard Community Futures Association.

6.9.3 Recent Studies

As part of activities to update Site C environmental studies to a shelf ready status, MacLaren Plansearch conducted some recent (1990) work on a recreation and tourism assessment for the Site C project. A summary of their activities and results follows:

The study process was organized in a series of Tasks within four phases. They include:

Phase I: Refinement of Terms of Reference and Data Gathering

Phase II: Collection of New Data, on Site Investigation

Phase III: Identification of Impacts, Mitigative Measures and Opportunities for Enhancement

Phase IV: Identify Additional Research Studies

TASKS ACCOMPLISHED TO DATE:

PHASE I: REFINEMENT OF TERMS OF REFERENCE AND DATA GATHERING

Task 1: Meeting with Client

Initial meetings were held with the Senior Environmental Coordinator and members of the project team.

Topics covered were:

- discussion of the activities of the Study
- transfer of all available documentation and background information
- establishment of communication linkages
- identification of ongoing studies by B.C. Hydro
- outlining of the proposed schedule

- definition of project status, related issues and concerns and the work plan.

This task was completed.

Task 2: Refinement of Terms of Reference

This task was completed to the draft level as directed by the client. Copies were circulated to stakeholders for commentary and feedback.

Task 3: Meetings with Regulatory Bodies

Work on this task was not initiated.

Task 4: Review of Documents/Literature/Inventory Area

A review was made of all documents that provide information on the recreation and tourism resources. It was carried out concurrently with the agency consultation process. This task was completed.

PHASE II: NEW DATA COLLECTION AND ANALYSIS AND ON SITE INVESTIGATION

Task 5: Assess Recreation Demand and Tourism Market Potential

Using available literature and interviews a review was made of:

- existing/potential recreation demand;
- tourism market potential

This task was partially completed through literature review, interviews, and a field visit to the Site C Impoundment area and Peace River Region. A full resource evaluation has not yet been completed. Regional recreation resources were inventoried and GIS

recreation mapping was completed.

The current recreation usage of the Site C area was assessed. A pre, post, and construction phase Assessment was not carried out.

Task 6: Initial Data Gap Identification

This task was completed.

Task 7: Presentation to Client

A review was presented to the client by both meeting and progress report as specified.

Task 8: Recreation and Tourism Resource Analysis

A review of recreation and tourism resources in the region and communities to be affected by impoundment was made.

The region was visited by two team members who investigated all indoor and outdoor recreation features and facilities, tourism accommodation attraction and operations as well as ancillary community and regional infrastructure. The one week field visit focused on updating of the recreation and tourist resources.

The resulting data is summarized in this status report, and is by no means comprehensive. More detailed research is required. No trans-border issues were addressed.

Task 9: Review of Local/Provincial Trends

This task was completed in a summary fashion for use projections for the Site C impoundment area, and for general tourism demand for the area.

Task 10: Future Demand and Market Projections

This task was not undertaken.

Task 11: Meeting with Local Recreation Leaders and Travel Industry Operators

Technical information meetings were held with selected individuals in the recreation and tourism industry: They include:

- Hotel/Motel Operators
- Chamber of Commerce
- Community Administrators
- Campground Directors
- Recreation Directors
- Tourism Development Officers

Emphasis was placed on determining their long term plans and the compatibility of recreation and tourism initiatives. This task was completed.

Task 12: Assessment of Completeness of Database

Data gaps for immediate action or future study are identified on the basis of existing documentation as well as comprehensive on-site analyses. This task was completed.

Task 13: Preparation of Recreation and Tourism Resources Assessment Information Baseline

Several elements of this task have been assembled, but not yet written up in report format.

Task 14: Presentation to Client

This task was not undertaken.

PHASE III: IDENTIFY IMPACTS AND MITIGATIVE MEASURES

Substantial information and data relevant to Phase III has been assembled.

The tasks under this phase are Task 15: Identification of Impacts of Construction and Operators of Site C; and Task 16: Identification of Mitigative Measures and Enhancement Opportunities. These tasks have not been completed.

PHASE IV: IDENTIFY ADDITIONAL RESEARCH AND STUDIES

Some elements of this phase have been assembled. Tasks 17 and 18 were not undertaken.

EVALUATION OF KEY RESOURCES AND ISSUES

Key resources that were evaluated included:

- Natural Resources: vistas, vegetation, parks, waterways;
- Cultural Resources: special events, ethnic groups;
- Historic Resources related to tourism and recreation;
- Community Resources, e.g. community centres, museums, parks, area;
- Commercial Recreation Resources, e.g. pools, golf courses;
- Tourism Plant, e.g. accommodation, food services, attractions, operators and suppliers;
- Regional and Community Infrastructure, e.g. airports, roads, waterways;
- Current environmental attitudes, (Environmental Scan);
- Agency and stakeholder interests;
- Needs of regulatory bodies.

Field Visit to Region

A field visit to review and inventory tourism, community recreation, and outdoor recreation features and facilities was completed. Interviews to update existing data and a field survey of the communities and the river corridor were undertaken by the consultants. Community recreation facilities were evaluated in terms of their capacity to absorb increased utilization and their present condition. Information for the GIS mapping project was collected.

Current facilities, usage, and long term plans and prospects are identified in the interview transcripts from the field visit. Notes for a preliminary regional analysis of recreation and tourism were developed, including the identification of positive and negative impacts of the project on community plans, strategies, and resources. No specific work was commenced on the impact assessment of the pre-construction, construction and operational phases of Site C development.

The interviews confirmed ongoing resident use of the Peace River Resource at varying levels within each community. Hudson's Hope interviewees identified the river as an essential part of their lifestyle. Informal riverside facilities continue to provide water based activities with additional capacity available.

Each community in the region continues to develop plans to enhance recreation opportunities for their residents, and tourists. Outdoor recreation use of the Peace River corridor by residents is based on informal facilities and there has not been a significant increase in demand in the past 5 years.

Development of regional outdoor recreation opportunities has provided additional capacity over the past decade for residents. Outdoor activities conducted in the area continue to closely resemble those reported in the 1979 study. There appears to be an

increase in touring activity and in Wildlife viewing. Cross-country skiing was identified as in increasing activity as well.

GIS Base Map Preparation

A base map was prepared updating the outdoor recreation resource inventory for the Site C impoundment, as specified in the terms of reference. The map included current viewscapes and incorporated the Provincial map symbol system for recreation. The base map was forwarded to Hugh Hamilton and Associates for conversion into GIS format. An accompanying map key was constructed indicating the point information to be entered into the GIS system. This data updates the original study prepared by Edwin, Reid and Associates in March, 1979. The GIS base map was completed by the second week of February, 1991. Twenty-four sites were identified and described.

Tourism impacts which concerned the public in the 1989/1990 public meetings included the general effect of the project on the tourism, loss of aesthetics of the flooded valley, potential impacts on the proposed underground museum at Hudson's Hope, effect on the region's tourism strategy and its plans for a 1992 Alaska Highway 50th Anniversary celebration, and the potential for enhancement of tourism by assess to the south side of the river.

6.10 HERITAGE RESOURCES

6.10.1 Background

Four basic kinds of heritage resources have been identified in the Site C study area.

Prehistoric Resources

Archaeological sites and objects dating to the period prior to he arrival of Europeans in the Peace River region in the late 18th century. These include seasonal villages, short and long term camps, tool production locations, animal kill sites, rock cairns, etc. Prehistoric sites dating back 10,500 years have been found in the region.

Historic Resources

Buildings, archaeological sites, and objects dating to the period following the arrival of Europeans in the Peace River region. These include fur trade "forts," homesteads, old wagon roads, missions, etc. Historic resources from two periods are present in the region: early Fur Trade period forts, and settlement period sites. The former include forts and small posts such as Rocky Mountain Fort and Rocky Mountain Portage House located along the river dating between 1794 and the 1860s; the latter consist mainly of log structures of various types dating between the 1860s and about World War II.

Paleontologic Resources

Fossils and places which contain fossils (paleontological sites).

Ethnographic Resources

Places of traditional social, religious, and other importance to native people which, because they do not contain any physical remains, do not qualify as archaeological heritage sites. Information about the existence and nature of ethnographic sites is usually obtained through interviews of native people, although archival and literature research is another source of such information. Ethnographic sites, and their contemporary use, are usually the main focus of the heritage concerns of native people for projects such as Peace Site C.

6.10.2 Previous Studies and Impact Assessments

The heritage resource study cited in the 1980 EPC application (Spurling 1978, 1980) documented 241 heritage sites within or near the proposed reservoir, of which 30% have been previously disturbed, primarily by agricultural operations, road construction and natural erosion. Earlier reports provided background survey information (Fladmark, 1975; Spurling et al., 1976). The Site C reservoir was projected to inundate 64 known heritage sites, 16 of which were historic in origin, including the Rocky Mountain Fort and Rocky Mountain Portage House sites. Adverse effects of flooding include loss of access for further investigations and possible physical changes due to continued inundation. The surface of these sites could also be disturbed during reservoir clearing operations.

Approximately 49 known sites occur very near full supply level where beaching, water erosion and minor sloughing would be greatest. It is expected that all of these sites would be directly affected. An additional 41 known sites occur above full supply level and beyond the zone of local beach erosion. The degree to which these 41 sites would be affected would depend on the degree of active erosion or instability that develops.

The relocation of Highway 29 and construction at the damsite could disturb another 23 known sites bringing the total number of known heritage sites directly affected by the Site C development to 146.

The Heritage Conservation Branch expressed concern about potential additional damage to, or loss of, heritage resources from post-construction development.

The execution of a comprehensive mitigation program would allow some of these resources to be salvaged or protected. The nature and extent of the resource base would be destroyed by inundation.

BCUC did not recommend that B.C. Hydro be required to compensate for the value of heritage resources in the region. First, it viewed these values as impossible to measure, and, second, the project would not preclude the immediate excavation of heritage sites prior to the construction of Site C.

BCUC stated that B.C. Hydro must match funds raised by the government through public subscription for the extra capital cost of a heritage resource recovery program up to a maximum of $500,000. B.C. Hydro was to continue working with the Ministries to establish a program for impact resolution, including the significance of area and items to be affected.

The public expressed concern in the 1989/1990 public meetings about the archaeological sites which would be lost, including the historic Old Fort site on the south bank of the river, and about B.C. Hydro policy on protection of historic sites and compensation.

Since the BCUC hearings, both the Rocky Mountain Fort and Rocky Mountain Portage House sites have been excavated by Simon Fraser University through Heritage Trust Fund financing. The regional

tourism associations report increased interest in heritage resources in recent years drawing more tourists to the region.

6.10.3 Recent Studies

A study was initiated in 1990 to update the heritage resource impact assessment for Site C. The work was conducted by Arcas Ltd. In particular, the assessment was to define changes which have occurred in the heritage baseline information since B.C. Hydro's 1980 EPC application for the Project, and to collect the data needed to meet or exceed the requirements for a new EPC application and for the federal government's Environmental Assessment and Review Process (EARP) for the Project.

B.C. Hydro's draft terms of reference for the update studies identified more than a dozen objectives, and divided the assessment into four sequential phases. The four phases consistent with that used in the provincial Archaeological Impact Assessment and Review Process, are:

Phase I	-	Terms of Reference
Phase II	-	Overview
Phase III	-	Impact Assessment
Phase IV	-	Follow-up

Work Undertaken and Methods

This section summarizes by phase the work undertaken to date (July 16, 1990 to March 30, 1991). Where appropriate, the methods used in the assessment are outlined.

Terms of Reference (Phase I)

Interest Groups

Public and interest group meetings were held by DPA Group and B.C. Hydro in the region as part of the Project's public consultation program. Heritage concerns were raised at a few meetings. These meetings took place prior to the initiation of the heritage assessment, and are not part of this study. The results of these meetings were forwarded to Arcas Ltd.

Draft Terms of Reference were sent to a number of local interest groups by DPA Group for review as part of the public consultation program. These groups were identified before the heritage assessment was initiated, and this activity was not part of the heritage assessment. Additional interest groups were identified by Arcas Ltd. and their names forwarded to DPA Group.

As part of this study Arcas Ltd. held consultations in person, by telephone, or by mail with the following interest groups and individuals to identify heritage concerns about the Project:

- North Peace Historical Society
- Dr. Finola Finlay, Campus Principal, Northern Lights College, Fort St. John
- Mr. Keary Walde, archaeologist, Heritage North Consulting Services, Fort St. John
- Mrs. Myrna Gething, Chairperson "Rendezvous '92", Hudson's Hope
- Ms. Donna Kyllo, Curator, Fort St. John - North Peace Museum, Fort St. John
- Ms. Janice McCarthy, Curator, Hudson's Hope Museum, Hudson's Hope
- Mr. Frank Koop, resident, Fort St. John

The study also identified a number of provincial and national interest groups with a potential interest in the Project.

Regulatory Agencies

As part of this assessment, Arcas Ltd. held consultations in person or by mail with the following agencies to identify regulatory and other requirements pertaining to heritage resources for an EPC application and EARP review:

- Archaeology Branch, B.C. Ministry of Municipal Affairs, Recreation and Culture, Victoria
- B.C. Ministry of Native Affairs, Victoria
- Ministry of Communications, Ottawa

The Ministry of Native Affairs is a new provincial regulatory since the last EPC application. Similarly, the Ministry of Communications is a new federal regulatory agency as is the Federal Environmental Assessment Review Office which had not been consulted at the time completion of the assessment was deferred.

Native Heritage Concerns

Initial attempts were made to contact local native Indian groups as a prerequisite to identifying their heritage resource concerns about the Project. Robin Ridington, the anthropologist/ethnographer on the study team, made initial telephone and written contact with the Halfway River Indian Bank, the Doig Indian Band, and the Treaty 8 Tribal Association. Subsequently Arnoud Stryd, the Study Director, was contacted by Harry Slade, counsel for the Treaty 8 Tribal Association regarding participation by the Association and its member banks in the Heritage Resources Assessment.

Other EARP Experiences

Three individuals familiar with heritage studies for recent large-scale hydroelectric developments outside of British Columbia were briefly consulted by Arcas Ltd. to determine their experience with federal regulatory requirements. They were: (1) Dr. Marty Magne,

Director of Research, Archaeological Survey of Alberta, who participated in designing the heritage studies for the Oldman Project; (2) Dr. Jim Finnigan, Archaeology Section, Saskatchewan Research Council, who directed a number of the heritage studies for the Rafferty-Alameda Project; and (3) Dr. David Burley, Simon Fraser University, who co-directed the heritage studies for Nipawin Project in Saskatchewan.

Definition of a Heritage Assessment Plan

No heritage assessment plan was prepared because the Terms of Reference for the assessment had not been finalized.

Establishment of Final Terms of Reference

Even though a number of possible changes to the Terms of Reference were identified during the review of the draft terms, no attempt was made to prepare final Terms of Reference for the assessment because consultations with regulatory agencies, native people, and interest groups had not yet been completed.

Overview (Phase II)

Review of Previous and Current Heritage Studies

This task consisted of three main activities.

Review of previous heritage studies

This review included the identification and review of the following:

- identification and review of heritage documentation from the 1980 EPC application
- identification and review of publications and reports dealing with previous heritage studies in the region

- identification and review of the documentation (field notes, excavation records, catalogues, etc.) from previous Peace Site C heritage studies by Fladmark, Alexander, and Spurling presently stored at Simon Fraser University
- identification and review of the documentation for non-Peace Site C heritage studies in the area
- discussion of previous studies in the region with the archaeologist and others who had conducted or participated in these studies.

Search of B.C. Archaeological Site Inventory

As part of the review of previous heritage studies, a search of the B.C. Archaeological Site inventory in Victoria was undertaken for registration forms of archaeological sites already recorded in the area.

Review of current heritage studies and plans

This task consisted of:

- discussions with heritage specialists and interest groups resident in the Project area as to their current and future heritage study plans
- discussions with heritage specialists presently conducting research in the area, or who have recently carried out research in the area, to determine their current and future research plans
- discussions with the Archaeology Branch

Preliminary Assessment of Site Significance and Project Impacts

As part of the review of the revised EPC application, a preliminary assessment of site significance and potential Project impacts was undertaken. This assessment followed the

procedures outlined in the British Columbia Archaeological Impact Assessment Guidelines (1989).

Identification of Additional Data Requirements and Studies

A considerable effort was made to identify and assess the additional data and studies which would be needed for an EPC application and EARP review. The emphasis on this task occurred because this information was needed in the preparation of a timetable for completion of the heritage study. Three approaches were used:

- heritage experts familiar with the Project area and the requirements of an AIARP Impact Assessment were asked their professional opinions on the current state of heritage information for the area, and what still needed to be known or done in order to meet the requirements of an AIARP Impact Assessment. The experts were:

  Ms. Diana Alexander, archaeologist, Simon Fraser University, Burnaby
  Dr. David Burley, archaeologist, Simon Fraser University, Burnaby
  Fr. Finola Finlay, historic archaeologist (currently Campus Principal, Northern Lights College, Fort St. John)
  Dr. Knut Fladmark, archaeologist, Simon Fraser University, Burnaby
  Dr. Scott Hamilton, historic archaeologist, Lakehead University
  Mr. Geordie Howe, archaeologist, Arcas Ltd.
  Dr. Marty Magne, Director of Research, Archaeological Survey of Alberta, Edmonton
  Dr. Jack Nance, archaeologist, Simon Fraser University
  Dr. Robin Ridington, anthropologist, University of British Columbia, Vancouver

Mr. Bjorn Simonsen, archaeologist, Bastion Group Heritage Consultants, Victoria
Mr. Brian Spurling, archaeologist, Saskatchewan Culture, Multiculturalism & Recreation, Saskatoon
Mr. Keary Walde, archaeologist, Heritage North Consulting Services, Fort St. John

- the heritage literature was examined for critical assessment of the Peace Site C studies that have been conducted, and for suggestions or recommendations as to further data and assessment needs.

- interest groups and other individuals were asked what they thought still needed to be done in order to address their heritage concerns for the Project. These were then divided into requests for Impact Assessment actions/information and Mitigation actions/information. Only those concerned with the Impact Assessment are included in this study since mitigation concerns are beyond the scope of the present assessment.

Overview Report

No Overview report was prepared.

Impact Assessment (Phase III)

This phase has not been undertaken.

Follow-up (Phase IV)

This phase has not been undertaken.

6.11 WATER RESOURCES

6.11.1 Background

Water resources in the Site C project area have been studied under the general categories of hydrology, water quality and use, and downstream. Hydrology studies include flow regimes, sediment balances and ice conditions.

The land area that naturally drains to the proposed Site C dam site on the Peace River totals approximately 85,000 km^2 (32,700 mi^2). The Lake Williston drainage basin accounts for about 82 percent of this total area; the Halfway River drainage basin about 12 percent; and the Moberly River drainage basin about 2 percent. Other smaller drainages downstream of the Bennett Dam make up the total.

The rate at which water is released from the Bennett Dam is dependent mainly on power demands. Monthly flows are relatively constant (±15 percent) and the preregulation flood flows caused by the melt of the large snow pack west of the Rocky Mountains have been eliminated. The Halfway and Moberly rivers which flow into the Peace River downstream of the Bennett Dam exhibit typical seasonal flood and low flow characteristics as well as flood flows produced by summer rain storms.

On an annual basis, the Peace River flow at Hudson Hope, averaging 1044 m^3/s represents 90 percent of total inflow into the area; the Halfway River, averaging 80 m^3/s represents about 7 percent of the total inflow. In May and June when the tributaries downstream of Williston Lake are in freshet, the average monthly Peace River flow at Hudson Hope drops to around 75 percent of the total inflow into the area; in January, when the tributaries exhibit seasonal low flow, the Peace flow represents 98 percent of total inflow.

6.11.2 Previous Studies and Impact Assessments

Hydrology

The hydrologic characteristics, sediment regime and ice conditions of the Peace River were summarized by Thurber Consultants Ltd. (1979a), based primarily on earlier reports prepared by B.C. Hydro (1976; 1977). Since the Site C reservoir will be operated primarily as run-of-the-river, the flow regime downstream of the project will not be altered appreciably after initial filling.

Bed-load materials entering the reservoir from the tributaries will be deposited in the reservoir forming gravel deltas at the heads of the tributary arms. Most of the larger sized particles of the suspended load (i.e. sand and silt size) will be deposited in the reservoir, and some of the finer clay particles will also settle out before the water is passed downstream. It is estimated that the Halfway River arm of the reservoir would take about 50 years to fill with sediments, while the Moberly River arm and the main reservoir would take centuries to fill.

Stream bed degradation and bank erosion processes which are now occurring in the tributaries in the Site C area would be halted by the ponding of the reservoir.

Ice cover will form on the reservoir in most years, although open water will persist for more than 13 km below the Peace Canyon Dam, and in the forebay area of the Site C dam. Thin ice or open water areas would be expected to prevail down much of the center of the reservoir.

The major potential impacts on hydrological aspects of the proposed project are the downstream effects as summarized:

- decreased flows during reservoir filling, with particular concern about the timing of decreased flows;
- reduced suspended sediment loads to downstream areas including the Peace Athabasca delta;
- reduced ice cover in downstream areas;
- reduction of peak flows (by attenuation of flood flows from the Halfway and Moberly rivers) which may have an effect on downstream areas such as the Peace-Athabasca delta.

A review of present and expected ice regimes within the Site C area has been completed (Klohn-Crippen Consultants Ltd. 1989). They noted that ice cover currently extends as far upstream as Site C in 1 out of 10 years.

Water Quality and Use

An assessment of water quality and water use in the Site C area was conducted in 1977-1978 (Canadian Bio Resource Consultants (CBRC) 1979a). The major effects of the Site C development on water quality and use will be related primarily to increased water temperature and decreased suspended sediment levels. Other water quality parameters such as dissolved oxygen levels and nutrients are expected to remain similar to present conditions.

Average water temperature in the Site C reservoir during the summer months is expected to be 2°-3° C higher than in the river at present, reaching a maximum in July of about 13.5° C at the end of the reservoir nearest the dam. Thermal stratification of the reservoir is not expected to occur, although stratification may develop in the tributary arms under certain conditions. The tributary arms, especially the Moberly, may experience greater temperature increases in late summer due to low flows and associated long retention time of water.

Turbidity and suspended sediment levels within the reservoir are expected to be less than presently encountered in the Peace River since the sediment will settle out in the calmer waters of the reservoir. The tributary arms, however, will experience turbid conditions during freshet and major storm events due to incomplete settling of inflowing sediment material.

Only three major users in the study area draw water from the Peace River - two for domestic water for communities and one for cooling and process waters for a Taylor refinery. Small irrigation projects occur at Bear Flats and at Taylor. The effects of the Site C development on water supply use should be beneficial due to a reduction in seasonal suspended sediment levels and increased summer water temperature which may be better for irrigation purposes. However, these warmer waters may have a negative effect on downstream industries that use the waters for cooling.

With regard to increased water temperatures and the potential effect on downstream cooling water use, the 1983 BCUC report concluded that "Westcoast Transmission facilities might be affected, but the exact nature and consequence cannot be identified at this time".

The B.C. Ministry of Environment generally agreed with the results of the CBRC (1979a) study. The Ministry, however, felt that the water temperature increases predicted may be overstated since greater evaporation might offset the heat gain (B.C. Ministry of Environment 1981; p.B26). No detailed evidence supporting this concern was presented. The Ministry also concurred with BCUC's position on downstream industrial users (e.g. Westcoast Energy and Petro Canada) and was prepared to advise B.C. Hydro and Westcoast on the design of a monitoring program.

The public concerns regarding water quality include both seepage from the Fort St. John dump and the possible accumulation of mercury in the reservoir.

Environment Canada has measured chemical parameters in the Peace River supplementing studies done at seven stations between the W.A.C. Bennett Dam and the B.C.-Alberta border in 1975-1976 (Sheehan 1986), maintains a water quality monitoring site near the B.C.-Alberta border and conducted a study of dioxins and furans in sediment and fish in the Peace River in relation to the Fibreco Pulp Mill during the summer of 1989 (S. Sheehan, pers, comm.). B.C. Hydro initiated a seasonal water quality and water temperature study as part of the fisheries inventory program.

Downstream

In the past, the assessment of downstream impacts has been covered by several separate reports, including those related to hydrology, suspended sediment, water quality, ice regimes and supersaturation. It was felt, however, that there is now a need to consolidate the information into one report and to analyze the data to determine the expected impacts for downstream environmental and social resources. The initiation of this more comprehensive effort is described in the next section.

6.11.3 Recent Studies

Downstream

A list of available studies has been prepared, and cross-referenced under subject headings corresponding to each of the environmental studies to be performed. A brief summary of some of the major studies will be included in the report, as background to developing terms of reference. In some instances, it will be suggested that former sampling locations (i.e.

surveyed cross sections for geomorphology studies) should be reoccupied to permit comparison with existing data and avoid duplication of effort.

Preliminary Hydrology Report

Most of the existing Peace River flow regime has been fairly well defined in the report by the Hydrology Subcommittee associated with the B.C./Alberta Water Management Agreement (1990). However, the proposed Site C regulated flow regime has not yet been defined and routed downstream, so that a comparison can be made with the existing Peace River flow regime. The furthest downstream station where effects of the proposed Site C regulation will be felt should be identified.

Study Schedule

A schedule for the sequencing and approximate duration of the individual downstream environmental studies has been prepared, with the relative timing of studies. The absolute timing for commencement of the studies is independent of this schedule.

Outline of Approach to Impact Assessment

This section outlines suggested integrated studies approach to be followed by the team of consultants participating in the Peace River Site C downstream environmental impact assessment. The use of common data sets and sampling sites to the greatest extent possible will be stressed in order that a consistent and efficient study is performed. The impact assessment would depend upon the following anticipated studies:

Flow Regime
Thermal Regime
Ice Regime
Sediment Regime

Channel Morphology and Riparian Vegetation
Water Quality - Reservoir and Downstream
Fisheries
Wildlife - Furbearers, Waterfowl and Ungulates

Preparation of draft terms of reference for the physical impact studies were prepared. However, the downstream limits of the study still need to be defined. This requires information on the proposed Site C regulated flow regime still to be supplied. The flow regime study should be the first to proceed, as all of the other studies will require this information.

Outlines for the biological studies have been prepared, but cannot be completed at this time.

References

Over fifty references on the Peace River below Taylor have been compiled and reviewed.