

PROVINCE OF BRITISH COLUMBIA  
MINISTRY OF ENVIRONMENT  
WATER MANAGEMENT BRANCH

REPORT ON THE FLOODPLAIN MAPPING STUDY

CHEAKAMUS RIVER

An Overview of the Study Undertaken  
to Produce Preliminary Floodplain Mapping  
for the Cheakamus River  
Squamish-Lillooet Regional District

by

R.W. Nichols, P. Eng.  
Senior Hydraulic Engineer  
Special Projects Section

Victoria, British Columbia  
January, 1986  
File: 90-1300-S.1

TABLE OF CONTENTS

Page No.

Title Page.....	i
Table of Contents.....	ii
Preface.....	1
1. LOCATION.....	1
2. BACKGROUND.....	2
3. DESIGNATED FLOOD.....	2
4. SURVEY AND MAPPING DATA.....	3
5. FLOOD MAGNITUDES.....	4
6. HYDRAULIC ANALYSIS.....	5
6.1 General.....	5
6.2 Cross Section Plot Run.....	5
6.3 Model Calibration .....	6
6.4 Sensitivity to Manning's "n".....	6
6.5 Sensitivity to Flow.....	6
6.6 Dam Breach Flood Levels.....	7
7. FLOODPLAIN MAPPING.....	7
8. CONCLUSIONS AND RECOMMENDATIONS.....	8

Appendices

- Appendix 1 - Detailed Information Sources used in the Floodplain Mapping Study
- Appendix 2 - Study Area Location
- Appendix 3 - Floodplain Mapping, Cheakamus River, Drawing 85-15, Sheets 1 to 3

REPORT ON THE FLOODPLAIN MAPPING STUDY  
CHEAKAMUS RIVER

Preface

The purpose of this report is to present a description of the methodologies used and results of the study undertaken to produce floodplain mapping of the lower Cheakamus River in the Squamish-Lillooet Regional District (Drawings 85-15, Sheets 1 to 3 - Appendix 3).

1. LOCATION

The Cheakamus River is located approximately 100 km. north of Vancouver in the southern coastal mountains of British Columbia as shown on Appendix 2.

The river flows 42 km. west from its source at McBride Glacier into Daisy Lake which is the reservoir formed by the Cheakamus Project dams, owned by British Columbia Hydro and Power Authority (B.C.H.P.A.). Below the dams the river funnels through a narrow rock canyon and then flows south 26 km. to the confluence with the Squamish River. From the confluence, the Squamish River flows south a distance of 13 km. to Howe Sound (Appendix 1.1).

The floodplain mapping study area covers a distance of 11.3 km. of the Cheakamus River from its confluence with the Squamish River in the Squamish-Lillooet Regional District.

## 2. BACKGROUND

The Ministry issued floodplain mapping (Dwg. 5461, Sheets 1 to 10) of the Squamish River in October of 1983. Sheet 5 of this project covers the confluence area of the Cheakamus River.

The Ministry of Environment has been involved in a number of studies related to the Cheakamus Dam - Rubble Creek Slide. In September of 1980, the Comptroller of Water Rights increased the assigned priority of the Cheakamus Project dams in the Provincial program involving all licences of dams to undertake studies and prepare contingency plans for the extremely remote possibility of a dam failure.

B.C.H.P.A. carried out studies of the effect of a hypothetical breach in Daisy Lake Dam of the Cheakamus Project coincident with the Probable Maximum Flood spillway discharge and has prepared inundation maps corresponding to such an event. Results of these studies are contained in Report No. H 1728 by B.C.H.P.A. (Appendix 1.1), dated October, 1984.

## 3. DESIGNATED FLOOD

The storage available behind Daisy Lake dam, combined with the diversion to the Squamish River of 56 m<sup>3</sup>/s for power generation, is insufficient to attenuate major flood peaks. For example, in the flood of 1981 the inflow to the reservoir on October 31 was 374 m<sup>3</sup>/s and the outflow was 264 m<sup>3</sup>/s. However,

the reservoir was filled by October 31. The November 1 inflow was 400 m<sup>3</sup>/s and the outflow was 416 m<sup>3</sup>/s, so that, on a daily basis, the peak was not attenuated at all.

Flood levels and floodplain limits shown on the floodplain mapping sheets for the study area are based on a designated instantaneous flow of 1,600 m<sup>3</sup>/s (1:200 year frequency) plus an allowance for freeboard, assuming open water flow conditions, in accordance with the policy of the Ministry of Environment.

#### 4. SURVEY AND MAPPING DATA

The river cross section data from Project No. 76 FDC-10 (Appendix 1.2) was utilized in connection with flood profile calculations for the Cheakamus River. The data for the 22 cross sections are obtained by the Surveys Section of the Ministry of Environment in August of 1978. Analysis of the data in July of 1982 indicated the need for additional cross section information in the study area. The additional data was obtained in September of 1983 (Project No. 83 FDC-13, Appendix 1.3). A total of 32 river cross sections were used in the final profile calculations in the study area. The cross sections locations are shown on the attached floodplain mapping sheets (Appendix 3).

Highwater mark elevations based on the flood of October 31, 1981 were obtained by the Surveys Section at five locations in the study area and the results used in calibration of the river model.

Base mapping of the study area at 1:5000 scale was obtained from the Surveys and Resource Mapping Branch Project No. 77-166T-0. Contours (1 metre) and spot heights for the project were obtained from September, 1976 air photography (Appendix 1.4).

## 5. FLOOD MAGNITUDES

The Modelling Section, Water Management Branch, carried out a study (Appendix 1.5) to estimate the required peak flows for the study area. The study was based on Gauge No. 8GA043, Cheakamus River near Brackendale, which has a total drainage area of 1,010 sq. km. (780 sq. km. of this upstream of Daisy Lake dam). The gauge, which has flow records for the periods 1958 to 1971 and 1973 to date, is located about 5 km. upstream of the Squamish River confluence.

Maximum annual floods occur both in the September to January period, as a result of heavy winter rainfall combined with snowmelt conditions, and in the May to July period as a result of snowmelt conditions. The largest flood peaks occur in the September to January period.

The October 31, 1981 instantaneous flow used in model calibration was estimated to be 739 m<sup>3</sup>/s and the 1:200 year daily and instantaneous flows at the gauge were estimated to be 1,150 m<sup>3</sup>/s and 1,600 m<sup>3</sup>/s, respectively.

The initial flow at the instant of dam break downstream of Daisy Lake dam was estimated by B.C.H.P.A. to be 9,700 m<sup>3</sup>/s (Appendix 1.1). The maximum flood

discharge just upstream of the Cheakeye River confluence was reduced to 7,080 m<sup>3</sup>/s as the flood flow is routed through the Cheakamus River Valley. These flows are considerably in excess of the designated flood (1,600 m<sup>3</sup>/s) used in the floodplain mapping study, but have been included here for comparative purposes.

## 6. HYDRAULIC ANALYSIS

### 6.1 General

The information sources listed in Appendix 1 were utilized in the HEC-2 water surface profile computer program developed by the Hydraulic Engineering Centre, U.S. Army Corps of Engineers. The profile calculations assumed open water flow conditions.

### 6.2 Cross Section Plot Run

A computer plot of river cross sections was obtained to assess the river survey data input and the extensions of these sections obtained from the existing topographic mapping. Output from this run was also used to review other data such as flow regime, loss coefficients, bridge information, reach lengths, overbank information and relative Manning's "n" values.

### 6.3 Model Calibration

Manning's "n" values were determined to match to observed highwater marks at five locations in the study area as a result of the October 31, 1981 flood. Channel "n" values averaged 0.045 in the study area and the calculated flood levels averaged to within 0.10 metres of the October 31, 1981, observed levels.

### 6.4 Sensitivity to Manning's "n"

An increase in "n" values for the channel from 0.045 to 0.060 for a 1150 m<sup>3</sup>/s flow in the study area results in an average flood level increase of 0.50 metres.

### 6.5 Sensitivity to Flow

Results of the studies indicate that flood levels for a 1:200 year frequency daily flow of 1150 m<sup>3</sup>/s average 0.8 metres above the calculated October 31, 1981, flood levels where the flow was 739 m<sup>3</sup>/s at the gauge. The designated flood level for the 1:200 year instantaneous flow of 1600 m<sup>3</sup>/s (freeboard included) averages 1.7 metres above the October 31, 1981 flood levels.

### 6.6 Dam Breach Flood Levels

The report by B.C.H.P.A. (Appendix 1.1) indicates that, in the floodplain mapping study area, maximum flood levels as a result of a dam breach occurrence exceed the designated flood levels used for floodplain mapping purposes by approximately 3.0 metres.

### 7. FLOODPLAIN MAPPING

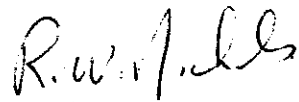
The flood levels determined in the study were used to draw the designated floodplain limits onto the existing topographic mapping of the study area. The attached drawings (Appendix 3) were produced and indicate the following information:

- the orthophoto (1 metre contour) mapping indicates the location of the river cross sections, the designated floodplain limits and the flood levels determined in the study.
- the study area covers 11.3 km. of the Cheakamus River upstream from the confluence with the Squamish River. For the first 3.0 km., to just upstream of the Cheekye River confluence, the flood profile is extremely steep rising a total of 30 metres (slope of 1%). For the remainder of the study area, the flood profile rises 32 metres in a distance of 8.3 km. (slope of 0.38%).

- the fan of the Cheakamus River at the confluence of the Squamish River has been cross hatched on the mapping sheets. It is noted that flood levels are indeterminate in this area which is susceptible to flooding during high flow periods.
- the Cheekye River fan covers a large portion of the study area. It is noted that information related to this fan is available from the Ministry of Environment, Water Management Branch.

8. CONCLUSIONS AND RECOMMENDATIONS

1. This report serves to present an overview of the studies undertaken to produce the floodplain mapping sheets for the Cheakamus River for a distance of 11.3 km. upstream from the confluence the Squamish River.



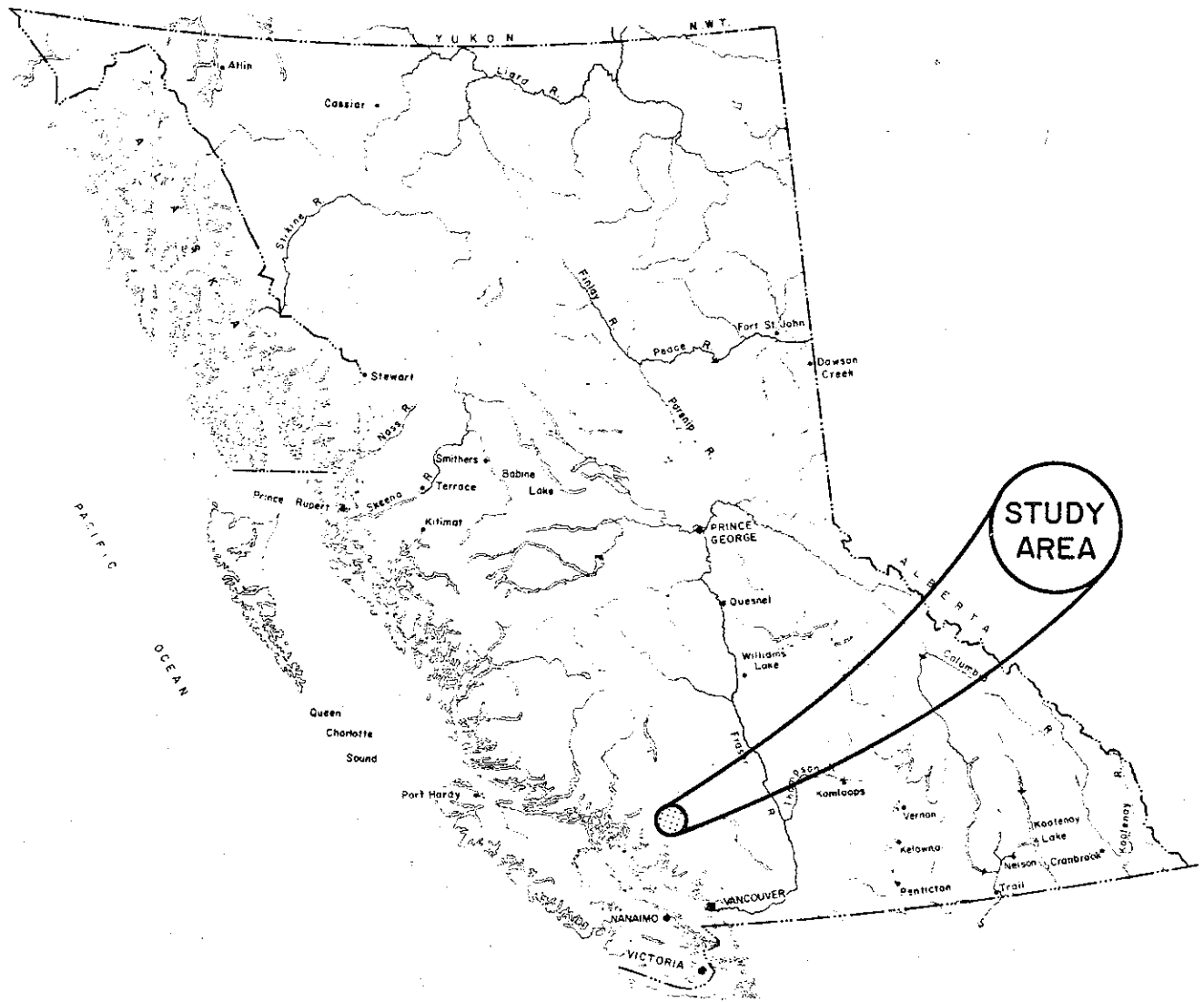
R.W. Nichols, P. Eng.  
Senior Hydraulic Engineer  
Special Projects Section

RWN:res

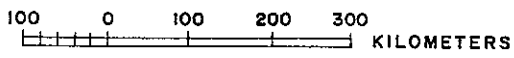
APPENDIX 1

Detailed Information Sources Used for the Floodplain Mapping Study - Cheakamus River

No.	Source	Contents
1.	Report No. H 1728, October, 1984 B.C.H.P.A., "Daisy Lake Dam, Dam Breach Indundation Study".	Results of studies into the effects of a hypothetical breach of Daisy Lake Dam to estimate the extent of inundation as far as Howe Sound.
2.	Ministry of Environment, Water Management Branch, Surveys Section, Survey Project No. 76 FDC-10, "Cross Section Data Cheakamus River", August 1978	22 River Cross Sections obtained in the floodplain mapping study area.
3.	Ministry of Environment, Water Management Branch, Surveys Section, Survey Project No. 83 FDC-13, "Cross Section Data, Cheakamus River", September 1983	10 River Cross Sections obtained in the floodplain mapping study area.
4.	Ministry of Environment, Map Production Division, Surveys and Mapping Branch, Project No. 77-166 T-0.	1 metre orthophoto, 1:5000 scale topographic mapping based on air photos taken in September, 1976.
5.	Ministry of Environment, Modelling Section, Water Management Branch, Cheakamus River Peak Flows Estimates", Memo dated. March 30, 1982.	Estimates of daily peak flows in the study area.



**STUDY AREA LOCATION**



**Province of British Columbia**  
 Ministry of Environment  
 WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON  
**FLOODPLAIN MAPPING STUDY**  
**CHEAKAMUS RIVER**

SCALE: VERT .....  
 HOR. **AS SHOWN**

DATE  
**DECEMBER 1985**

**R. W. NICHOLS** ..... ENGINEER  
 FILE No. **90-1300-S.1** ..... APPENDIX NO. **2**

BCIL 7673-ME