CANADA/BRITISH COLUMBIA
FLOODPLAIN MAPPING AGREEMENT

Ministry of Environment, Lands and Parks
Environment and Lands Headquarters Division
Inventory and Data Management Branch

A Design Brief on the Floodplain Mapping Project for Somass River and Tributaries at Port Alberni, B.C.

Floodplain Mapping Program
Victoria, British Columbia
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Preface

The purpose of this design brief is to present a description of the methodologies used and results of the study undertaken to delineate the floodplains of the Somass River and tributaries at Port Alberni, Drawing 93-10, Sheets 1 to 4 (Appendix 5).

1. Background

This design brief and associated floodplain maps for the Somass River and tributaries were prepared under the Canada/British Columbia Floodplain Mapping Agreement. The floodplain mapping program is a joint initiative by the federal and provincial governments to provide information which will help to minimize future flood damage. The program identifies and maps areas that are highly susceptible to flooding. These areas may be designated as floodplains by the federal and provincial Environment Ministers. Designated floodplains are subject to development restrictions. Subdivisions within a floodplain require the approval of the Regional Water Manager, BC Environment. Crown agencies such as Canada Mortgage and Housing Corporation do not support development on designated floodplains unless adequate floodproofing measures are taken. As well, disaster assistance is available only if new developments have incorporated adequate floodproofing measures. Local governments may impose further restrictions.(Appendix 1.6)

The low lying areas within and adjacent to the City of Port Alberni are subject to both watercourse and ocean flooding. In May of 1964 an earthquake off the Alaska coast generated a tsunami which swept along the coast of British Columbia. The tsunami entered Alberni Inlet and made its way to Port Alberni resulting in considerable damage to homes, buildings, autos and services situated in low lying areas, especially adjacent to River Road (Sheet 2 and Appendix 4). A flood control project to raise River Road along the Somass River and to control Kitsucksus Creek and thus reduce the possibility of flooding in the lowland areas was designed in 1967. The project was subsequently implemented and involved federal, provincial and local government participation.

2. Location

The City of Port Alberni is located on south central Vancouver Island at the head of Alberni Inlet. Typical of many coastal communities, forestry and fishing provide the economic basis for this area. The study area lies within the boundaries of the City of Port Alberni, the Alberni Clayoquot Regional District, the Tseshaht and the Opetchesaht Band Lands.

Figure 1 is a location plan of the study area. Figure 2 is a key map showing the locations of the four floodplain map sheets for the study area at a scale of 1:125,000.

3. Present Studies

The 1996/97 studies undertaken to delineate the floodplains for the Somass River and tributaries are based on the following information:

- Survey data obtained by the Technical Support Section, Hydrology Branch, Water Management Division , Project 9402F057 (Appendix 1.1) and includes cross section data, longitudinal profiles, high water mark elevations, photographs and bridge details for the Somass River and tributaries. During the course of the survey, Technical Support Section staff provided background information on the mapping program to local municipal and band officials.
- Topographic base mapping of the study area issued in September 1992 by the Mapping Section, Surveys and Resource Mapping Branch, Project 89-080, NAD 83 (Appendix 1.2). The mapping is at a scale of 1:5,000 with 1 meter contour intervals and utilizes air photography obtained in 1990.
- Environment Canada, Surface Water Data Publications prepared by personnel of Water Survey of Canada, Ministry of the Environment.

4. Designated Flood

In accordance with the policy of the Ministry of Environment, Lands and Parks, the flood levels and floodplain limits on the floodplain mapping sheets are based on a designated (1:200 year frequency) flow plus an allowance for hydraulic and hydrologic uncertainties. The mapping also includes 1:20 year flood frequency elevations to facilitate Public Health requirements for septic tank purposes.

5. Flood Frequency Study

5.1 General

The Somass River watershed is made up of 3 major drainage components, those being the Stamp River, the Sproat River and the Ash River. Two of these components, the Stamp and Sproat Rivers, have major lakes near the downstream end of their watersheds. Also included in the study is Kitsucksus Creek, a tributary to the Somass River located near tidewater (Figure 2).

5.1.1 Somass River

The Somass River makes up a 9.2 km reach from tidewater upstream to the Sproat River/Stamp River confluence (Sheet 3). Water Survey of Canada

(WSC) has operated gauge 08HB017 (Somass River near Alberni) located just downstream of the confluence from 1957 to date. The maximum daily discharge recorded at the gauge occurred on December 15, 1962 at 1130 m^3/s (estimated). An event of similar magnitude was recorded on January 15, 1961 and produced discharges of 1150 m^3/s instantaneous and 1100 m^3/s daily. Appendix 4 contains newspaper articles on the 1961 flood.

5.1 2 Sproat River

The Sproat River watershed at the WSC gauge 08HB008 has a published drainage area of 347 km^2 and accounts for approximately 26% of the total combined area of the Somass River watershed. Maximum watershed elevation, as taken from 1:250,000 scale topographic map sheet 92F, is 1,642 m. Approximately 95 km^2 or 39% of the watershed lies above the 1,070 m. elevation. At the downstream end of the Sproat River watershed lies Sproat Lake which has an area of 43 km^2 and provides significant attenuation to the instantaneous flood events. WSC has operated gauge 08HB015 almost continually since 1913 providing maximum and minimum daily lake levels. Sproat Lake has been regulated since 1956.

5.1.3 Stamp River

The Stamp River begins upstream of the confluence of the Somass and Sproat Rivers. WSC has operated two stream flow gauges on the Stamp River over the years.

Station 08HB010, Stamp River near Alberni, has been in operation for the period of 1914 to 1931 and 1941 through 1978 and recorded maximum and minimum daily discharges. WSC gauge 08HB009, Stamp River near Great Central, has been in operation through the periods 1913 to 1922 and 1958 to date. This station provides both maximum instantaneous and maximum daily discharge information. The published drainage area is 456 km^2 and accounts for approximately 33% of the total combined area of the Somass River watershed.

Great Central Lake, the largest within the watershed, has an area of 52 km^2 and provides significant attenuation to flood peaks. There is also some additional inflow through power diversion from Elsie Lake in the Ash River watershed to Great Central Lake. Maximum elevation, as taken from 1:250,000 scale topographic map sheet 92F, is Mt. Rosseau at an elevation of 1,830 m.

5.1.4 Ash River

Water Survey of Canada has operated two streamflow gauges on the Ash River over the years. Station 08HB016, Ash River near Great Central, operated during the period of 1956 through 1966 and provided maximum instantaneous and maximum and minimum daily discharges. WSC gauge 08HB023, Ash River below Moran Creek, has been in operation from 1960 through the present and has a published drainage area of 378 km² and accounts for approximately 26% of the total combined area of the Somass River watershed.

The Ash River headwaters originate on the southwestern slopes of Forbidden Plateau. Maximum elevation, as taken from 1:250,000 scale topographic map sheet 92F, is 2,031 m. The Ash River flows through three lakes, Oshinow Lake, Elsie Lake and Dickson Lake before it meets with the Stamp River. B.C. Hydro holds water licenses for storage and power purposes on the Ash River, diverting a portion of the flow from Elsie Lake through to Great Central Lake.

5.1.5 Kitsucksus Creek

There are no gauges in operation on Kitsucksus Creek at this time. Water Survey of Canada operated Station 08HB063, Kitsucksus Creek above Cherry Creek, during April through September from 1978 to 1981 inclusive.

5.2 Design Flood Flows

As stated in the Hydrology Report, (Appendix 2), annual peak flows in the Somass River watershed occur generally between November and February as a result of rain on snow events. Peak flows for various locations within the study area were based on a frequency analysis of five long term Water Survey of Canada (WSC) gauges in the watershed and a regional model for tributary inflow and routing of flows to tidewater. Results of the hydrology study are summarized below:

Location	***Drainage Area*-km²**	***Flow*- m³/s** Inst. 20yr.	Inst. 200yr.	Daily 20yr.	Daily 200yr.	March 2, 1994 Inst.
Stamp at mouth	952	813	1167	787	1130	633
Sproat at mouth	350	325	424	318	414	213
Somass at junction	1302	1147	1393	1120	1360	813
Somass above Kitsucksus	1337	1174	1426	1148	1394	874
Kitsucksus at mouth	43	87	105	58	70	61
Somass below Kitsucksus	1380	1223	1485	1196	1453	922
Somass at mouth	1431	1282	1556	1257	1526	974

6. Hydraulic Analysis

6.1 General

The information sources listed in Appendix 1 and 2 were utilized in the HEC 2 water surface profile computer program version 6.4, developed by the Hydrologic Engineering Centre, US Army Corps of Engineers in Davis, California. The flood profile studies assumed open channel flow conditions.

Flood profiles calculated for the Somass River and tributaries in the study area are outlined as follows. A plot run of river cross sections was obtained. An assessment was made of the river channel survey data and cross section extensions which were obtained from the 1 meter contour topographic mapping. Output from the plot run was also used to review other data such as flow regime, loss coefficients, reach lengths, overbank information and relative Manning's "n" values.

The selection of Manning's "n" values were initially estimated by utilizing color photographs of the river cross sections provided by the Surveys Section, experience gained in other studies and a review of the information provided (Appendix 1.3) by the US Department of the Interior in a Water Supply Paper entitled "Roughness Characteristics of Natural Channels". The "n" values were modified based on the model calibration studies outlined below.

6.2 Model Calibration

The Somass River model was calibrated to high water marks determined by the Survey Section following the high flows, listed in Section 5.2, which occurred on March 2, 1994 during the time that the river surveys were underway. Figure 3 is a stage discharge curve for the Somass River at XS-21, including the model calibration data.

The total length of the Somass and Stamp Rivers in the study area is approximately 18.5 km. A total of 38 river cross sections were obtained in this reach. Calculated water levels at 21 cross sections in the study area were calibrated to average within 0.17 meters of the levels obtained after the 1994 high flow event in which the flow was estimated to vary from 813 m^3/s to 974 m^3/s in the study area. Manning's main channel "n" values varied from 0.028 to 0.045.

The Kitsucksus Creek model was calibrated in a similar manner but, as discussed below, the study indicated that flood levels from the Somass River dominated over the Kitsucksus Creek flood levels except in the upper portion of the study area

6.3 Calculated Flood Levels

Flood levels were calculated using Manning's "n" values obtained from the model calibration studies for the 1:20 year and the 1:200 year daily and instantaneous flows listed in Section 5.2.

In keeping with Ministry practice, the 1:20 and 1:200 year flood levels shown on the floodplain mapping sheets for the Somass River were based on the greater of the daily flood levels plus 0.6 meters or the instantaneous flood levels plus 0.3 meters. For both the 1:20 and 1:200 year events, daily flood levels plus the allowance for hydraulic and hydrologic uncertainties of 0.6 meters slightly exceeded the instantaneous level criteria. Table 1 lists the Somass River flood levels.

The Alberni Inlet flood level of 3.3 meters, discussed in Section 7.1, dominates the flood levels determined for the Somass River up to river cross section #2 which is located just upsteam of the sewage treatment plant (see Sheet 2).

Flood levels determined for Kitsusksus Creek were exceeded by the flood levels for the Somass River for the major portion of the area under study (up to creek cross section #7) as shown on Sheet 2.

6.4 Sensitivity Studies

Sensitivity to discharge (Q) studies were made using the estimated Q200 daily flow multiplied by factors of 1.1, 1.2, and 1.3. The studies indicate that the Somass River flood levels shown on the mapping drawings (includes an allowance of 0.6 meters for hydraulic and hydrologic uncertainties) will not be exceeded by increases to Q of 30% from tidewater to River Road bridge near river cross section #9. Upstream of the bridge, flood levels shown will not be exceeded by increases in Q of approximately 20%.

Sensitivity studies were also undertaken to determine the effect of increased Manning's "n" values on flood levels. Results were similar to the Q sensitivity studies, with the lower reach being relatively insensitive to "n" value increases. The reach above the bridge near cross section #9 would sustain an "n" increase of about 20% before flood levels are exceeded.

The starting flood level assumed in the study at cross section #1 at tidewater was 2.6 meters based on an observed calibration level of 2.37 meters. This exceeds the HHWLT of 2.0 meters because of the relative narrowness of the effective flow area during the calibration event. At cross section #1, the natural topography on the left bank and the confinement of the sewage treatment plant dikes on the right bank restricted the effective calibration flow width. Upstream of the influence of the Alberni Inlet flood level of 3.3 meters, the model was relatively insensitive to starting level assumptions which varied from 2.0 to 2.9 meters.

7. Ocean Flood Level

7.1 General

A coastal flood level for the purposes of floodplain mapping is defined as the highest ocean still water level (OSWL) that might result from a severe combination of hydrometeorlogical and other factors that is considered reasonably possible at a specific ocean site. The level is exclusive of wave run-up from normal wind generated waves and flooding from tsunamis.

The coastal flood level is based on higher high water large tide (HHWLT), a storm surge allowance based on an analysis of historic data and an allowance for uncertainties such as wind chop.

The results of an analysis of the coastal flood level for Port Alberni (Appendix 1.4) are summarized below. For administrative purposes, an allowance of 0.3 meters has been added to the OSWL for wind chop, seiche and unit conversion factors.

HHWLT	2.0 meters
Storm Surge	1.0 meters
OSWL	3.0 meters (GSC Datum)

The Alberni Inlet flood level of 3.3 meters is shown on Sheet 1.

7.2 Tsunami

The tsunami hazard in the City of Port Alberni has been under review for a number of years. Ministry policy with respect to Tsunami in the study area is stated in a letter to the Mayor of Port Alberni and Councillors from the Minister of Environment, Lands and Parks, dated March 3, 1994.

Several tsunami studies have been undertaken since the 1964 tsunami event. Mr. Brendan Holden, P.Eng, of the Regional Operations Section of the Ministry of Environment, Lands and Parks, prepared a discussion paper in July, 1995 which analyses tsunami and tidal information and provides recommended tsunami flood levels for critical and non critical structures (Appendix 1.4). Additionally, Mr. David Barlow, P.Eng, also of the Regional Operations Section, has produced a

"Tsunami Hazard Appraisal" for property in British Columbia and has also created an annotated bibliography of available tsunami information (Appendix 1.5).

The water level for the 1964 tsunami event at the tide gauge in Port Alberni Harbor was 4.4 meters GSC. It is estimated that the actual water level run-up at the head of the inlet was about 1 meter higher or 5.4 meters GSC. As noted on Sheet 2, the 1964 tsunami exceeded the Somass River 1:200 year flood levels from the area downstream of the Highway 4 bridge to tidewater.

The discussion paper by Holden identifies a number of possible future tsunami flood levels as follows:

- a **tsunami safe level** for critical structures of 10 meters GSC which includes HHWLT, maximum probable tsunami amplitude, maximum probable storm surge and an allowance for the uncertainties of run-up, bores and scour.

- a **tsunami flood level** for non-critical structures of 7 meters GSC which includes HHWLT, the tsunami amplitude of record and an allowance for the uncertainties of run-up, bores and scour.

Water level rise due to tsunamis cannot be assigned a probability since the data base of seismic events and related rise in coastal levels is sparse. It is possible only to estimate maximum levels due to seismic events as was done in the above noted discussion paper by Holden

Tsunami is not a criterai for designation under the Canada /British Columbia Floodplain Mapping Agreement. In accordance with Ministry practice with respect to special flood hazards, a note has been placed on floodplain mapping Sheets 1 and 2.

The note indicates that a tsunami flood level has been recorded in Alberni Inlet which has exceeded the river flood levels shown on the drawings. There is a risk of tsunami flood damage on land below 10.0 meters in the Port Alberni area. It is also noted that land use policies with respect to the tsunami hazard are available from the municipal and provincial governments.

8. Floodplain Mapping

The flood levels determined in the study were used to delineate the floodplain limits onto the existing 1 meter contour mapping for the study area. The studies were based on the information noted in Section 3.

The floodplain mapping of the Somass River and tributaries, Drawing No. 93-10, Sheets 1 to 4, (Appendix 4) was produced and provides the following information:

- the location of river cross sections;
- the designated floodplain limits;
- the flood levels determined in the study;
- the location of survey monuments established for the study,
- notes pertaining to flood, erosion and tsunami hazards.

A field visit was made to the study area in March, 1997 to verify the floodplain limits shown on the Drawings. Discussions were also held with BC Environment staff familiar with provincial and local government tsunami policies.

9. Conclusions

1. This design brief presents an overview of the studies undertaken to produce the floodplain mapping sheets for the Somass River and tributaries. The floodplain limits shown on the maps correspond to the area which would be inundated by a flood having a 200-year recurrence interval based on an analysis of historic flow records. The floodplain in the study area has an ongoing history of flooding and erosion dating back to the early 1900's.

2. In the tidal area, as indicated on Sheets 1 and 2, the 1964 tsunami exceeded the flood levels shown on the mapping from the area downstream of Highway 4 bridge to tidewater. There is a risk of tsunami flood damage on land below 10.0 meters in the Port Alberni area.

3. The floodplain maps are administrative tools to provide information which will help to minimize future flood damages. They are not comprehensive floodplain management plans, nor do they provide site specific solutions to hazards such as land erosion, sudden channel shifts during flooding or tsunami hazards.

4. Flooding may occur outside the designated floodplain due to a variety of reasons including tributary flooding, ponding behind transportation routes, floods that exceed the design event, channel obstructions or tsunami. These special flood hazards are noted on the maps.

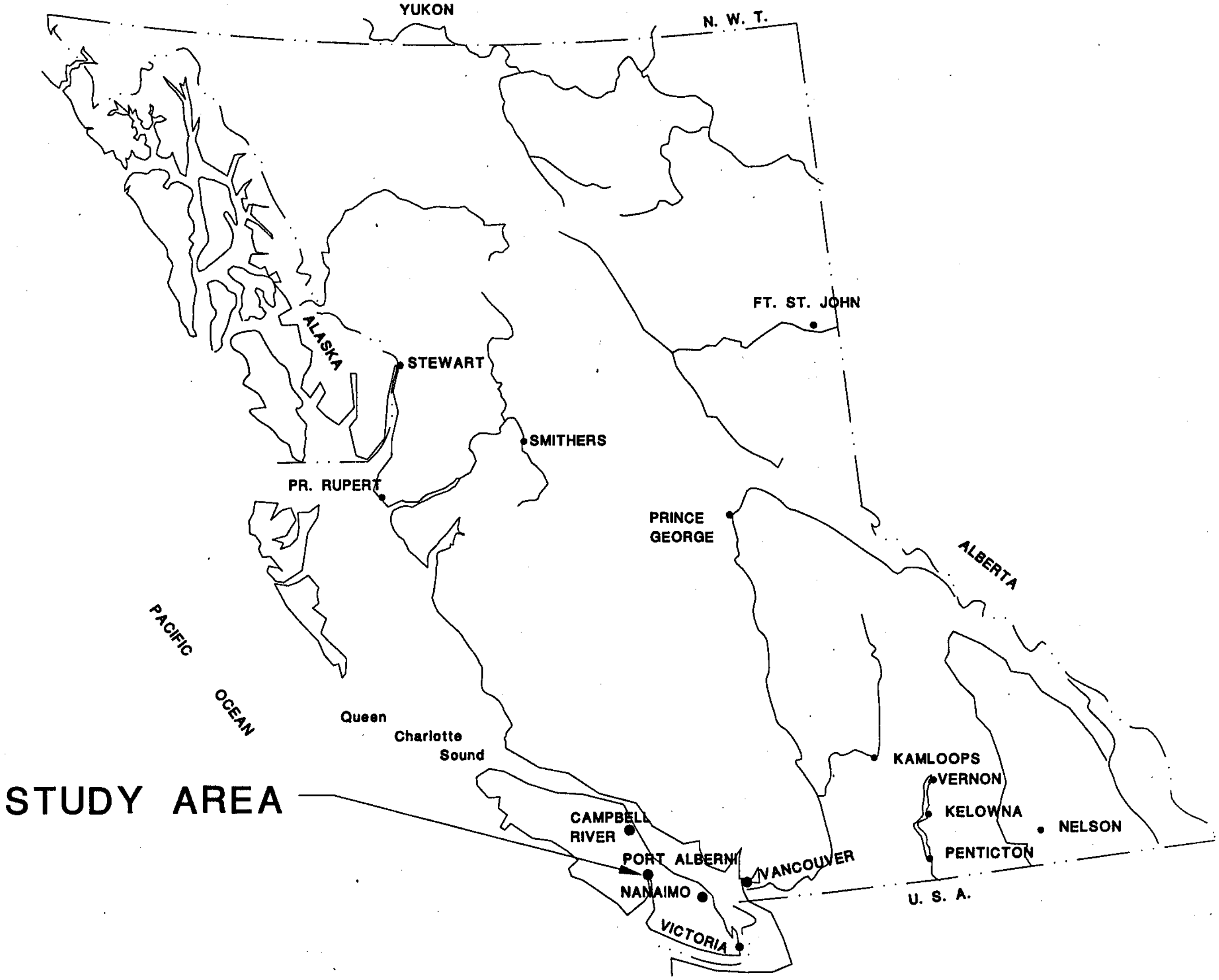
10. Recommendations

1. It is recommended that the floodplains delineated on Drawing 93-10, Sheets 1 to 4, be designated under the terms of the Canada/British Columbia Floodplain Mapping Agreement.

2. The information shown on these drawings, along with policies with respect to tsunami established for the study area, may be used for administrative purposes related to the preparation of hazard map schedules for official plans; floodproofing requirements in zoning and building bylaws; and the identification of floodable lands by Subdivision Approving Officers.

3. The drawings should be reviewed when a flood event of significant magnitude occurs in order to document any changes to the river regime which may have occurred since the mapping was issued.

R.W. Nichols, P.Eng
Head
Floodplain Mapping Program



Province of British Columbia
Ministry of Environment, Lands and Parks
WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING

SOMASS RIVER AND TRIBUTARIES
STUDY AREA LOCATION

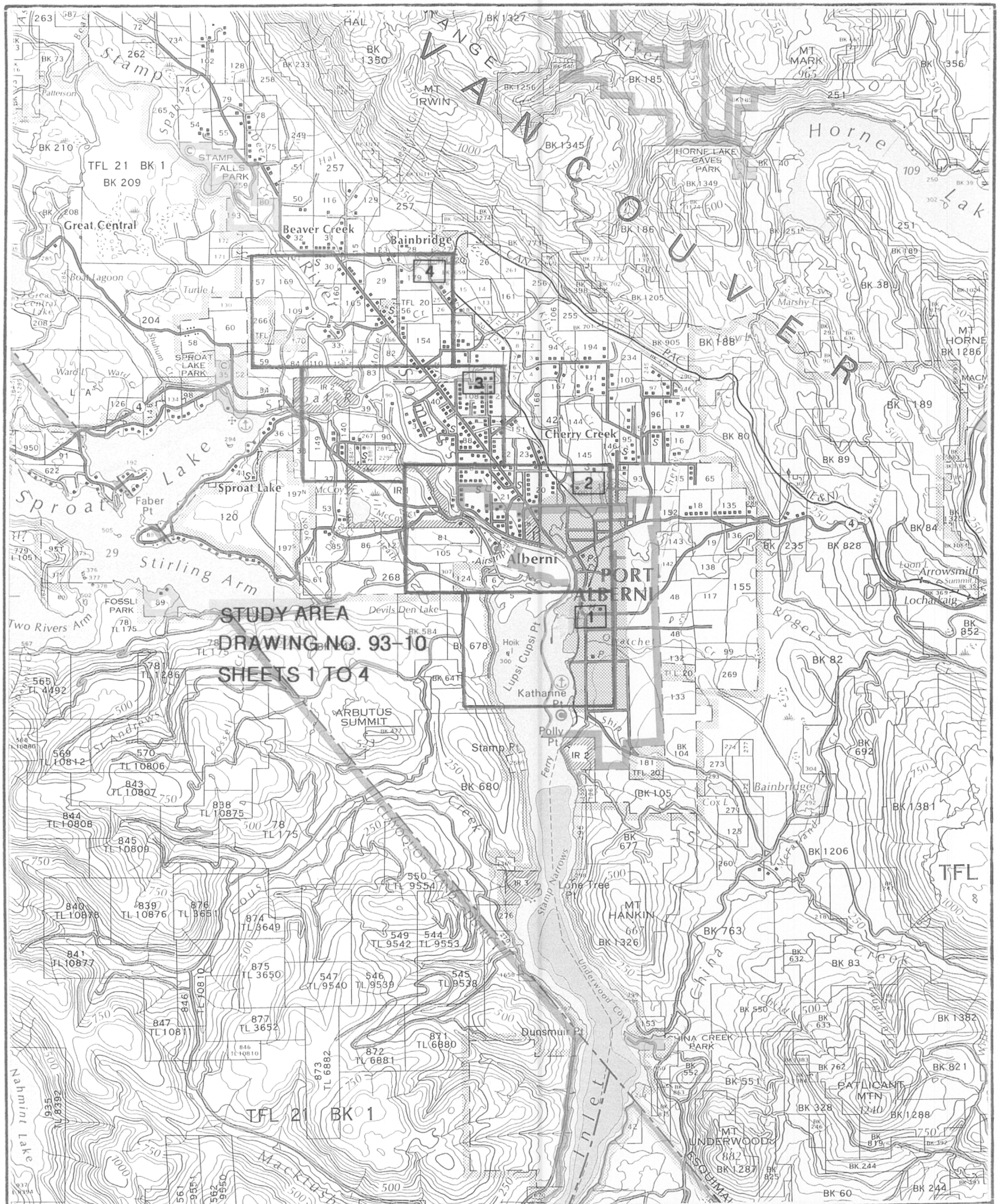
R.W. NICHOLS ENGINEER

SCALE: VERT / HOR — NOT TO SCALE

DATE: DECEMBER 1996

FILE No. 35100-30/930-1374

DWG. No. FIGURE 1



Province of British Columbia

Ministry of Environment, Lands and Parks

WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING STUDY

SOMASS RIVER AND TRIBUTARIES

KEY MAP

SCALE: VERT ....

HOR 1 : 125,000

DATE DECEMBER 1996

R.W. NICHOLS ENGINEER

FILE No. 930-1374

DWG No. FIGURE 2

VAN CAL 15712

FIGURE 3

SOMASS RIVER
STAGE DISCHARGE CURVE
XS-21 (WSC 08HB017)

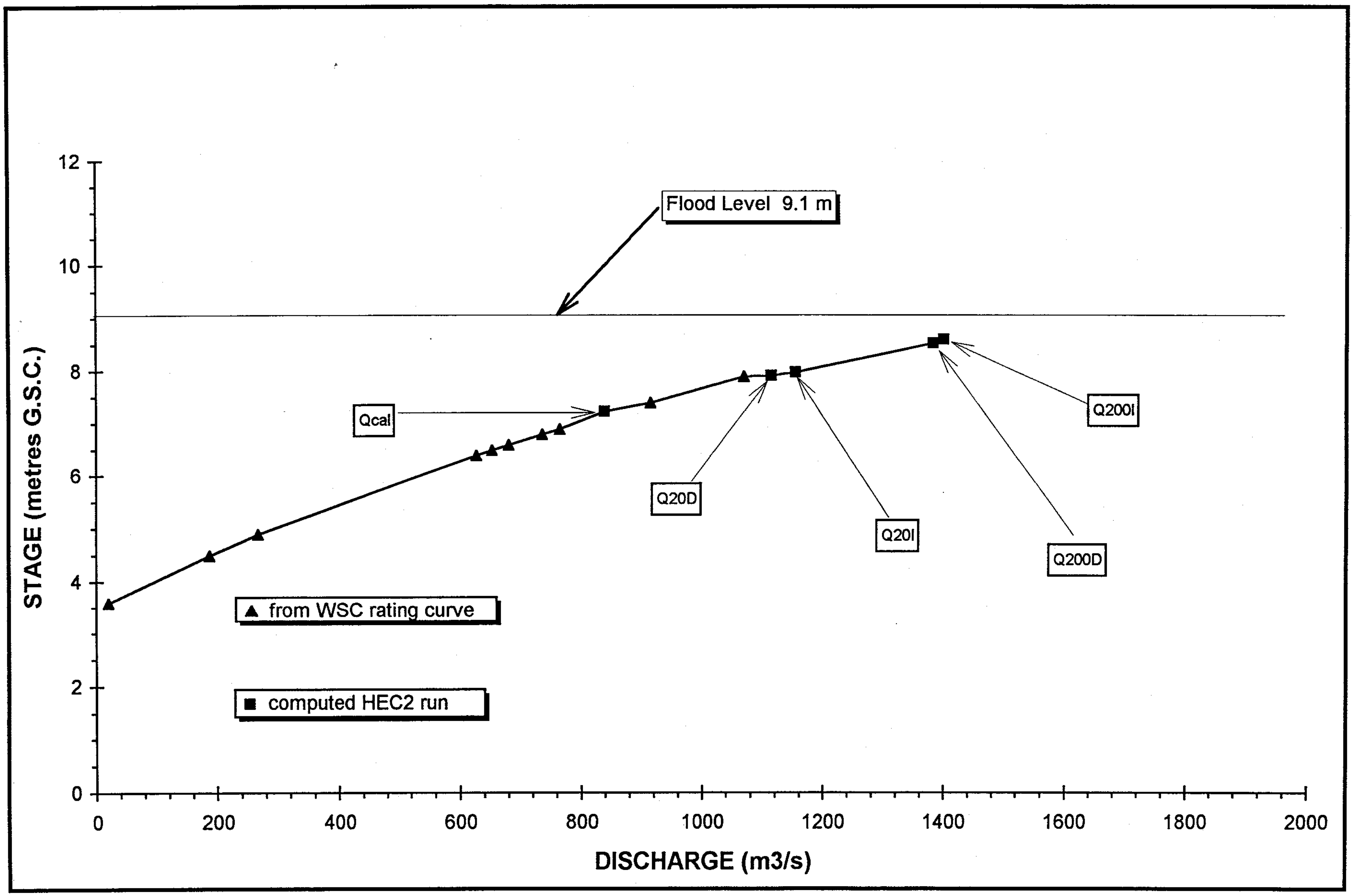


TABLE 1

SOMASS RIVER FLOOD LEVELS			
Section Number	Flood Level m (1)	Section Number	Flood Level m (1)
1	3.3 (2)	19	8.7
2	3.3 (2)	20	8.9
3	3.4	21	9.1
4	3.6	22	9.2
5	3.9	23	9.5
6	4.1	24	10.1
7	4.5	25	11.3
8	4.9	26	11.9
9	4.9	27	12.2
10	4.7 (3)	28	12.5
11	6.7	29	12.6
12	7.1	30	12.6
13	7.2	31	13.1
14	7.4	32	14.2
15	7.4	33	15.8
16	7.4	34	17.4
17	7.5	35	17.9
18	8.4	36	19.1

(1) Includes allowance for freeboard
(2) Coastal flood level
(3) High velocity area

APPENDIX 1

DETAILED INFORMATION SOURCES

APPENDIX 1

Detailed Information Sources

No.	Source	Contents
1.	Technical Support Section, Water Management Division Project No. 9402F057 February / March 1994	36 cross section on Somass & Stamp Rivers, 2 cross sections on Sproat River 12 cross sections on Kitsucksus Creek - including photos of each section and bridge details.
2.	Map Production Division Surveys and Resource Mapping Branch Project No. 89-080, September 1992	Base Mapping for Somass River and tributaries, 1:5000 scale 1 meter contours, NAD 83 from 1990 air photography.
3.	United States Geological Survey Water Supply Paper #2339	Guide for selecting Mannings' Roughness Coefficients for Natural Channels and Floodplains.
4.	Tsunami Flood Levels Port Alberni, British Columbia B.J. Holden, P.Eng, July 1995.	A discussion paper to determine Tsunami Flood Levels
5.	Tsunami Hazard Appraisal D.P. Barlow, P.Eng, January 1995	An analysis of the extent and character of the threat of tsunami flooding*
6.	A Users Guide to Floodplain Maps in British Columbia.	A pamphlet providing information on the mapping program.

*Available on the internet at:
http://wtrwww.env.gov.bc.ca/wat/fpm/fpmhome.html

APPENDIX 2

HYDROLOGY SECTION REPORT

SOMASS RIVER NEAR PORT ALBERNI

Study No. 423
November 1996
file: 76840-40

SURFACE WATER SECTION REPORT

SOMASS RIVER NEAR PORT ALBERNI

DETERMINATION OF 20 AND 200 YEAR PEAK FLOWS

At the request of the Floodplain Mapping Unit, a hydrology study was carried out to determine the 20-year and 200-year peak flows on the Somass River and its tributaries: Stamp River, Sproat River and Kitsucksus Creek.

The Somass River enters the Alberni Inlet at Port Alberni. Its watershed drains a portion of central Vancouver Island and contains two fairly large lakes, Great Central and Sproat. Stamp River flows out of Great Central Lake while Sproat River flows out of Sproat Lake. Stamp River and Sproat River come together approximately 7 km north-west of Port Alberni at which point the combined flow becomes the Somass River. Kitsucksus Creek enters the Somass River about 1 km above the mouth.

November, December, January and February are the high flow months with 50% of the annual flow occurring in these four months. The highest peak flows which also occur in these four months are the result of heavy warm rain falling on a light snowpack.

Hydrometric data are available from six gauges in the watershed. The long- term gauges with their period of record of annual peak flows used in this study are:

Stamp River near Great Central	8HB009	1913 to 1921, 1958 to 1995
Ash River below Moran Creek	8HB023	1960 to 1995
Stamp River near Alberni	8HB010	1914 to 1931, 1941 to 1978
Sproat River near Alberni	8HB008	1913 to 1931, 1939 to 1995
Somass River near Alberni	8HB017	1957 to 1995

Kitsucksus Creek was measured April to September only, 1978 to 1981 at gauge:

Kitsucksus Creek above Cherry Creek	8JC014

1. Data Analysis

The method used for determining peak flows at the required locations was based on a frequency analysis of the above five long-term gauges, a regional model for tributary inflow and routing of flows to the mouth. A regional analysis of hydrologic zones is currently being carried out by the Surface Water Section. Datasheets from the regional analysis are included in this report.

The regional work includes analysis of short term rainfall to produce estimates of peak flow from small watersheds. The datasheet for the Port Alberni weather station is also included.

2. Frequency Analysis of Peak Flows

Frequency analysis of daily and instantaneous peak flows was carried out for the long-term stations. The log-Pearson type III distribution was selected which is consistent with regional analysis for this hydrologic zone. The following table provides a summary of instantaneous and daily peak flow as taken from the frequency analysis.

station	drainage area km^2	inst peak flow m^3/s 20-yr	inst peak flow m^3/s 200-yr	daily peak flow m^3/s 20-yr	daily peak flow m^3/s 200-yr
8HB009	456	380	456	364	434
8HB023	378	555	810	470	669
8HB010	899	*765	*1102	739	1065
8HB008	347	322	419	314	409
8HB017	1316	1154	1400	1115	1383

* instantaneous values estimated from daily values and I/D ratio.

3. Regional Analysis

The regional analysis is based on the period 1960 to 1995 and uses the 10-year return period instantaneous peak flow for regionalization. The graph for this zone showing flow versus drainage area is included with this report. Estimates of peak flow based on the modified Rational Formula are also plotted. Estimates of peak flow for Kitsucksus Creek were made using this graph and ratios for the 20-year and 200-year return periods .

4. Peak Flow Routing

The 20-yr and 200-yr instantaneous and daily peak flows at the required locations were determined by routing the peak flows from the frequency analysis. The results are in the following table.

location	drainage area km^2	inst peak m^3/s 20-yr	inst peak m^3/s 200-yr	daily peak m^3/s 20-yr	daily peak m^3/s 200-yr
Stamp at mouth	952	813	1167	787	1130
Sproat at mouth	350	325	424	318	414
Somass at junction	1302	1147	1393	1120	1360
Somass above Kitsucksus	1337	1174	1426	1148	1394
Kitsucksus at mouth	43	87	105	58	70
Somass below Kitsucksus	1380	1223	1485	1196	1453
Somass at mouth	1431	1282	1556	1257	1526

5. March 1994 Flow Estimates

The instantaneous peak flow of March 2, 1994 and the daily flow of March 11, 1994 was requested. The observed flows are as follows:

Station	inst peak flow m^3/s 1994 Mar 02	daily flow m^3/s 1994 Mar 11
8HB009	281	68.2
8HB023	321	6.7
8HB010	na	na
8HB008	205	79.6
8HB017	838	187.0

Using the above observed flows and the routing procedure developed for the previous section, estimates of flow for the two dates were made.

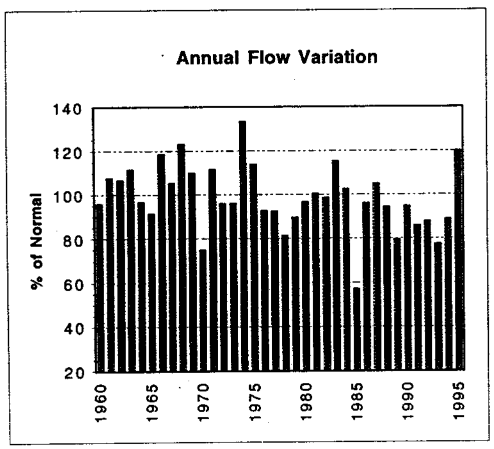
Location	inst peak flow m^3/s 1994 Mar 02	daily flow m^3/s 1994 Mar 11
Stamp above falls	561	89.8
Stamp at mouth	633	102
Sproat at mouth	213	80.3
Somass at junction	813	182
Somass above Kitsucksus	874	192
Kitsucksus at mouth	61.4	9.8
Somass below Kitsucksus	902	202
Somass at mouth	974	214

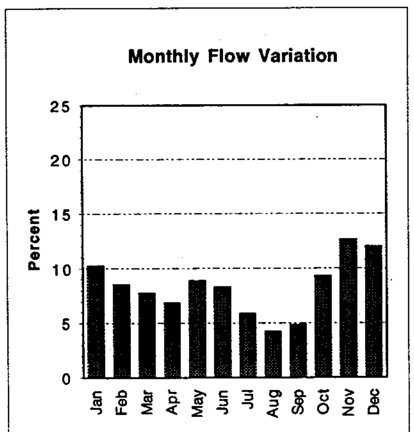
C.H. Coulson
Surface Water Section

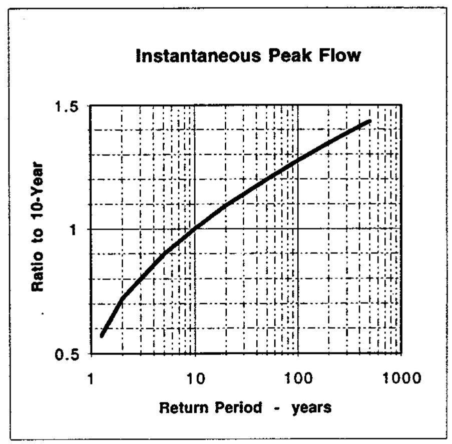
STAMP RIVER NEAR GREAT CENTRAL 8HB009

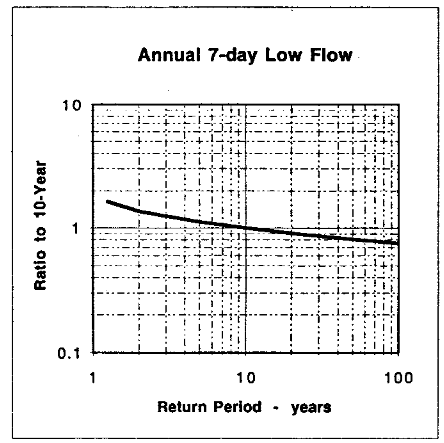
Monthly and Annual Flow in m3/s   d.a. = 456 km2   median elevation= 536 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	m3/s	7-Day Low Flow Jun-Sep	Annual	Year
1960	37.7	80.2	39.0	82.3	60.3	72.6	44.2	29.0	26.5	72.5	81.8	85.9	59.1	Oct 26	198	22.9	22.6	1960
1961	146.0	112.0	71.0	62.1	78.1	59.6	36.6	32.8	30.3	51.7	61.6	58.3	66.4	Jan 15	371	25.0	24.8	1961
1962	83.1	69.8	30.1	45.6	46.5	49.5	34.4	34.5	29.0	103.0	109.0	154.0	65.8	Dec 16	269	24.4	23.2	1962
1963	69.0	112.0	53.2	56.9	55.4	42.2	36.2	23.8	29.3	116.0	127.0	107.0	68.7	Feb 06	331	19.0	17.1	1963
1964	98.1	54.8	35.3	35.2	58.5	90.7	69.3	33.7	43.9	63.7	58.1	72.5	59.5	Jan 03	188	28.1	27.0	1964
1965	30.5	66.3	35.9	37.7	54.8	42.4	26.1	26.3	27.4	113.0	103.0	114.0	56.4	Oct 21	193	22.1	22.1	1965
1966	84.9	63.6	42.0	74.2	54.4	71.2	48.9	33.1	51.8	70.0	101.0	182.0	73.2	Dec 19	311	31.2	31.2	1966
1967	86.0	67.3	32.9	31.5	73.6	74.7	37.9	30.1	29.0	147.0	84.4	83.8	64.9	Oct 08	292	28.7	23.8	1967
1968	157.0	81.5	83.5	30.3	62.0	53.9	40.1	30.9	38.5	118.0	118.0	94.8	75.8	Jan 21	360	28.3	22.0	1968
1969	44.1	44.7	39.6	81.5	116.0	106.0	41.6	32.8	60.7	71.0	86.5	87.5	67.7	May 29	183	30.5	27.1	1969
1970	51.4	61.1	26.6	53.5	53.4	50.0	34.5	29.3	33.6	50.2	61.6	51.4	46.2	Apr 05	177	28.3	18.0	1970
1971	63.0	89.5	47.6	46.3	102.0	94.2	70.4	44.6	57.2	57.3	114.0	41.9	68.7	Nov 10	224	34.6	31.8	1971
1972	32.3	47.1	110.0	61.4	72.2	74.0	65.3	31.6	31.8	35.2	63.6	83.8	59.1	Mar 19	227	24.3	24.0	1972
1973	103.0	47.5	51.2	39.2	73.3	61.5	40.4	34.7	33.6	38.6	71.5	115.0	59.3	Dec 16	206	30.7	30.7	1973
1974	98.5	84.5	157.0	85.5	80.5	97.1	80.3	53.1	39.1	35.7	68.3	106.0	82.2	Jan 16	261	37.1	29.0	1974
1975	54.1	42.3	42.9	34.7	70.3	75.2	43.6	36.7	47.6	108.0	203.0	84.6	70.3	Nov 05	408	19.8	19.8	1975
1976	74.9	46.9	30.5	52.6	81.6	73.4	62.1	38.3	36.0	31.8	76.8	80.5	57.1	Jan 01	147	31.0	23.2	1976
1977	55.4	46.4	61.0	58.5	50.6	51.2	24.1	24.2	36.7	67.4	115.0	93.1	57.0	Nov 01	225	22.9	22.3	1977
1978	60.3	63.4	54.8	41.1	49.6	43.1	30.7	47.4	73.5	45.7	55.7	38.7	50.2	Aug 26	234	24.3	24.3	1978
1979	26.4	42.0	62.7	39.8	71.1	38.8	49.0	27.0	68.9	60.9	55.2	119.0	55.2	Dec 19	257	25.6	23.7	1979
1980	62.3	65.6	58.9	60.0	46.1	42.3	38.5	30.1	33.6	35.9	106.0	136.0	59.6	Dec 27	327	28.2	28.2	1980
1981	107.0	86.6	35.4	46.1	43.9	37.4	26.9	22.4	34.4	86.1	139.0	81.2	62.0	Nov 01	249	19.9	19.9	1981
1982	43.0	74.5	45.6	36.3	60.7	84.4	43.8	32.4	27.6	105.0	80.4	95.8	60.7	Oct 26	354	24.4	24.4	1982
1983	119.0	132.0	86.0	44.8	58.8	67.1	52.0	29.5	35.2	53.5	143.0	37.4	71.0	Nov 17	256	22.5	22.5	1983
1984	79.9	79.0	71.2	55.9	60.2	57.0	44.6	27.2	36.9	114.0	80.5	53.0	63.3	Oct 10	319	22.2	22.2	1984
1985	23.6	29.7	24.2	51.1	51.7	40.7	23.5	20.3	20.6	62.8	42.6	33.6	35.4	Oct 22	167	17.7	17.3	1985
1986	112.0	65.7	90.1	36.1	75.3	55.2	32.7	20.3	21.3	26.0	75.4	99.6	59.2	May 26	273	18.0	18.0	1986
1987	108.0	108.0	89.4	53.6	68.1	79.0	40.3	22.6	22.8	22.0	80.2	85.7	64.7	Mar 06	276	18.1	18.1	1987
1988	57.0	59.7	47.0	68.8	82.3	66.5	45.3	31.6	23.3	31.0	121.0	66.1	58.2	Nov 05	220	21.5	18.6	1988
1989	48.1	40.4	41.2	75.5	50.4	49.3	36.4	19.5	18.0	59.1	76.0	73.9	49.0	Dec 04	161	13.5	13.5	1989
1990	65.1	55.7	42.2	47.0	39.7	52.6	28.3	25.1	26.2	58.0	171.0	92.4	58.5	Nov 12	328	22.4	21.3	1990
1991	52.2	135.0	19.7	30.5	47.6	28.5	20.0	57.2	44.0	24.6	89.4	94.1	53.0	Aug 30	306	15.8	13.3	1991
1992	130.0	130.0	39.5	55.2	28.8	25.4	21.7	18.5	16.6	66.1	74.2	47.5	54.2	Feb 03	327	16.0	14.8	1992
1993	42.5	54.2	65.8	64.5	83.7	48.2	23.7	25.2	22.7	22.8	30.6	89.0	47.8	Mar 23	167	20.5	17.4	1993
1994	81.8	59.9	86.1	54.2	40.2	47.4	25.2	18.9	19.6	37.2	73.9	113.0	54.8	Mar 02	281	17.6	17.1	1994
1995	90.8	115.0	78.2	46.7	64.7	56.1	35.0	25.8	19.7	85.0	151.0	122.0	73.9	Nov 18	344	17.8	17.8	1995
normal	74.8	68.0	56.6	51.4	64.7	62.7	42.8	30.9	36.6	67.9	94.9	87.4	61.5	average	262	23.7	22.0	average
mm	439	364	333	292	380	356	251	181	208	399	540	513	4257	10-year	355	17.0	16.1	10-year





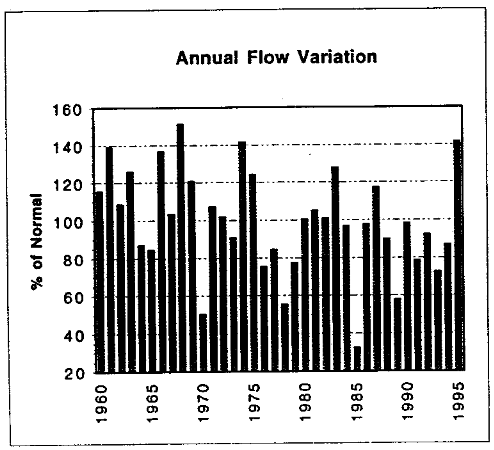


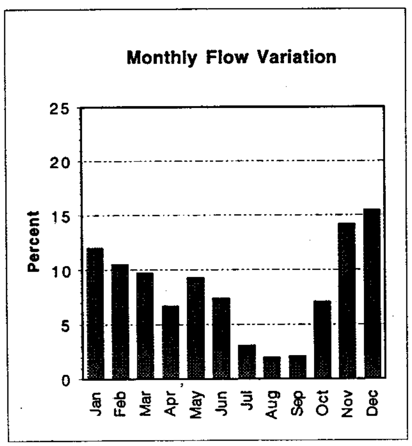


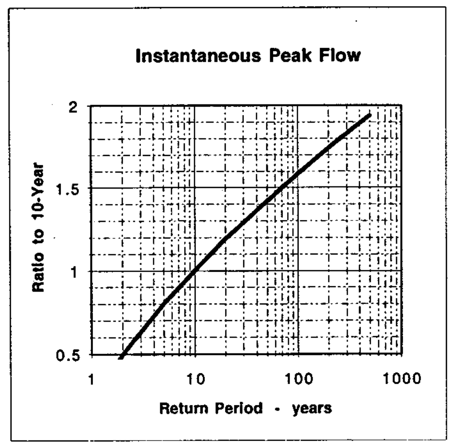
ASH RIVER BELOW MORAN CREEK 8HB023

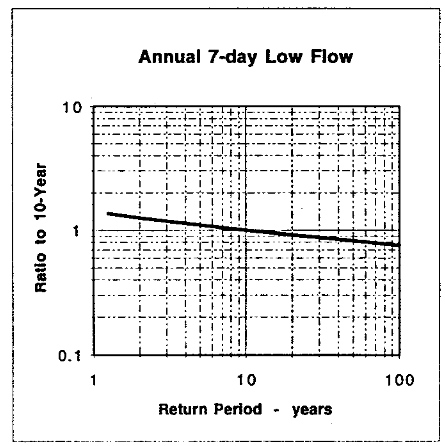
Monthly and Annual Flow in m3/s — d.a. = 378 km2 — median elevation= 134 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	Instantaneous Peak Flow m3/s	7-Day Low Flow Jun-Sep	7-Day Low Flow Annual	Year
1960	7.3	34.2	11.9	33.4	35.7	21.5	9.3	3.5	3.4	10.3	29.2	31.9	19.2	Dec 13	320	3.15	3.10	1960
1961	73.7	53.8	29.3	21.6	28.9	23.7	8.7	3.5	3.9	7.8	11.9	12.3	23.1	Jan 15	620	3.37	3.37	1961
1962	25.6	20.5	6.3	7.0	9.4	6.6	3.5	4.4	4.3	17.5	47.9	63.4	18.0	Dec 15	388	3.23	3.13	1962
1963	17.5	57.7	19.1	13.5	13.7	3.6	4.0	3.6	3.5	26.1	44.4	47.6	21.0	Feb 06	586	3.21	3.20	1963
1964	25.9	11.7	11.0	7.4	17.6	29.0	12.9	3.6	4.1	5.4	10.4	33.6	14.4	Dec 07	152	3.28	3.28	1964
1965	8.1	14.3	8.0	8.5	10.9	4.7	3.8	3.9	3.6	26.6	36.5	39.8	14.1	Oct 21	184	3.39	3.39	1965
1966	28.8	17.6	24.1	22.7	19.5	17.3	7.4	3.6	4.1	8.9	35.0	82.7	22.7	Dec 18	278	3.31	3.31	1966
1967	26.8	18.3	13.9	4.6	17.0	24.0	4.0	3.7	3.9	38.8	20.9	29.8	17.2	Dec 24	112	3.20	3.20	1967
1968	85.5	27.5	32.0	6.0	17.8	7.0	3.9	4.2	4.4	45.2	40.5	25.7	25.1	Oct 29	487	3.44	3.37	1968
1969	5.6	15.5	17.1	24.3	58.4	40.0	4.3	3.9	7.7	7.0	28.5	28.3	20.0	May 29	104	3.28	3.28	1969
1970	9.1	11.2	11.1	14.4	8.3	6.6	3.7	3.6	3.8	7.1	9.5	12.5	8.4	Apr 10	70	3.37	3.12	1970
1971	14.3	22.1	15.0	14.9	38.3	27.9	12.6	5.8	5.1	8.0	44.8	5.8	17.8	Nov 09	405	3.78	3.72	1971
1972	7.4	14.4	40.2	20.6	30.5	24.8	11.7	3.7	5.1	3.7	10.8	29.4	16.9	Mar 18	225	3.49	3.49	1972
1973	39.4	11.9	10.8	3.6	25.7	11.0	4.1	3.6	3.9	8.6	12.8	44.3	15.1	Dec 16	183	3.52	3.06	1973
1974	37.5	19.4	39.7	29.1	28.3	41.1	20.8	5.4	4.4	4.3	16.6	35.0	23.5	Jan 16	326	3.95	3.95	1974
1975	7.9	6.2	13.6	8.9	9.1	20.2	4.3	5.5	4.0	32.1	106.0	30.0	20.6	Nov 04	580	3.60	3.58	1975
1976	16.2	15.5	14.0	11.7	21.8	20.8	12.7	4.2	4.0	5.2	8.4	15.8	12.5	Dec 26	101	3.65	3.11	1976
1977	6.8	25.9	16.3	15.0	7.0	8.6	4.0	3.8	4.0	12.4	35.1	31.2	14.1	Nov 14	138	3.31	3.31	1977
1978	15.2	19.4	22.3	8.6	5.2	4.5	3.9	4.9	6.9	4.4	8.8	7.0	9.2	Feb 08	91	3.39	3.39	1978
1979	3.6	16.3	14.9	6.3	16.8	4.4	3.8	3.6	7.7	19.7	9.5	47.4	12.9	Dec 18	219	3.20	2.33	1979
1980	14.9	26.4	16.7	19.8	6.9	4.6	4.0	3.7	4.2	3.9	30.4	65.0	16.7	Dec 27	358	3.43	2.76	1980
1981	29.8	31.2	6.1	13.1	8.3	4.4	4.3	3.8	5.9	19.4	57.3	27.3	17.4	Nov 01	278	3.38	3.38	1981
1982	9.0	21.6	12.2	9.3	20.3	30.3	6.8	3.6	3.7	35.5	14.9	34.3	16.8	Oct 26	210	3.27	3.27	1982
1983	52.6	62.2	32.8	10.0	13.6	8.9	7.0	3.9	3.8	5.4	51.5	7.0	21.2	Nov 15	265	3.45	3.45	1983
1984	23.5	30.5	23.1	15.0	16.7	11.0	4.4	3.6	3.9	24.7	25.9	11.5	16.1	Feb 20	129	3.24	3.05	1984
1985	5.1	6.6	6.6	8.0	5.4	3.9	3.8	3.6	3.5	8.2	4.7	6.0	5.4	Oct 22	41	3.23	2.64	1985
1986	33.9	24.6	36.0	5.1	21.6	7.2	3.3	3.4	3.2	3.7	12.5	40.2	16.3	Mar 27	230	2.89	2.89	1986
1987	43.5	42.4	42.6	13.7	22.7	17.6	4.2	3.2	2.8	2.9	11.2	28.1	19.5	Mar 05	294	2.66	2.66	1987
1988	14.6	14.2	15.4	27.8	29.1	15.3	3.8	3.2	3.2	3.6	34.1	15.8	14.9	Nov 22	118	2.87	2.87	1988
1989	9.4	6.8	10.4	22.8	12.2	5.1	3.2	3.1	3.0	8.3	9.4	21.2	9.6	Dec 04	156	2.52	2.52	1989
1990	16.6	12.0	11.1	13.4	4.9	13.0	3.4	3.6	3.6	11.3	72.2	31.4	16.3	Nov 23	277	2.73	2.73	1990
1991	11.6	58.6	4.9	6.6	3.7	3.6	3.5	7.8	4.0	3.4	16.0	36.8	13.1	Feb 05	243	3.40	2.98	1991
1992	67.8	46.0	10.3	6.7	5.9	3.9	3.8	3.9	3.6	9.3	15.7	8.0	15.3	Jan 30	276	3.23	3.13	1992
1993	7.6	10.7	24.2	27.7	27.6	9.3	3.4	3.6	3.5	3.5	4.7	18.6	12.1	Mar 23	142	3.17	1.90	1993
1994	25.7	16.5	38.2	17.4	5.7	4.1	3.7	3.7	3.8	5.8	13.3	34.9	14.4	Mar 02	322	3.26	3.09	1994
1995	41.0	40.1	28.5	11.3	18.8	8.5	4.1	4.3	3.7	8.3	63.3	51.3	23.5	Nov 18	391	3.22	3.22	1995
normal	23.6	22.6	19.1	13.6	18.2	14.9	6.1	3.9	4.3	13.9	28.7	30.3	16.6	average	258	3.28	3.12	average
mm	167	146	135	93	129	102	43	28	30	98	197	215	1382	10-year	465	2.89	2.56	10-year





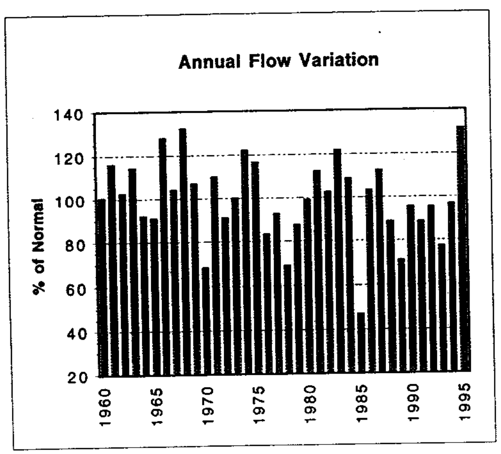


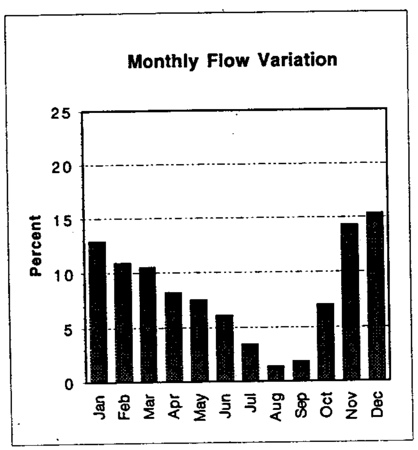


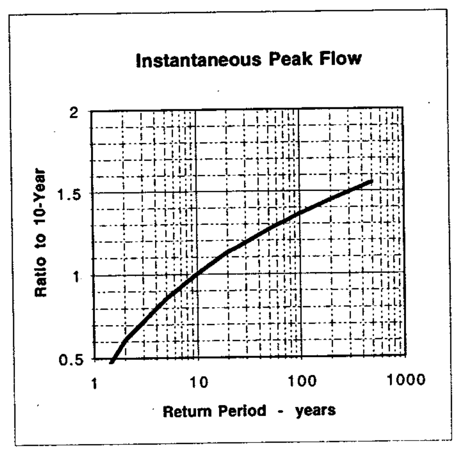
SPROAT RIVER NEAR ALBERNI 8HB008

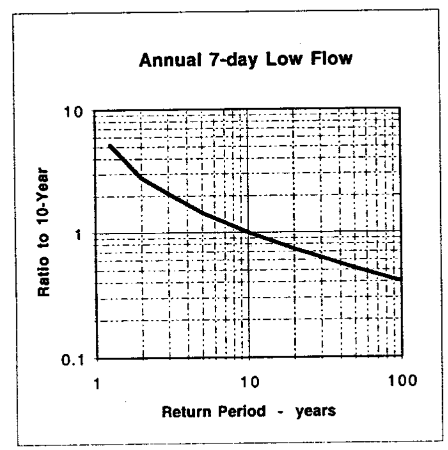
Monthly and Annual Flow in m3/s — d.a. = 347 km2 — median elevation = 430 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	Instantaneous Peak Flow m3/s	7-Day Low Flow Jun-Sep	7-Day Low Flow Annual	Year
1960	27.4	73.1	24.9	61.1	45.3	35.9	14.6	6.5	5.4	31.7	60.9	68.8	37.7	Dec 13	151	4.920	4.920	1960
1961	117.0	100.0	64.7	44.5	41.3	27.7	13.0	4.5	5.2	19.7	38.0	50.0	43.5	Jan 15	308	2.200	2.200	1961
1962	60.8	37.8	16.9	30.8	35.0	21.0	10.7	8.2	5.8	47.8	73.1	114.0	38.6	Dec 16	208	2.730	2.730	1962
1963	54.3	90.7	46.2	42.0	31.3	12.7	7.7	4.6	1.8	55.9	91.3	80.2	42.9	Feb 06	227	1.310	1.140	1963
1964	79.3	43.4	29.8	28.4	28.9	41.0	28.5	16.1	9.1	25.3	34.9	50.0	34.6	Jan 01	151	5.990	5.990	1964
1965	22.3	45.9	30.1	29.3	30.3	15.1	5.5	2.3	2.4	61.4	75.4	90.7	34.2	Dec 05	158	1.910	1.910	1965
1966	71.3	58.0	50.5	49.9	29.6	25.9	19.9	7.9	11.6	27.4	67.8	156.0	48.0	Dec 19	285	4.940	4.940	1966
1967	67.2	51.5	41.1	26.5	27.1	32.5	13.5	3.5	4.9	82.2	57.8	61.1	39.1	Oct 13	158	2.560	2.560	1967
1968	128.0	61.6	63.8	29.6	26.0	22.7	13.9	5.7	11.0	65.6	93.0	73.6	49.6	Jan 20	374	3.690	3.690	1968
1969	28.6	28.0	35.4	65.1	66.1	59.7	18.3	5.2	21.7	33.1	55.9	65.6	40.2	May 29	108	3.130	3.130	1969
1970	37.6	40.8	34.1	39.3	22.4	16.1	6.3	3.3	3.6	18.4	43.1	44.6	25.7	Nov 12	70	2.540	2.540	1970
1971	46.4	65.2	39.7	38.7	55.5	42.7	32.1	17.2	23.5	29.0	77.1	31.0	41.3	Nov 10	163	12.100	12.100	1971
1972	19.9	37.0	90.0	51.4	35.2	31.5	25.3	8.0	8.1	7.3	36.4	59.9	34.2	Mar 19	174	4.040	4.040	1972
1973	90.1	38.7	43.5	20.2	32.5	35.9	16.4	5.2	3.3	16.0	47.5	101.0	37.6	Dec 16	188	2.930	2.930	1973
1974	80.4	58.6	62.7	66.7	40.5	46.7	36.1	15.8	7.2	6.1	48.9	80.7	45.8	Jan 17	217	5.910	5.260	1974
1975	35.4	18.2	36.2	23.5	37.4	34.6	16.1	10.8	19.2	64.2	170.0	59.2	43.7	Nov 15	299	6.150	6.150	1975
1976	51.0	46.7	33.0	34.7	39.2	35.3	28.9	12.5	8.7	8.2	33.6	44.8	31.3	Jan 01	82	6.820	5.260	1976
1977	35.0	49.8	47.3	33.4	28.2	23.5	5.9	1.1	6.8	31.7	88.3	69.0	34.8	Nov 02	144	0.400	0.400	1977
1978	45.6	45.7	43.2	31.2	19.6	15.1	4.4	7.4	33.1	20.6	26.7	20.8	26.0	Feb 09	72	0.472	0.472	1978
1979	11.6	40.2	61.9	26.4	32.4	14.1	16.4	3.5	31.6	29.7	39.7	86.8	32.9	Dec 21	177	1.950	1.950	1979
1980	53.3	51.4	53.3	41.3	25.0	11.8	12.2	2.5	3.4	13.7	74.5	105.0	37.3	Dec 27	376	1.510	1.510	1980
1981	79.7	66.9	31.9	37.1	27.3	16.5	9.8	3.2	10.3	48.4	104.0	73.1	42.1	Nov 01	166	2.010	2.010	1981
1982	31.0	60.1	41.7	26.7	33.7	38.5	19.1	6.5	4.6	60.7	66.0	75.3	38.5	Oct 26	245	4.370	4.050	1982
1983	87.3	117.0	79.8	34.3	22.4	24.3	21.6	8.0	5.5	13.5	105.0	35.9	45.7	Nov 17	209	4.900	3.680	1983
1984	57.6	58.5	58.7	46.1	38.6	28.6	15.7	5.7	4.7	73.4	58.5	43.5	40.8	Oct 10	174	4.220	4.220	1984
1985	14.0	16.6	16.6	35.5	28.0	17.8	5.1	1.7	1.3	20.9	29.2	26.1	17.7	Oct 23	62	1.160	1.150	1985
1986	88.8	55.1	66.4	36.9	38.2	33.2	11.2	2.6	1.5	3.2	42.9	85.7	38.8	Jan 19	190	1.440	1.230	1986
1987	97.5	90.8	80.3	35.8	34.6	38.6	11.0	2.5	1.5	1.4	39.2	77.1	42.3	Jan 12	184	1.380	1.250	1987
1988	39.5	45.9	36.7	47.0	45.6	37.8	13.8	4.4	1.8	6.2	79.3	44.3	33.4	Nov 06	121	1.460	1.460	1988
1989	34.8	25.2	32.5	49.1	29.8	16.9	12.7	3.3	1.4	17.9	46.3	51.0	26.7	Dec 04	103	1.240	1.140	1989
1990	46.0	44.5	29.3	29.1	18.8	25.3	9.0	2.8	2.1	27.0	120.0	79.0	35.9	Dec 04	215	1.890	1.790	1990
1991	38.0	114.0	20.8	23.1	21.9	9.0	4.9	21.5	26.4	5.1	52.8	68.8	33.3	Feb 05	308	3.920	3.920	1991
1992	109.0	120.0	33.5	23.1	18.7	5.3	2.7	2.0	2.6	27.1	56.1	33.1	35.8	Feb 03	302	1.580	1.580	1992
1993	19.9	41.3	53.3	52.6	50.8	26.2	6.9	3.0	1.9	2.9	15.7	75.1	29.1	Dec 14	207	1.030	0.771	1993
1994	68.9	47.5	80.7	34.0	18.1	21.3	8.6	1.9	2.7	10.2	50.8	90.8	36.3	Mar 02	205	0.814	0.814	1994
1995	75.6	91.1	66.4	35.5	24.0	19.9	8.5	3.6	1.7	34.1	122.0	113.0	49.3	Feb 01	176	1.020	1.020	1995
normal	57.0	53.0	46.6	37.7	33.4	28.1	15.3	6.2	8.6	31.2	65.4	67.8	37.4	average	193	3.073	2.942	average
mm	440	373	360	281	257	210	118	48	64	241	489	524	3404	10-year	303	0.869	0.831	10-year





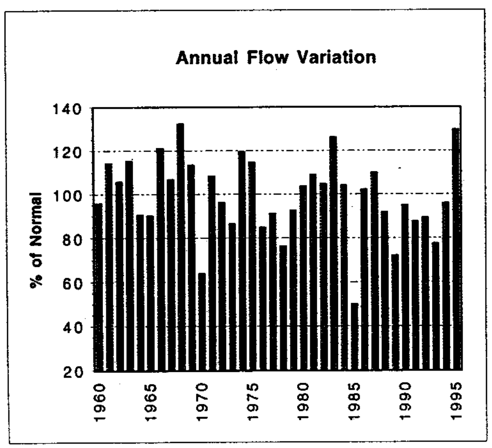


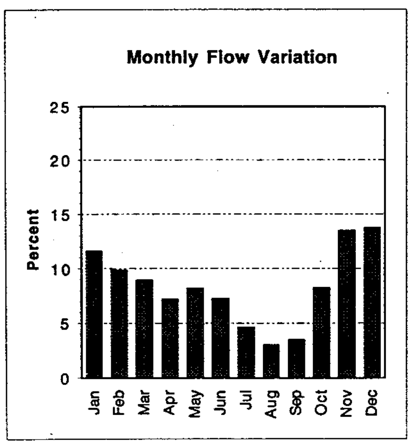


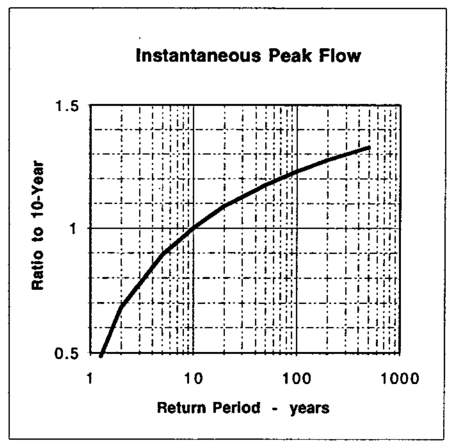
SOMASS RIVER NEAR ALBERNI 8HB017

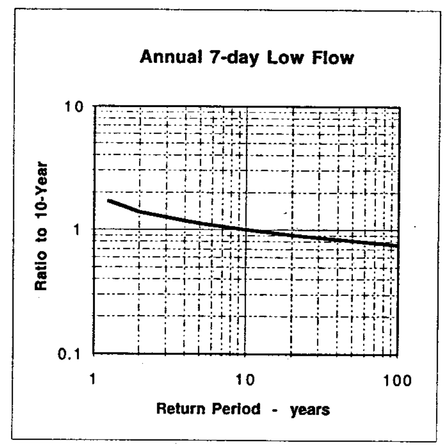
Monthly and Annual Flow in m3/s — d.a. = 1280 km2 — median elevation= 524 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	Instantaneous Peak Flow m3/s	7-Day Low Flow Jun-Sep	7-Day Low Flow Annual	Year
1960	82	184	78	177	139	126	68	38	35	112	173	188	116	Dec 13	647	30.1	30.1	1960
1961	360	292	174	129	154	113	57	39	40	75	109	127	138	Jan 15	1150	34.3	34.3	1961
1962	176	126	55	85	88	78	49	47	39	169	252	372	128	Dec 15	1176	33.4	33.4	1962
1963	151	293	128	117	102	59	47	30	34	209	279	238	140	Feb 06	1124	24.1	24.1	1963
1964	223	114	81	73	105	161	112	54	56	88	102	147	110	Jan 01	493	40.9	40.9	1964
1965	65	135	76	78	93	62	35	33	33	207	229	266	109	Oct 21	572	28.4	28.4	1965
1966	209	151	133	160	106	118	84	46	71	112	217	352	147	Dec 19	693	42.2	42.2	1966
1967	195	145	96	71	120	132	60	41	39	286	172	193	129	Oct 11	550	37.7	37.7	1967
1968	401	193	191	72	109	89	62	43	55	225	273	208	160	Jan 20	1062	38.8	38.8	1968
1969	80	98	104	187	235	207	68	45	95	134	198	198	137			40.6	40.6	1969
1970	107	113	54	89	78	72	45	35	41	73	113	113	77			33.8	33.8	1970
1971	130	189	103	96	199	164	116	72	84	97	248	86	131	Nov 10	714	56.6	56.6	1971
1972	65	108	253	138	130	131	105	48	52	48	103	220	117	Mar 18	643	38.6	38.6	1972
1973	194	79	101	66	129	100	52	46	41	61	129	256	105			38.2	35.2	1973
1974	228	150	180	179	143	178	129	76	54	53	138	228	145	Jan 16	716	50.7	46.7	1974
1975	102	72	103	71	114	123	65	53	68	214	501	180	139	Nov 05	1020	31.3	31.3	1975
1976	146	118	85	102	140	127	103	58	53	46	119	139	103	Dec 27	311	45.6	32.1	1976
1977	99	125	131	108	88	84	36	31	52	115	253	207	110	Nov 14	504	29.3	29.3	1977
1978	131	138	129	89	81	70	45	64	121	77	95	75	93	Feb 08	286	33.2	33.2	1978
1979	49	113	151	82	126	66	77	43	114	122	115	285	112	Dec 19	702	39.3	39.3	1979
1980	143	162	144	131	88	69	62	43	47	60	223	336	126	Dec 27	981	41.2	41.2	1980
1981	237	203	81	102	84	62	47	33	53	157	329	204	132	Nov 01	773	30.0	30.0	1981
1982	92	174	112	82	118	161	74	51	45	217	172	226	127	Oct 26	829	40.6	40.4	1982
1983	286	354	220	98	101	106	87	50	53	78	327	90	153	Nov 15	780	40.1	40.1	1983
1984	172	180	160	116	117	98	67	38	49	225	174	120	126	Oct 09	612	32.6	32.6	1984
1985	44	56	50	99	87	62	32	27	27	95	80	69	61	Oct 22	266	24.5	24.5	1985
1986	258	159	214	84	143	102	47	28	29	36	138	247	124	Jan 19	658	27.0	27.0	1986
1987	284	270	224	106	124	133	55	27	28	27	127	200	133	Mar 05	758	22.3	22.3	1987
1988	120	123	108	151	160	123	64	39	29	41	247	133	111	Nov 05	513	26.6	26.6	1988
1989	99	81	98	155	92	69	51	25	22	83	125	149	87	Dec 04	455	17.9	17.9	1989
1990	131	122	91	88	62	86	39	29	31	97	382	225	115	Nov 12	802	26.2	26.2	1990
1991	110	322	52	67	73	43	30	86	78	39	169	221	106	Feb 04	795	26.1	26.1	1991
1992	336	312	79	82	50	30	27	24	23	104	149	91	108	Jan 30	875	22.7	21.7	1992
1993	80	110	156	156	167	89	36	33	28	31	53	188	94	Mar 23	525	25.2	24.2	1993
1994	179	137	235	114	68	75	37	27	33	61	162	265	116	Mar 02	838	25.6	25.6	1994
1995	229	276	189	99	113	89	51	35	26	129	345	312	157	Nov 18	989	28.6	28.6	1995
normal	166	155	128	107	117	107	66	43	52	117	199	196	121	average	722	33.5	32.8	average
mm	347	295	267	216	245	216	137	90	105	246	403	411	2978	10-year	1049	23.5	23.4	10-year









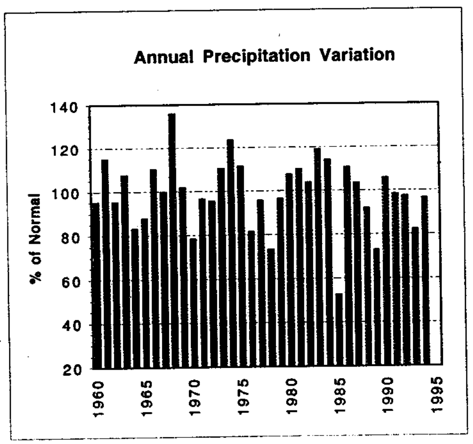
Port Alberni A 1036206

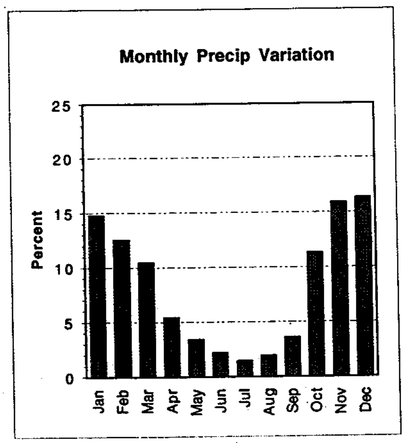
location: 49°15', 124°50', 2 m

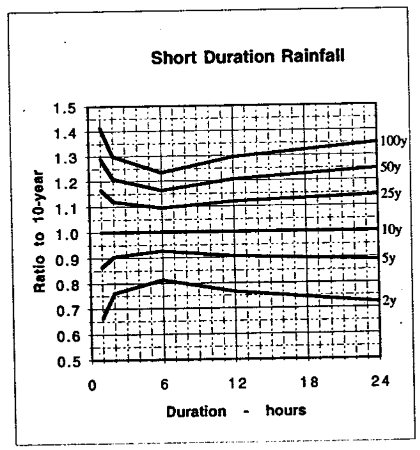
Monthly and Annual Precipitation in mm

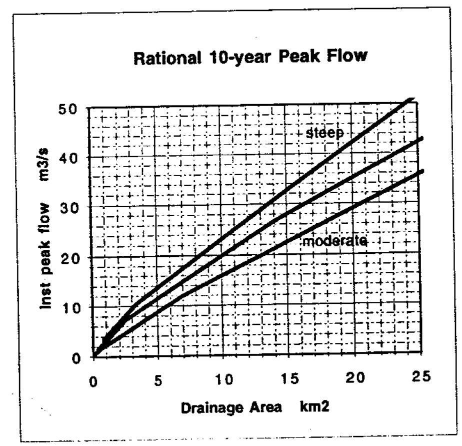
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	253	248	198	210	116	20	1	39	39	206	319	188	1838
1961	505	487	196	77	52	22	33	63	54	197	244	288	2217
1962	184	64	120	142	42	56	22	132	76	138	455	411	1843
1963	41	349	226	115	58	21	53	18	27	403	334	433	2078
1964	460	103	162	55	30	58	55	29	84	135	236	199	1606
1965	167	180	67	96	63	3	7	104	10	387	319	296	1698
1966	448	136	266	44	33	51	32	15	71	152	373	509	2129
1967	388	225	226	55	17	18	9	0	45	448	146	350	1926
1968	721	212	236	92	39	54	59	53	56	404	332	364	2622
1969	258	211	227	232	84	30	12	47	175	140	216	334	1965
1970	246	80	123	186	28	16	24	13	55	149	243	353	1515
1971	236	201	370	91	29	85	17	50	107	152	343	180	1861
1972	180	332	295	148	24	20	50	14	142	27	211	401	1845
1973	509	178	121	11	130	59	9	7	50	231	345	483	2131
1974	368	376	379	99	95	50	72	1	62	59	403	419	2382
1975	179	205	142	50	52	19	3	119	5	519	579	281	2152
1976	289	309	230	65	91	26	34	70	50	128	99	185	1574
1977	107	230	221	97	102	18	29	45	64	306	348	281	1847
1978	259	134	227	82	89	11	8	113	135	49	132	181	1418
1979	81	413	111	82	51	24	37	32	157	221	147	504	1860
1980	241	295	151	140	35	100	28	15	104	99	386	479	2073
1981	157	275	127	161	76	68	61	35	139	341	331	352	2122
1982	242	412	78	125	32	40	16	8	47	383	238	383	2004
1983	339	529	305	59	36	75	64	36	51	154	505	146	2298
1984	220	374	165	191	171	33	12	7	99	352	403	176	2203
1985	33	126	128	98	61	28	0	21	67	260	50	144	1016
1986	482	214	295	64	170	50	31	1	35	68	357	369	2136
1987	471	206	280	143	127	63	24	10	33	26	307	307	1997
1988	267	105	229	183	118	52	32	18	81	115	427	151	1778
1989	181	100	229	128	32	64	43	20	13	224	185	193	1411
1990	304	226	147	54	26	93	11	39	8	326	514	292	2040
1991	250	325	76	143	56	25	20	203	3	33	385	381	1898
1992	627	225	41	155	6	43	16	69	61	258	235	146	1881
1993	207	29	300	198	124	68	27	45	4	91	126	372	1591
1994	221	440	196	72	64	73	7	27	55	187	369	152	1862
1995	362	245	256										
normal	285	243	203	105	67	44	29	38	70	220	307	315	1925
excess	246	243	184	66	3	0	0	0	0	0	241	287	1270

Year	Maximum Daily Precip month	mm	Short Duration Rainfall 24h	12h	6h	2h	1h
1960	Dec	86					
1961	Jan	76					
1962	Jan	72					
1963	Dec	100					
1964	Nov	89					
1965	Oct	58					
1966	Nov	83					
1967	Dec	96					
1968	Jan	107					
1969	Dec	60	83	59	33	15	8
1970	Nov	52	58	45	33	16	8
1971	Nov	68	76	57	38	18	11
1972	Dec	68	80	49	33	15	9
1973	Jan	99	107	71	44	22	13
1974	Mar	93	104	61	38	18	10
1975	Oct	79	101	78	47	21	12
1976	Dec	56	70	54	34	15	9
1977	Dec	72	73	52	40	20	11
1978	Mar	78	87	48	36	30	27
1979	Dec	100	127	86	47	17	13
1980	Dec	111	63	52	39	16	10
1981	Oct	101	115	70	43	25	15
1982	Oct	74	80	55	34	19	11
1983	Feb	95	143	89	45	19	11
1984	Feb	82	117	70	44	20	13
1985	Oct	54	55	40	25	13	9
1986	Dec	83	91	63	43	24	13
1987	Jan	83	97	64	40	15	9
1988	Jan	63	91	71	49	23	12
1989	Dec	66	71	65	45	20	12
1990	Dec	98	108	68	47	21	13
1991	Feb	96					
1992	Jan	102					
1993	Dec	93					
1994	Dec	78					
1995		80					
average		82	91	62	40	19	12
10-year		108	121	79	48	24	17

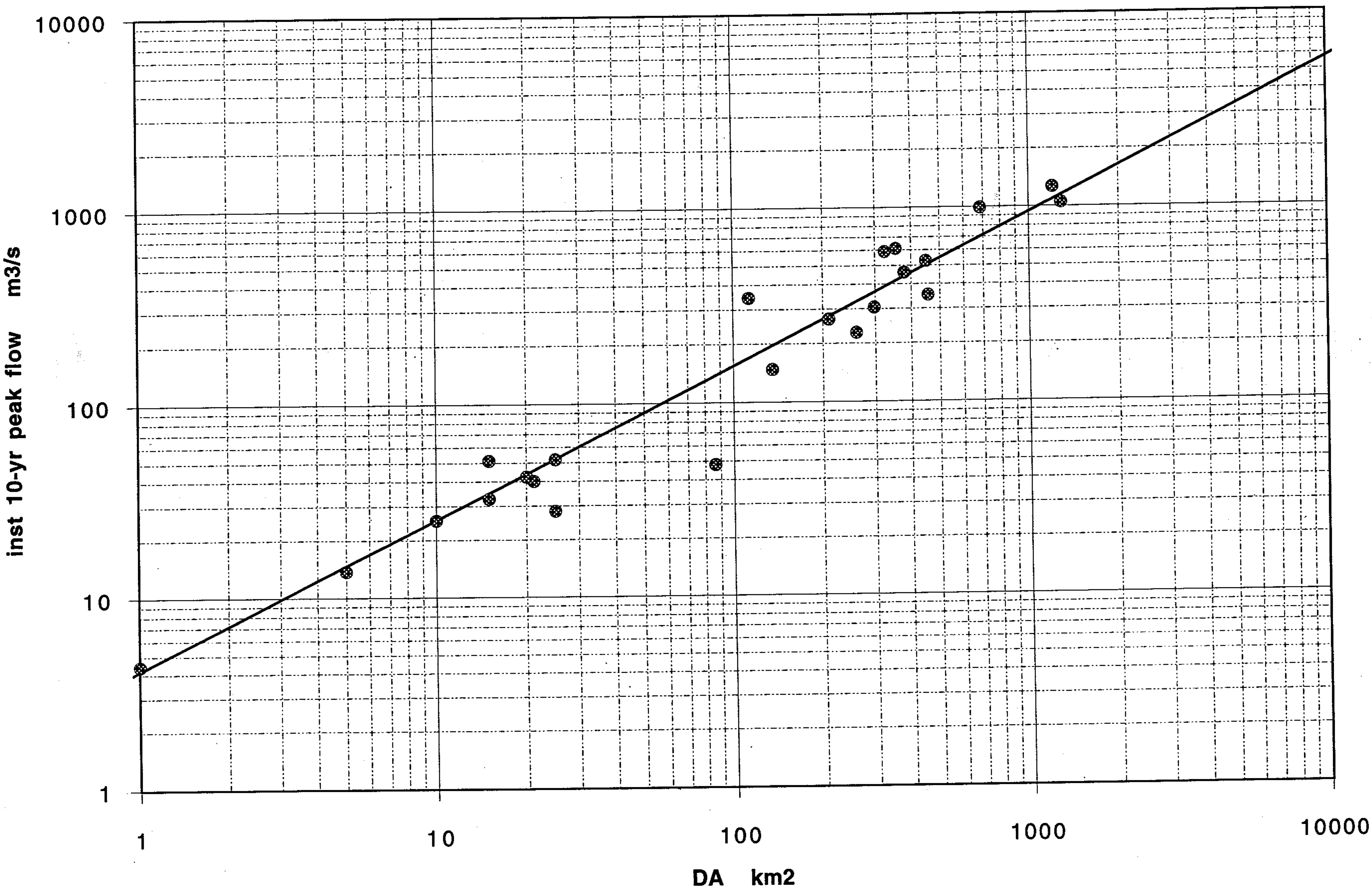








Hydrologic Zone 39 - Leeward Island Mountains



APPENDIX 3

PHOTOGRAPHS

SOMASS RIVER

Photo 1 Typical view of the Somass River lower reach looking upstream at cross section 2.

Photo 2 Looking upstream to the Kitsucksus Creek confluence. Kitsucksus Creek flows under the road bridge, centre of photo.

SOMASS RIVER

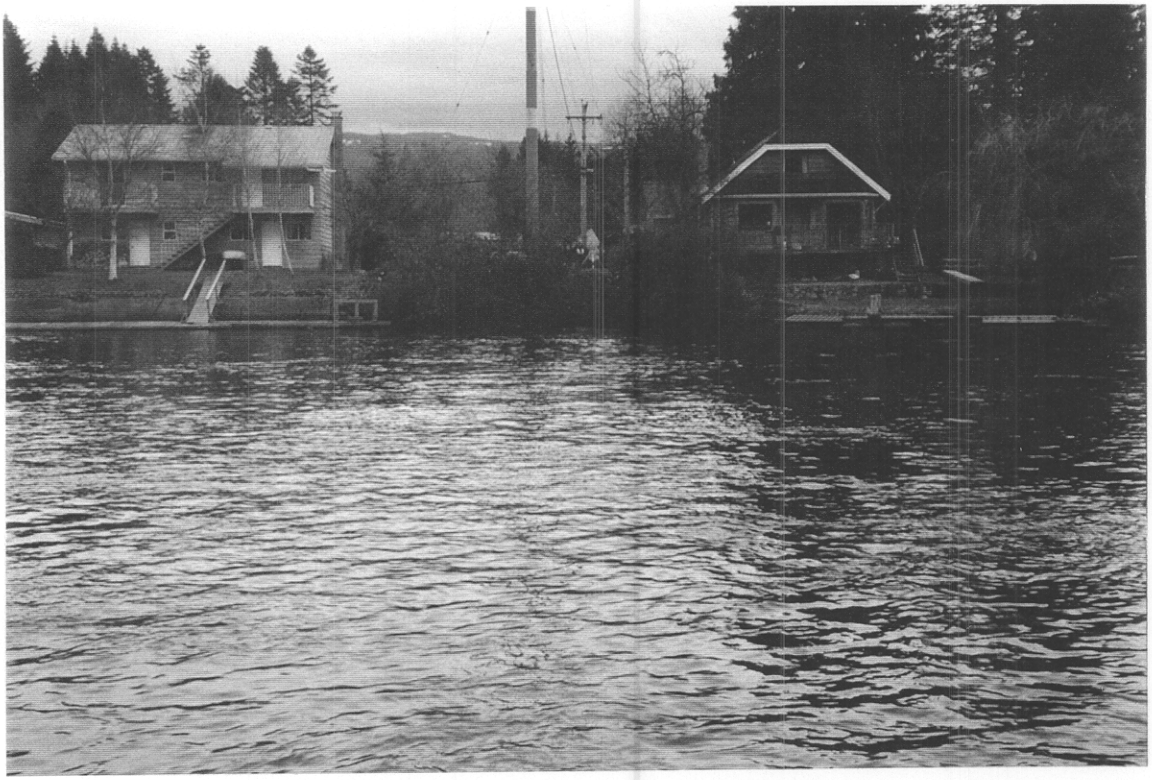


Photo 3 Residential development on the left bank of the Somass River at cross section 7.

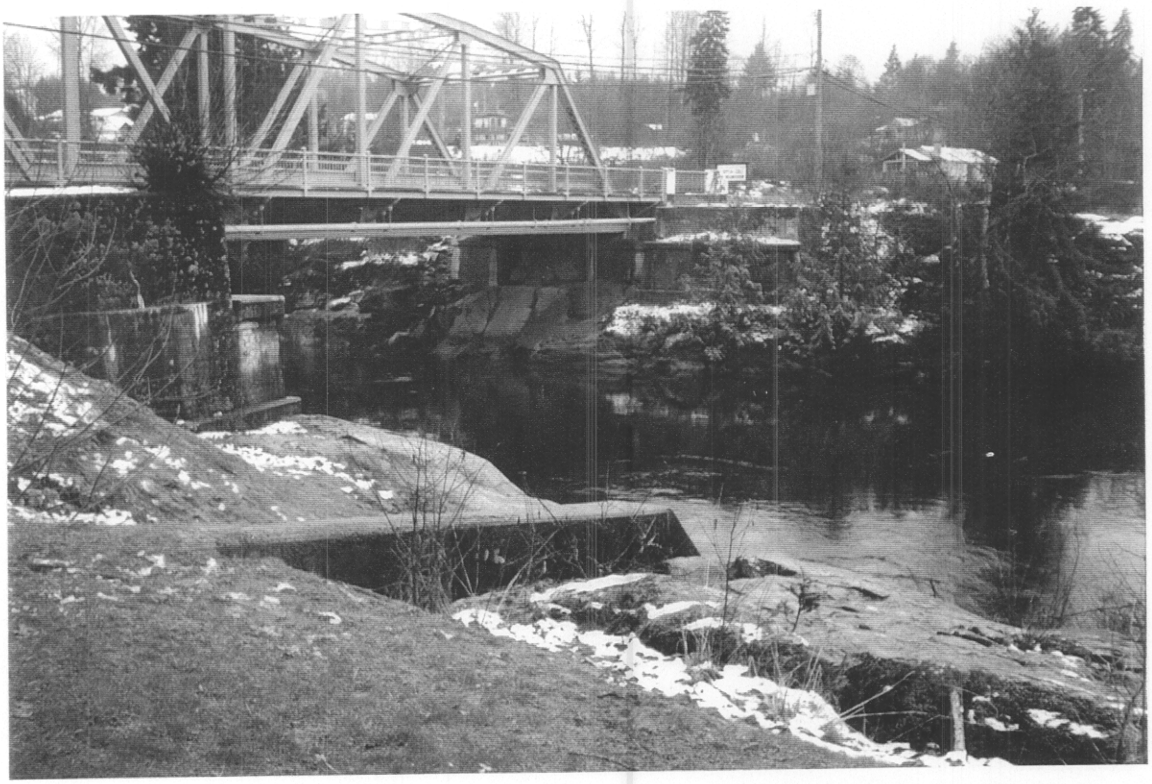


Photo 4 Looking at the upstream side of the Highway 4 bridge. Note abutments of earlier bridge.

SOMASS RIVER

Photo 5 Right bank at cross section 15. Note erosion and slumping.

Photo 6 Left bank area between cross sections 19 & 20. 1990 flood reached main floor level of house.

APPENDIX 3 - PHOTOGRAPHS

SOMASS RIVER

Photo 7 Looking upstream from the Somass to the Sproat River on the left and the Stamp River on the right.

STAMP RIVER

Photo 8 Left bank erosion at cross sections 29.

Photo 9 Looking northwest (upstream) from a bend in Mackenzie Road approximately 1.4 km west of the intersection with Beaver Creek Road and due east of cross section 32. The floodplain boundary would be near the toe of the slope below the residence to the right.

STAMP RIVER

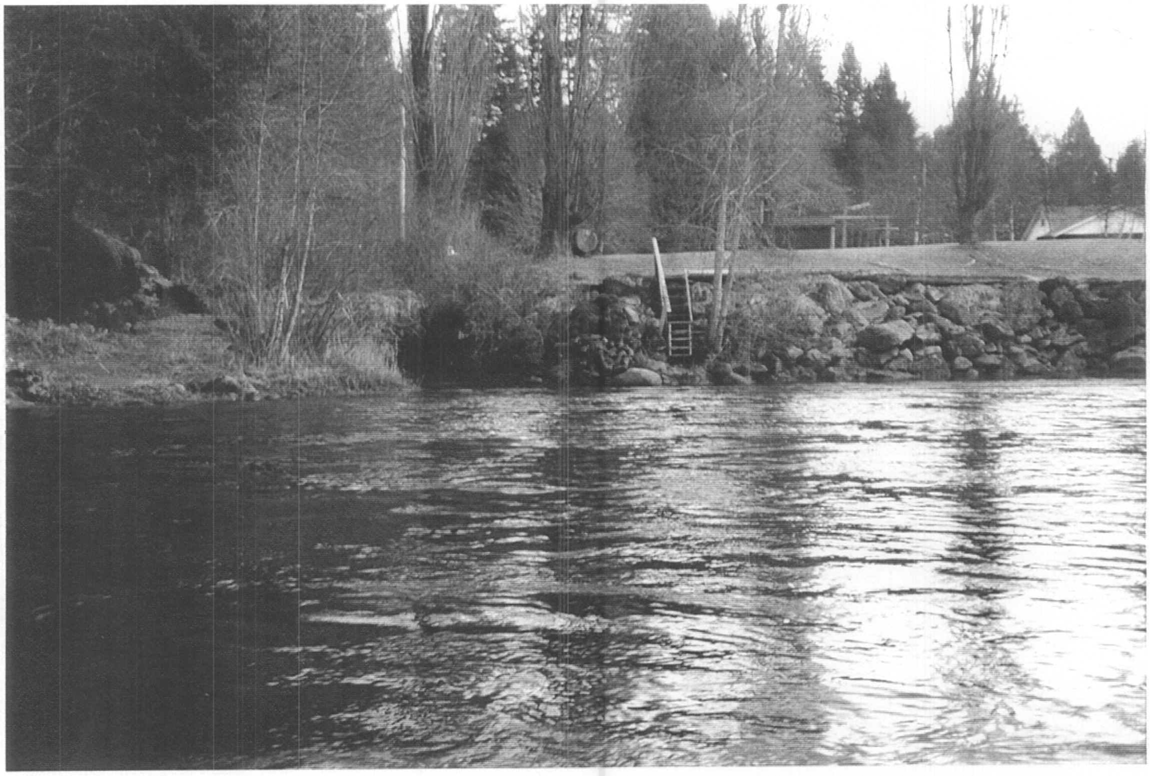


Photo 10 Left bank at cross section 34. Note bank protection.

KITSUCKSUS CREEK

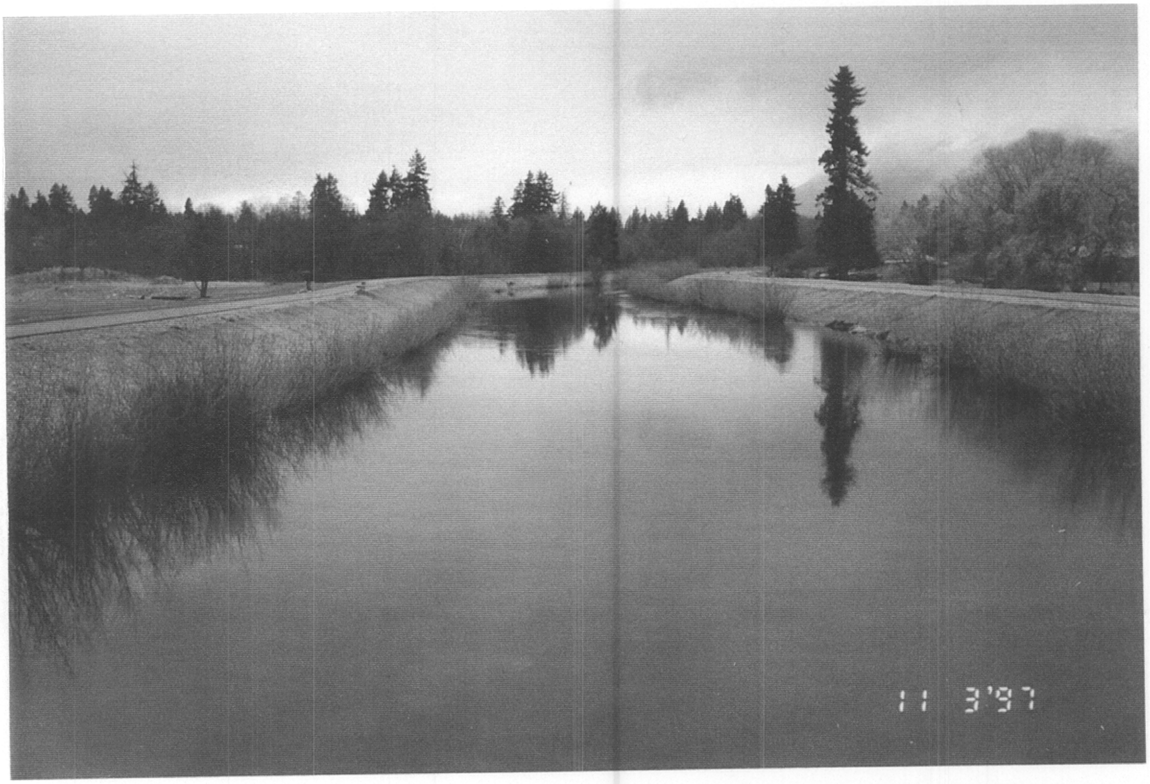


Photo 11 Looking upstream from footbridge at cross section 4. Typical of lower reach of Kitsucksus Creek.

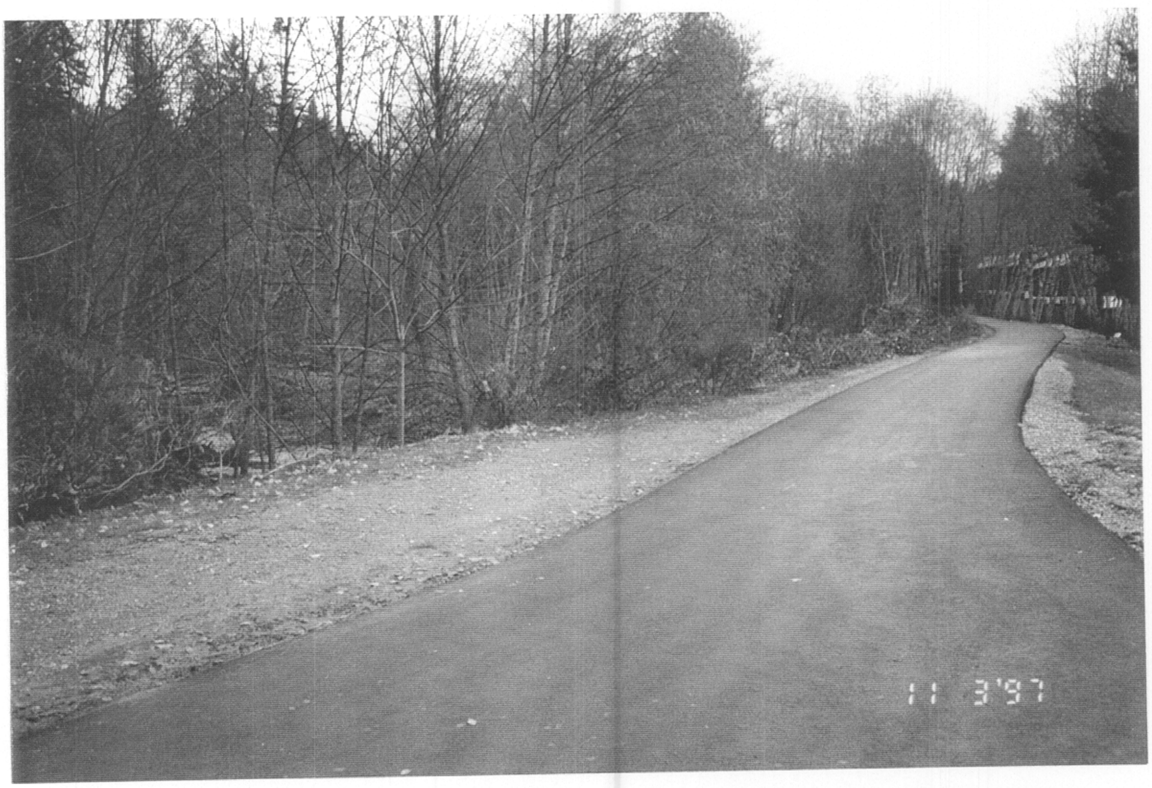


Photo 12 Looking upstream from the left bank just upstream of the Gertrude Street bridge.

APPENDIX 4

NEWSPAPER ARTICLES ON FLOODING

Maple Bay is still cut off from Duncan by water on Lakes and Tzouhalem Roads.

WASHED OUT

A bridge on Cowichan Lake Road near the tennis club had pilings knocked from under it and 10 feet of one approach washed out. Water was six feet over the bridge.

Up to this gap, unawares, rolled a bread truck driven by John Tscheslog. He saw the washout too late to stop, and tried to jump it. The truck nearly made it. Damage was about $100.

Duncan council last night

Ride to Rescue

Rescuer carries small son of Andy Anand from flooded home on Beverley Street in Duncan, surrounded by foot-deep water Sunday. Forty homes in the area were evacuated, and water later rose even more.—(Ryan Bros. photo.)

Lake Higl

Lakes are high ll over the south half of Island.

Sproat Lake 15 feet above its normal vels, invading a number ottages.

Cameron Lake ed over the Alberni Hi way in places — about ht feet above normal.

Shawnigan ... up around the porch f some cottages.

VICTORIA COLONIST, page 22 JANUARY 17, 1961

Alberni Flooding

Weary Refugees Begin Back-Breaking Clean-Up

* * *

Typical scene in soggy Alberni Sunday morning was this one—with Lloyd Kolstad carrying his daughter from their home on Margaret Street as Kitsuksis Creek rose rapidly. An hour later the water began dropping about a foot an hour.—(Photo by Margaret Trebett.)

ALBERNI—Wear efugees evacuated from th flooded homes here Sunday t back yesterday to begi back-breaking clean-up and make a heartbreaki assessment of damage.

Works superinten Robert Waugh said the as no way of estimating th umber of families evacu nor actual damage figu

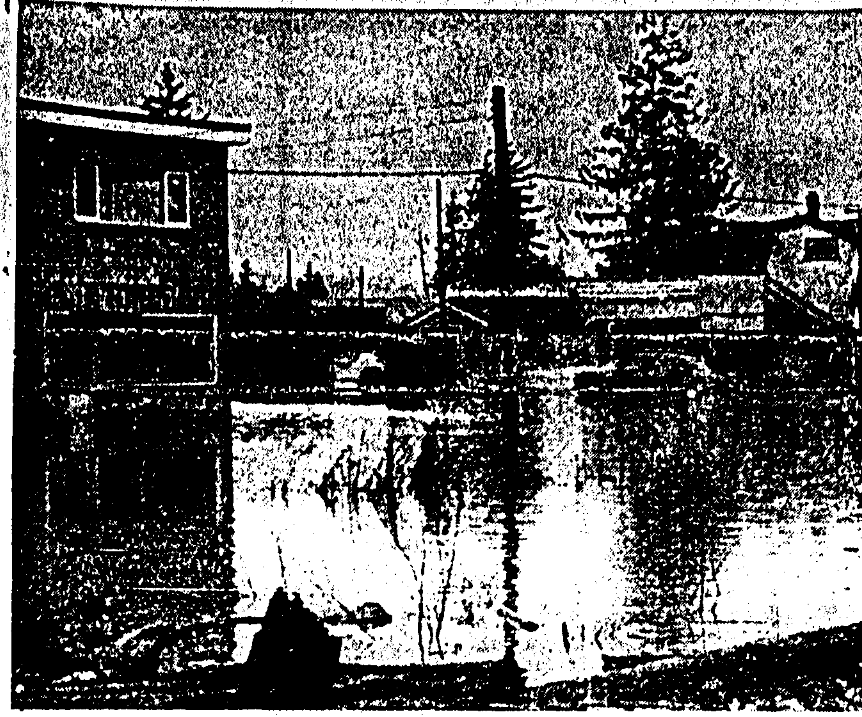
But there was a rrific amount of damage homes and furnishings, he last night.

Homes were flood along Somass River and uksis Creek, where wate pilled over sodden banks S y after 36 hours of rain.

High tides and win owed the escape of wat nto the inlet, contributin the flooding.

The Salvation Ar hall and All Saints' lican Church hall were thr open to refugees but the ilities were not needed. Mo the refugees went to st with relatives or friends e here in Alberni or Port A ni.

WEST COAST ADVOCATE (PORT ALBERNI)
JANUARY 19, 1961 (Vol. 41, No. 2)
PAGE 1



Water reached quite a depth at intersection of Beaver Creek and River Roads Sunday, as is evidenced by the half-submerged sedan in right background. Traffic was unable to get through on either road, and had to be detoured around Margaret Street and Compton Road, not badly affected by flooding this year.

Weekend Flooding Conditions Put Many Valley Homes Under Water

"Bad, but it could have been considerably worse," appeared to be the general consensus of opinion in the Alberni Valley after the flooding which occurred in the early part of this week.

With the heavy rain of the previous week, adverse wind conditions, plus a high tide in Alberni Inlet the most popular song on Sunday appeared to be "River Stay Away From My Door".

Unfortunately for some of the River Road, Alberni residents and householders of lakeshore dwellings at Sproat Lake considerable damage was done to personal effects before relief arrived in the form of better weather and the assistance of local community services, friends and relatives.

So serious was the threat to riverside homes in Alberni and the lakeshore houses at Sproat Lake on Sunday that the Alberni Valley Mountain Rescue Squad, the combined forces of the RCMP, municipal work crews, community organizations and volunteer services plus the Salvation Army, and almost every church group in the Valley were 'standing by' or actively participating in offering all assistance required to 'flooded-out' or potentially evacuated residents of the stricken area.

Warnings issued through press and radio services warned Valley residents to boil all water which might be affected by surface run-off, also to stay clear of the possible disaster areas where mass evacuation might have been necessary.

At high tide on Sunday, River Road was covered in many places to well in excess of 16 inches of water, basements were completely flooded and water was several inches deep across the ground floor accommodation in many homes overlooking the Somass River.

Several residents of Sproat Lake reported that previous record 'high water' markings on buildings and mooring floats along the lake had been covered by two to three inches of water. Fortunately for this district the further storms predicted for the Valley on Sunday and Monday evening failed to develop.

The high tide of 13.2 feet due between 10 a.m. and noon on Monday kept all available rescue personnel on hand, but no further eventualities were reported and conditions after the further high tide on Tuesday began to rapidly improve.

Without doubt the greatest problem confronting the authorities and the victims of this flood was the unnecessary worsening of conditions created by 'sightseers' in cars who disregarded signs and barries erected especially to prevent further distress to victims.

It is reported that many cars ploughed through deep water along River Road at unreasonably high speeds and created tidewaves which washed against and into houses which might otherwise have escaped groundfloor flooding.

The major damage reported from Port Alberni was an eighty foot washout of the municipal water main. This damage was estimated at approximately $1000, but with city crews working contioually through Sunday, service to the reservoir was re-established by early Monday morning. Due to the excessive amount of water in the water-shed and trouble caused by logs jamming in the spillways damage was caused to the dam, and municipal works department crews have been constantly employed for most of this week in repair operations.

Washouts on the Franklin River Road caused closures of that area on Sunday and severe flooding in the region of Kennedy River and Sutton Pass where many washouts have occurred on the Tofino - Alberni highway have caused that road to closed entirely until further notice.

From January 1 to Monday, Jan. 16, a total of 19.03 inches of rain had fallen on the Albernis, it did not however cousitute a record for that period.

Municipal authorities have expressed appreciation to all persons who volunteered their services during the flood crisis, and at Monday evening's Alberni city council meeting, works superintendent Bob Waugh recommended in a verbal report to council on flooding conditions, that serious though be given to future flood control, particularly in the area of River Road, Alberni.

Charge Of Possession Of Stolen Property Adjourned January 25

The trial of George Chalifour, local jeweller charged with possession of stolen goods, opened in Port Alberni police court Tuesday and was ad-

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Vol 41, N

Albe Repl

Five q from Alberr Ohs at the written repl meeting of The o mayor that "a better f Anderson h

"Should the the minutes statement of by the mayor gard to alder "Is the reso Tuesday Sept by alderman alderman B inserted in structions of "If the ma advice of the tor gives be set out "Do the w sect 177 "H rights and p the council" motions and "The proc 19, provides therefore as cil have I have record 'noes' and ed"?

The reply stated:

Herewith reply to the raised in yo 1961.

1. It is th to set out in report of ev ing its mover disposition o Council.

In my opi such authorit the subject,

Hill Cli Sanctio From I

Alberni V sociation's the old hi will be one to be sancti west in 1961 week.

Sanction fo ed last week ing of the of Pacific Clubs, held sanctioned h new course a ton.

Attending representativ

Tidal Waves Strew Havoc Widespread in Albernis

LANDLOCKED BOAT is a 35-foot cabin cruiser belonging to Fred Plimlock which was carried off from its moorings and dropped on road five blocks inland in Alberni. Buildings formerly stood on foundations in foreground of picture. (Flett photo.)

FOUNDATIONS are all that's left of this church in Alberni, lifted bodily off its base by giant waves. Reporter stands on steps. (CP Wirephoto.)

UPENDED CAR on Third Avenue used car l[illegible] in Port Alberni was caught under building settli[illegible] as flood receded and tilted to awkward angl[illegible] (Strickland photo.)

'HEAVY DOWNPOUR' FIRST THOUGHT

Wet Welcome for Immigrants

Two families of British immigrants had to wade through waist-deep freezing water to escape from the tidal waves that hit the Alberni Valley early Saturday morning.

Back in their Vancouver homes now are the families of Brian Harris and Wilf Smith.

They were wakened early Saturday morning by waves slamming debris against the [illegible] side-Auto Court.

Both families fought their way through the water to high ground, then watched as the second tidal wave smashed the motel cabins 15 feet off their foundations into a concrete fence.

Churned up with the cabins was Mr. Smith's new car.

Then the seven of them—Brian and Pamela Harris, four-month-old Beverley, Wilf and Shirley Smith, two-[illegible] and Mrs. Elsie Hall, mother of the two wives—waded to the Arlington Hotel.

"We all went into one of the rooms and tried to get dry and warm by the radiator," said Mr. Harris.

SALVAGE TRIPS

Then the men made a few trips back to the motel salvaging their belongings.

"We were just terrified. We didn't know what to do," said Mr. Smith.

"Police were trying to [illegible] herd people to safety, but some women screamed as they tried to find their children . . .

"Houses, cars, debris floated by all the time.

"My car—a Rambler—was a complete wreck."

From the hotel, they started for Nanaimo, hiring a car that took them to a Vancouver-bound ferry.

It took them seven hours to get free of the flood-struck valley.

Their original reaction to [illegible]

"We thought it was just a heavy downpour."

FLIPPED TRUCK lies amid foundations of owner's home in Alberni. House itself was deposited 1,500 feet away. Houses across street in background of picture were not moved. (Strickland photo.)

TOSSED ABOUT by tidal wave which burst upon the twin cities of Alberni and Port Alberni, this car came to rest in water-filled hole. Cottages in background have been shifted from their bases. (Flett photo.)

BROKEN BOOMS scattered logs around head of Alberni Canal where twin cities of Alberni and Port Alberni are located. Canal acted as funnel, constricting tidal wave as it bore in from sea until it acquired devastating force. (Ryan photo.)

CARS AND CABINS at Riverside Auto Court [illegible] twisted out of shape by tidal wave in [illegible]

Earthquake Breaks New Pacific Cable

LONDON (Reuters) — The Commonwealth telecommunications cable linking Britain with Australia and New Zealand has been broken, probably as a result of the Alaskan earthquakes, a spokesman for the British Post Office said here today.

The spokesman said the break in the 8,700-mile-long trans-Pacific cable occurred 7½ miles off the Canadian Pacific coast. He said it might restrict communications between Britain, Australia and New Zealand.

The cable runs from Port Alberni, B.C., to Australia via Suva in the Fiji Islands and Takapuna, New Zealand. It was inaugurated only last December.

The Pacific section of the Commonwealth cable — code-named COMPAC—is to be part of an eventual, globe-girdling 14,000-mile cable linking the far-flung parts of the Commonwealth — the longest telephone cable project in the world.

The break was expected to affect virtually all British communications with the Pacific region. The cable, with 80 voice channels, also is used for press and commercial teleprinter circuits, and high-quality transmission of music, broadcasting and photos.

The post office spokesman said communications between Britain and New Zealand-Australia were being supplemented by radio via Singapore direct to Sydney and Melbourne.

"How long it will take to fix this break, I do not know," the spokesman said.

DAILY PAPER LENDS A HAND

FAIRBANKS (AP) — The Fairbanks Daily News-Miner flew 15,000 copies of a special edition by chartered plane to Anchorage Sunday for free distribution in that newspaperless city.

The edition carried the mastheads of the News Miner, Anchorage Daily Times and Anchorage Daily News. It contained both news and pictures of the earthquake which smashed Anchorage and half a dozen smaller cities Friday evening.

The Times and News plants were damaged in the quake

Only Gentle Waves Hit Hawaiian Isles

HONOLULU (UPI) — Tidal waves launched by Friday night's disastrous Alaskan quake forced evacuation of 300,000 Hawaii residents but did practically no damage to [illegible]

"more like a running tide rather than a typical tidal wave."

The only place reporting extensive flooding was Kahului, a town of 5,000, on the island of Maui. Waters moved about

THOSE WAVES 'TSUNAMI,' NOT 'TIDAL'

The waves which battere[d] Alberni and swept down th[e] coast to San Diego are tech[nically] not tidal waves at al[l].

Contrary to popular usag[e] the term tidal wave refers t[o] the large waves associate[d] with some tides in suc[h] places as the Bay of Fund[y]. Tidal bores are another ter[m] for them.

There is no word in th[e] English language for th[e] shock waves sent out [by] earthquakes. The Japane[se]

APPENDIX 5

FLOODPLAIN MAPPING

SOMASS RIVER AND TRIBUTARIES

DRAWING NO. 93-10, SHEETS 1 TO 4