Canada-British Columbia Floodplain Mapping Agreement

A Design Brief on the

Floodplain Mapping Study

Alouette and North Alouette Rivers

An Overview of the Study Undertaken
to Produce Floodplain Mapping for the
Alouette and North Alouette Rivers

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Preface

The purpose of this design brief is to outline the methodologies used and results of the study undertaken to delineate the floodplains of the Alouette and North Alouette Rivers, as shown on Drawings 89-44, Sheets 1 and 2 (Appendix 3).

1. Background

1.1 General

The Ministry of Environment, Engineering Branch, has been involved in flooding problems related to the Alouette and North Alouette Rivers for a number of years. Reports by Leach (Appendix 1.1) and Oxland (Appendix 1.2) document investigations related to flooding of the Alouette River in 1955 and 1961.

A note to file by R.H. Cameron, P. Eng., dated January 28, 1981 (Appendix 1.3) also documents problems resulting from the flood of November 3-5, 1955. Homes were evacuated on 132nd Avenue (see Drawing 89-44, Sheet 1) between 224th to 232nd Streets. A log jam on the South Alouette River near 132nd Avenue, west of 224th Street directed flows to the North Alouette River. The Tretheway farm, west of 216th Street was inundated. The road bridge on 232nd Street was nearly lost and many logs and debris were jammed against the 224th Street bridge. Five homes were completely destroyed by the floods. Dykes were breached in the Maple Ridge, Pitt Meadows, Edge and Tretheway farms and No. 1 Dyking District. The Leach Report (Appendix 1.1) estimates flow into Alouette Lake at 548 cms, (flow released at 280 cms) on November 3, 1955.

On December 26 and 27, 1980, flooding of the South Alouette River resulted in bank erosion problems resulting in damage to two homes on 128th Avenue between 224th and 232nd Streets (Appendix 1.4). Photos 1 to 6 (Appendix 2) indicates flood stage and damage resulting to the homes during the flood.

There are a number of floodproofed homes within the study area (Photos 8 to 10, Appendix 2 are examples) which conform to Provincial subdivision legislation and/or to local bylaw requirements.

The Ministry of Environment, Engineering Branch issued preliminary floodplain mapping of the Alouette and North Alouette Rivers in May, 1985. The mapping is listed in Schedule A.2.9 of the "Agreement Respecting Floodplain Mapping in the Province of British Columbia". The base mapping for the project was at a scale of 1:5000 and the contour interval was 2 metres.

1.2 Present Studies

The present studies (1989/90) utilize more detailed mapping of the study area (1 metre contour intervals) which was issued in March of 1989 (Appendix 1.5) by the Surveys and Resource Mapping Branch.

During the course of these studies, information was provided to B.C. Hydro and Power Authority (B.C.H.P.A.) (Appendix 1.5 to 1.7). The data has been used by B.C.H.P.A. to provide information to dam operators relating reservoir releases with flooding extent so that appropriate flood warnings can be issued when necessary. A draft report has been prepared entitled "Assessment of Flood Potential Downstream of B.C. Hydro Dams - Alouette River" (Appendix 1.8). Flows used in the study were between estimated bank full discharge and 0.75 times the 1:200 year discharge adopted by the Ministry of Environment.

2. Location

The study area is located in south-western British Columbia approximately 40 km east of Vancouver as shown in Figure 1. The area is north of the Fraser River and east of the Pitt River in the District of Maple Ridge, Dewdney-Alouette Regional District, as shown in Figure 2.

The watersheds of both the Alouette and North Alouette Rivers lie within the coastal mountains of British Columbia. Major flooding events generally occur during October to February as a result of intense rainfall combined with snowmelt.

The headwaters of the Alouette River lie within Golden Ears Provincial Park and issue from the southwest slope of Mount Robie Reid in the Coast Mountain Range. Flowing to the southeast, it enters Alouette Lake which is regulated by the B.C. Hydro and Power Authority "Alouette" control dam, a part of the "Alouette Stave Ruskin" hydroelectric system. From the outlet structure it flows in a generally westerly direction through the District of Maple Ridge until it reaches the confluence with the Pitt River, approximately 8 km west of the study area. The drainage area of the Alouette River above the Water Survey of Canada Gauge (08MH005) at 232nd Street is 234 km^2.

The North Alouette River watershed originates within the U.B.C. Research Forest Reserve and is located to the west of the Alouette River watershed. The drainage area above the Water Survey of Canada Gauge (08MH006) is 37.3 km^2 and is not regulated. From its headwaters, the North Alouette River flows initially in a southwesterly direction for approximately 7 km and then swings generally north westerly downstream of the study area for another 6 km until it meets the Alouette River approximately 3 km upstream of the Pitt River confluence.

Between the confluence of the Pitt River and the study area, the flood levels are affected by the Fraser River system. Dykes that are part of the Fraser River Flood Control Program are located along the lower reaches of the Alouette River system to provide protection to existing development on the floodplain lands. The flood level adopted for administrative puposes for this area (Appendix 1.14) by the Ministry is 5.33 metres (freeboard included).

3. River Survey Data

The location of river channel cross sections used in the study area are indicated on Drawings 89-44, Sheets 1 and 2 (Appendix 3). The survey data was obtained by the Surveys Section, Water Management Branch in June, 1981 and includes information on 1980 and historical high water elevations (Appendix 1.6).

4. Flood Magnitudes

4.1 Recorded Flows

Water Survey of Canada Gauge 08MH005 has been in operation on the Alouette River from 1911 to 1915, 1960 to 1964 and 1971 to date. According to the report by Leach, stream flow records were kept between January 1916 to May 1925 at the outlet of

Alouette Lake (Gauge 08MH014) prior to dam construction. The maximum recorded daily flow prior to dam construction occurred on October 29, 1921 and amounted to 425 cms at the lake outlet (Appendix 1.1). Since regulation by B.C. Hydro and Power Authority, the maximum recorded instantaneous flow of 158 cms at Gauge 08MH005 occurred on December 26, 1980.

The Water Survey of Canada gauge on the North Alouette River (08MH006) has been operational continually since March of 1960 and also recorded from November 1911 to December 1913. The maximum flow during this time period occurred on February 24, 1986 and was estimated to be 162 cms instantaneous and 86 cms daily.

4.2 Peak Flow Estimates

The Hydrology Section of the Water Management Branch undertook a study to estimate peak flows for the North Alouette and Alouette River. (Appendix 1.7) . The results of peak flow studies are summarized below.

The 1985 peak flow study for the North Alouette River was based on regional peak curves (Appendix 1.10) and on frequency analysis results for the hydrometric station at 232nd Street (08MH006). Since the maximum recorded flow at the gauge occurred in February of 1986, an updated frequency analysis of the period of record to 1988 (31 years for daily flow data) was undertaken.

The analysis resulted in 1:200 year daily flows varying from 100 cms (Pearson Type III Distribution) to 140 cms (Log Normal Distribution) at the gauge. Given that flow from the Alouette River has been known to overflow to the North Alouette River in the study area during high flow periods (Section 1.1), the flow of 140 cms was selected as the 1:200 year daily flow for mapping purposes. The 1:200 year instantaneous flow of 300 cms was selected based on a review of the available data and a ratio of maximum instantaneous-to-daily discharge of 2.15:1.0 (Appendix 1.7). The sensitivity of flood levels to flow on the North Alouette River is discussed in Section 5.3.

The peak flow estimates used in this study for the Alouette River were based on the 1985 analysis (Reference 1.7).

The recurrence interval regulated flow estimates for Alouette River were made in two steps, for the upper Alouette Lake basin and for the lower river reach basin. Alouette Lake peak daily inflows were based on frequency analysis results (Appendix 1.9, Figure 3-2). These estimates were converted to instantaneous values using regional maximum instantaneous-to-daily ratio curves (Appendix 1.10). Inflow hydrographs were constructed based on the shape of the January 14-16, 1961 hydrograph previously defined (Appendix 1.11) but reflecting the above noted instantaneous and daily estimated peaks. The inflow hydrographs were then routed in one-hour time intervals by a Surface Water Section computer program adapted for Alouette Lake hydraulic conditions to calculate peak outflows under various outflow regulation conditions.

The lower Alouette River basin peak flow estimates were based on data from the hydrometric station Alouette River near Haney (08MH005) and associated lake outflow data (Appendix 1.12). Outflow from Alouette Lake dam are highly dependent on the release gate operation during floods. Assuming no power or adit bypass diversion to Stave Lake, the Alouette Lake outflow for a 1:200 year event was calculated to be 528 cms instantaneous (558 cms at the confluence) with the flood gates fully open. These figures reduce by approximately 30% (i.e. to 363 cms lake outflow) if a power diversion of 28 cms (maximum licensed) plus adit bypass of 35 cms to Stave Lake is assumed.

For the purpose of this study, the flow estimate of 528 cms (flood gates fully open, no adit bypass or power diversion) was adopted.

5.0 Hydraulic Analysis

5.1 General

The HEC-2 water surface profile computer program developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers in Davis, California was used to calculate flood profiles. The flood profile studies assumed open channel flow conditions.

Flood profiles calculated for the Alouette and North Alouette Rivers in the study area are outlined in more detail in the following sections. An assessment was made of the river channel survey data and the cross section extensions which were obtained from the 1 metre contour topographic mapping. Output from the plot 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.

5.2 Alouette River

A total of 42 surveyed cross sections were utilized in the study covering a total distance of almost 9.8 km. Sufficient high water mark data was not available from the 1980 event to adequately calibrate the model. Manning's "n" values were based upon cross section photos, site visits and experience gained in other studies. Careful interpretation of flow distribution summaries produced from many trial and error runs resulted in a best estimate of the calculated 1:200 year water surface profile. From this data the flood levels were determined with 0.3 m added to the calculated water surface elevation as an allowance for freeboard in accordance with the policy of the Ministry of Environment.

Sensitivity studies were undertaken to assess the effect of increased Manning "n" values and flows on the computed flood levels. The studies indicated that a 20% increase in "n" values result in an average flood level increase of 0.21 metres. The freeboard (0.3 metres) was exceeded only at 4 of the 36 cross sections in the narrow, steeper portion of the floodplain east of 240th Street (Dwg. 89-44, Sheet 2). Increasing the flow by 20% from 558 to 670 cms results in an average flood level increase equivalent to the freeboard allowance. At approximately one half of the cross sections, the freeboard of 0.3 metres was exceeded by an average of 0.07 metres.

5.3 North Alouette River

River cross section data covering a distance of 4 km upstream of 136nd Avenue involving 26 surveyed cross sections and 4 bridge locations was utilized in the study. Photographs of the channel sections and overbank areas were reviewed for initial selection of the relative Manning's "n" values.

Highwater mark data obtained at 13 locations as a result of the December 26, 1980 flood event was used to calibrate the model. From this data, flood profiles for the 1:200 flows of 300 cms (instantaneous) and 140 cms (daily) were determined. A freeboard of 0.3 m or 0.6 m, for the instantaneous or daily profile respectively, was added to the flood levels in accordance with Ministry practice. The instantaneous flood levels plus freeboard generally predominated in the model area.

Sensitivity studies indicated that at flows of 10% above the 1:200 year (300 cms) instantaneous flow, the level rise averages 0.10 metres in the model area. Manning's "n" increases of 10% also result in an average level increase of 0.10 metres.

6. Floodplain Mapping

6.1 General

The flood levels determined in the study were used to delineate the floodplain limits into the 1 metre contour mapping of the study area.

As noted in Section 2, the Fraser River floodplain and dyking system extends to the downstream limits of the study area. The Fraser River flood level dominates in this area. An overtopping of the existing dykes adjacent to the Alouette River system would result in the inundation of the floodplain lands to the 5.33 metre level (freeboard included).

The adequacy of the Fraser River dyking system adjacent to the Alouette River to withstand a 1:200 year Alouette River flood was not determined in this study. Recent proposals to expand the existing dyking have involved an assessment of flood levels for the North Alouette system between Pitt River and the study area for 1:25 year return period flows (Appendix 1.13).

6.2 Drawings 89-44, Sheets 1 and 2

Drawings 89-44, Sheets 1 and 2 replace the existing preliminary floodplain mapping (2 metre contour) sheets produced under the Provincial program.

A field visit to the area was made in December, 1989 to review the floodplain limits as shown on the drawings. It was observed that ponded water was prevalent in many areas outside the floodplain limits indicating that properties may be subject to flooding from tributary watercourses during extreme flood events. Notes have been placed on the drawings to this effect.

A comparison with the floodplain mapping previously issued indicates that the preliminary mapping was generally more conservative (i.e. higher floodlevels). The floodplain limits are modified reflecting the more detailed topographic information.

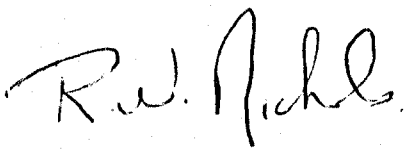
7. Conclusions and Recommendations

7.1 This design brief presents an overview of the studies undertaken to produce the floodplain mapping sheets of the Alouette and North Alouette Rivers.

7.2 The potential for Alouette River and North Alouette River flood levels downstream of the study area to exceed the capacity of the existing Fraser River dykes has been brought to the attention of the Provincial Inspector of Dykes.

7.3 Drawings 89-44, Sheets 1 and 2 replace the preliminary Drawings 85-7, Sheets 1 and 2, dated May 1985.

7.4 It is recommended that the floodplains delineated on Drawings 89-44, Sheets 1 and 2, be designated under the terms of the Canada-British Columbia Floodplain Mapping Agreement. The drawings may be used for administrative purposes related to the preparation of hazard map schedules for official plans; selection of floodproofing requirements in zoning and building bylaws; the designation of floodplains in floodplain management plans; and the identification of floodable lands by Subdivision Approving Officers.



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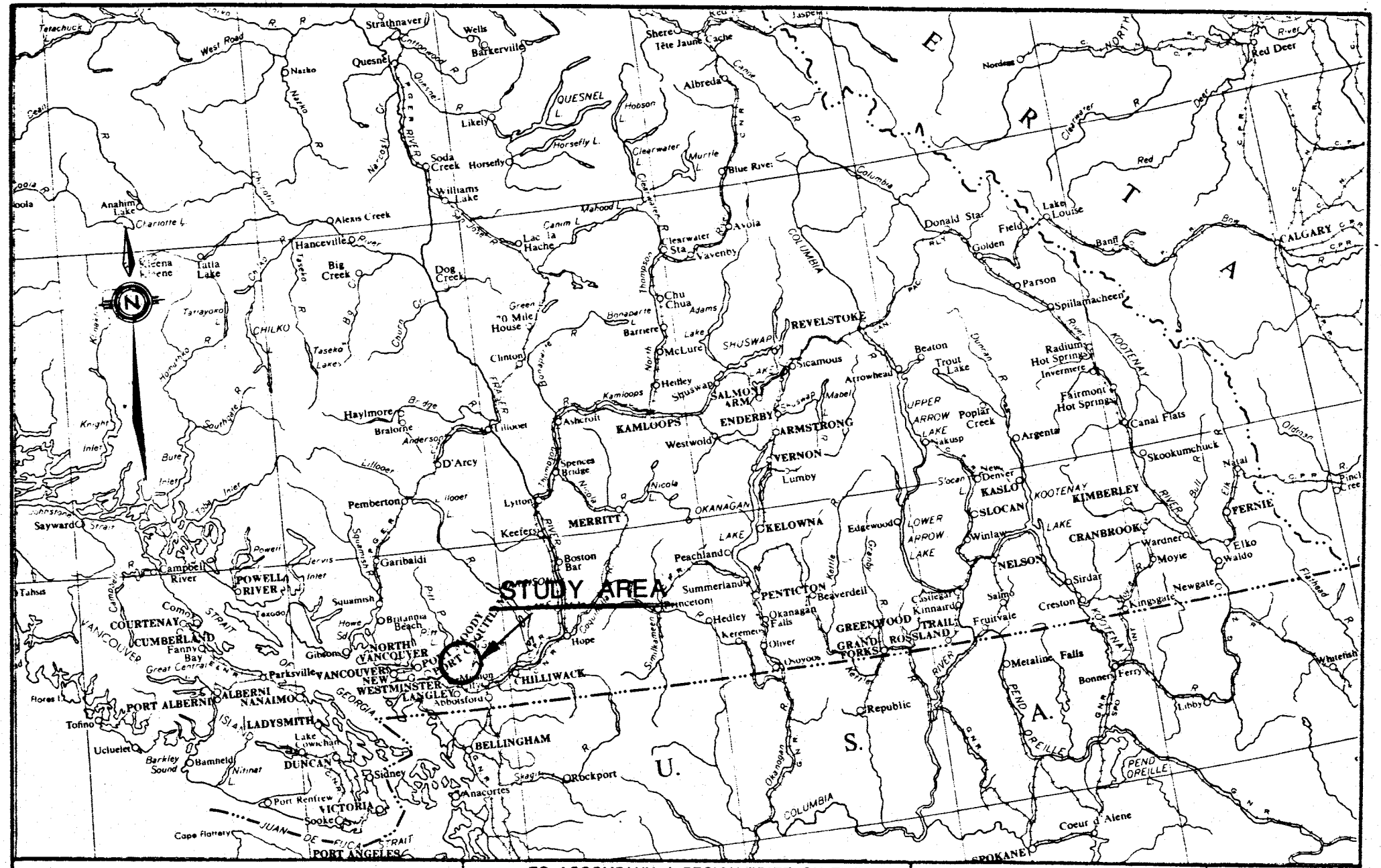
STUDY AREA
ALBERTA
U.S.A.
Province of British Columbia
Ministry of Environment and Parks
WATER MANAGEMENT BRANCH
TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING STUDY
ALOUETTE AND NORTH ALOUETTE RIVERS
STUDY AREA LOCATION
SCALE VERT
HOR 1 : 7,500,000 approx.
DATE
JAN. 1990
R.W. NICHOLS ENGINEER
FILE No 00-4200-S.2
FIGURE 1
BCIL 7674-M E

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING STUDY
ALOUETTE AND NORTH ALOUETTE RIVERS
KEY PLAN

SCALE: VERT.	DATE	R.W NICHOLS ENGINEER
HOR. 1:250,000	MAY 1990	FILE No. 004200 – S.2 DWG No. FIGURE 2

VAN CAL 15712

Appendix 1

Detailed Information Sources

No.	Source	Comments
1.1	"Alouette Lake Storage Dam", January 1956, T.A.J. Leach, File: 045208	A study of the November 1955 flood on the Alouette River.
1.2	"Alouette Lake and Alouette River Flooding" January 1961, File: 045208, T.H. Oxland"	A study of the January 1961 flood on Alouette River.
1.3	"Note to file" dated January 28, 1981 re: South Alouette River Flooding November 3-5, 1955, by R.H. Cameron, P.Eng., File: P73-89, Rivers Section, Water Management Branch, Ministry of Environment.	Documents sources related to home evacuation, log and debris jams, erosion and dyke breach problems as a result of the November 1955 flood event.
1.4	Memo to J. Wester, Head, Rivers Subsection from P.J. Woods, P. Eng., "South Alouette River-Erosion Inspection", January 19, 1981. File: P73-89.	Results of an inspection of severe river erosion and residential damage as a result of December 26-27, 1980 floods.
1.5	Map Production Division, Surveys and Resource Mapping Branch, Project No. 86-035, 1988 Air Photography, Base completed March, 1989.	1:5000 scale, 1 metre contour mapping of the study area.
1.6	Alouette and North Alouette River Cross Section data, Project No. 81-FDC-4, June 1981, Surveys Section, Water Management Branch.	River cross section data including photographs at each section, bridge data and high water mark data.
1.7	"Alouette River Peak Flow Study", Hydrology Section, Water Management Branch, File: S2014-2, February 1985.	Hydrology study to determine peak flows in the Alouette and North Alouette Rivers.
1.8	"Assessment of Flood Potential Downstream of B.C. Hydro Dams-Alouette River", by N.W. Hydraulic Consultants Ltd., 3-1606, Dated January 1990.	A draft report assessing flooded areas downstream of the B.C. Hydro dam on the Alouette River.
1.9	"Alouette Dam Probable Maximum Flood," Report No. H1576, B.C. Hydro Hydroelectric Generation Projects Division, January 1983.	Background information for the Peak Flow (1.7) Study.
1.10	"Regional Peak Flow Frequency Curves" from the Surface Water Section Report Input to the Fraser-Delta Strategic Plan, June 15, 1983, File: IE-4.1-Hy.	Curves developed for the Fraser-Delta Strategic Plan Study.

Appendix 1 (Continued)

No.	Source	Comments
1.11	"Alouette River near Haney-08MH005," memo to H.I. Hunter from C.H. Coulson, August 21, 1975, File: 0256957.	Background information for the Peak Flow (1.7) Study.
1.12	Alouette Lake inflow and outflow data provided by C.J. Morrison, B.C. Hydro, Ruskin, Letter to W. Obedkoff, November 28, 1984.	Background information for the Peak Flow (1.7) Study.
1.13	"The Effects of Dyke Construction at Golden Eagle Ranch on North Alouette River Flood Levels", Report No. 8601, May 1986, C.B.A. Engineering Ltd.	Analysis of the effects of a 1:25 year return period flow on flood levels with dyke construction.
1.14	Memo to J. Barker from J.D. Watts, File: 0305030-11, May 9, 1985 on "Elevation Requirement-Pitt Meadows and Maple Ridge Area Behind Standard Dykes."	Selection of a flood construction level for administration purposes.