FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT
Province of British Columbia
Ministry of Environment
Water Management Branch

A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING STUDY OF THE

NICOLA RIVER

An Overview of the Study Undertaken to Produce
Floodplain Mapping for the Nicola River from
Spences Bridge to Nicola Lake

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FLOODPLAIN MAPPING STUDY

NICOLA RIVER

Spences Bridge to Nicola Lake

Preface

The purpose of this design brief is to present a description of the methodologies used and the results of the study undertaken to produce the attached floodplain mapping sheets, Drawing 87-22, Sheets 1 to 15, (Appendix 3).

1. Study Area

The study area is located within the Thompson-Nicola Regional District in the south central portion of British Columbia as shown in Figure 1. The area extends a distance of approximately 100 km along the Nicola River from Spences Bridge, at the confluence of the Thompson River, to Nicola Lake. The City of Merritt is located in the study area near the confluence of the Nicola and Coldwater Rivers. Figure 2 is a Key Map showing the location of the floodplain mapping sheets in the study area which includes 5 kilometres of the Coldwater River at Merritt.

The Nicola River has a gradient which varies from 0.70% (Figure 3) in the lower reaches of the study area to 0.05% (Figure 6) in the reach upstream of the Coldwater River confluence. The gradient of the Coldwater River in the vicinity of Merritt averages 0.47% (Figure 6) while that of Spius Creek, a major tributary in the study area, averages 1.1% (Figure 5).

The drainage area of the Nicola River at the Thompson River confluence and at the outlet of Nicola Lake is 7670 and 2990 km^2, respectively. The drainage areas of the Coldwater River, Spius Creek and Guichon Creek at the confluence of the Nicola River are 914, 781 and 1230 km^2, respectively.

Elevations on the Nicola River watershed vary from 227 metres (GSC datum) near the Thompson River confluence to over 2250 metres in the Cascade Mountains in the upper reaches of the Spius Creek

watershed. The study area is within the Intermontane System, one of the six main physiographic regions in the Province. Mean annual precipitation averages less than 30 cm in the lower Nicola Valley to between 50 and 75 cms in the upper areas of the watershed. Mean daily temperatures average between -5° to -15°C in January to +14° to +22°C in July in the watershed (Appendix 1.1)..

2. Background

Floodplain mapping for the Nicola and Coldwater Rivers at Merritt was issued by the Ministry in April of 1974 (Drawing 5040, Sheets 1 to 5). The mapping was based on 2-foot contour intervals and river surveys carried out in 1966. Flood estimates were based on the flow data available at the time of the study (Appendix 1.25).

Studies were undertaken by the Ministry of Environment in the early 1980's in connection with the preparation of a strategic plan for the Nicola basin. A summary document, entitled "Nicola Basin Strategic Plan", (Appendix 1.2) was submitted in July of 1983 which recommended a management strategy for the basin.

The Water Management Branch became involved in a number of studies in support of the preparation of the strategic plan. A report entitled "Nicola River Study River Corridor" (Appendix 1.3), dated June, 1983, was issued by the Water Management Branch. A river corridor zone of probable erosional activity of the Nicola River, from the Thompson River to Nicola Lake, has been delineated on the evidence of historical channel mobility and relevant geological features.

River cross section data was obtained in order to provide the necessary data to determine flood profiles along the entire Nicola Valley. This data combined with topographic mapping, highwater level data and updated hydrology studies formed the basis for the present floodplain mapping study which replaces the floodplain mapping issued in April, 1974.

3. Designated Flood

In accordance with the policy of the Ministry of Environment,the flood levels and floodplain limits shown on the floodplain mapping sheets are based on a designated (1:200 year frequency) flow plus an allowance for freeboard. At the downstream limit of the study area, the designated (daily) flow is 380 m^3/s.

4. Survey and Mapping Data

Topographic base mapping for the study area (1:5000 scale) was

based on air photographs obtained in 1982 and 1986. The mapping is based on 2 metre contour intervals between the Thompson River confluence and the Canford area (Sheets 1 to 9) issued in May, 1983. Upstream of the Canford area to Nicola Lake, the contour interval is 1 metre (Sheets 9 to 15) issued in March, 1988. The mapping was produced by the Surveys and Resource Mapping Branch (Appendix 1.4).

The Surveys Section of the Ministry of Environment obtained a total of 285 river cross sections (Appendix 1.5) in the study area as follows:

River	Reach	Number of Cross Sections
Nicola River	Thompson River confluence to Canford (47 km)	127
Nicola River	Canford to Nicola Lake (51 km)	119
Spius Creek	Upstream of Nicola River confluence (1.5 km)	9
Coldwater River	Upstream of Nicola River confluence (4.9 km)	30

Figures 3 to 6 indicate the cross section locations and the water surface and thalweg profiles for the study area.

5. Flood Magnitudes

5.1 General

The Hydrology Section, Water Management Branch, Ministry of Environment carried out a study to estimate peak flows for the study area in December of 1986 (Appendix 1.6). A regional study, completed for the Nicola basin (Appendix 1.7) was updated and peak flow estimates were made for selected locations along the mainstream Nicola River and at the mouth of the main tributaries.

A summary of historical streamflow data for five gauges in the study area was obtained from an Environment Canada publication (Appendix 1.8) and is shown on Table 1. The summary indicates that the annual peak flows normally occur in the April to June period. The maximum annual recorded peak flows for the gauges have also occurred in this period, with the exception of the Coldwater River

where the maximum recorded peak flow occurred in December of 1980. In 29 of the 32 years of record from the Coldwater River at Gauge 08LG010, the annual recorded peak occurred in the April to June period. Problems of winter flooding are discussed in Section 6.4.4.

All hydrometric stations with at least five years of record were considered in a regional frequency analysis. The analysis consisted of estimating the mean 20 and 200 year maximum daily unit discharges ($L/s/km^2$) for each gauge using the best fit frequency distribution (Gumbel, Pearson Type III, log-Pearson Type III or three parameter log-Normal) and plotting them against drainage areas (km^2) on log-log graph paper. Envelope curves were drawn for three hydrologic zones, southwestern (west of lower Nicola River), middle (north of Nicola River) and eastern (east of Nicola River). The plots and envelope curves were used to determine unit peak flow estimates for the selected sites in the study area and converted to flow rates (m^3/s). Maximum ratio of instantaneous to daily discharge for all recorder stations were defined for the highest peak flows and a graph was plotted for deriving a ratio to adjust the daily estimates to instantaneous. The results are listed on Table 2.

Evidence suggests that the 1948 flood was the highest on record for the Nicola River based on highwater mark data obtained from the Canadian Pacific Railway. None of the 5 gauges shown on Table 1 were in operation in 1948. A comparison of the estimated 1:200 year flood levels relative to the 1948 recorded highwater mark data is discussed in Section 6.4.3.

5.2 Nicola Lake Outflows and Levels

The old Nicola Lake control structure, built in 1927, (Appendix 1.10) was replaced by a new dam in 1985-86 (See Photo 1). The old structure acted as an overflow weir at high lake stages; the new dam is a gated structure designed to provide maximum utilization of the water resource.

An operation and maintenance manual has been prepared by the Ministry of Environment (Appendix 1.11) which outlines the general description of the new dam and associated works and lists background documents of interest.

In connection with the Nicola Lake Operation Plan (Appendix 1.12) historic inflows were modelled and a theoretical 1:200 year inflow was developed by the Hydrology Section (Appendix 1.13). Assuming that the 1:200 year inflow was accurately forecast, the peak level simulated for Nicola Lake was 626.7 metres. The estimated maximum associated discharge was 83 m^3/s based on a formula developed by Crippen Consultants which reflects the hydraulic characteristics of the new dam and the approach and outlet channel system.

In another simulation, where the 1:200 year inflow was forecast 25% lower than "occurred", the lake peaked at 626.9 metres (outflow capability 93 m^3/s). In routing the flow through the dam and channel system, it was assumed that it was not necessary to restrict outflow from Nicola Lake while the uncontrolled Coldwater freshet peak passed through Merritt.

In simulations using recorded inflows for the 1969-85 period (17 years), the peak simulated stage was 626.5 metres which was the result of an assumed poor forecast - a situation that may happen in reality. The associated maximum outflow is calculated to be 70 m^3/sec which is equivalent to an outflow with a return period of approximately 20 years.

According to the operation and maintenance manual, whenever the lake rises above elevation 626.5 metres, the Nicola Lake dam is designed to allow a portion of the flow to bypass the gates and spill (uncontrolled) over the embankment. (Appendix 1.11).

The Nicola Lake outflows and lake levels are summarized as follows:

Q (downstream of dam) m^3/s	Lake Level (metres)	Comments
--	626.9	maximum recorded (June 18, 1974) (1)
--	625.8	normal full supply level (2)
70.0	626.5	1:20 return period (2)
83.0	626.7	1:200 return period (accurate forecast) (2)
93.0	626.9	1:200 return period (25% error in forecast) (2)

(1) Appendix 1.9
(2) New dam operating plan

For the purposes of floodplain mapping of the area between the Nicola Lake dam and the confluence of the Coldwater River, a flow of 70.0 m^3/s (1:20 year) and 93.0 m^3/s (1:200 year) was adopted. Sensitivity studies in this reach are discussed in Sections 6.6.3. Operational concerns and the recommended designated flood level (including freeboard) for Nicola Lake are discussed in Section 6.5.

6. Hydraulic Analysis

6.1 General

Flood profiles were calculated using the HEC-2 water surface profile computer program developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, in Davis, California. The flood profile analysis assumed open water flow conditions.

6.2 Cross Section Plot Run

Plots of the river cross sections were obtained for the study area to assess the river survey data and the extensions of the cross sections obtained from the existing 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.

6.3 Model Calibration

During the week of May 4 to 8, 1987 staff of the Special Projects Section identified high water marks at river cross section locations in the study area from the peak flow which occurred on May 1, 1987.

The high water marks were photo identified and the location details provided to the Surveys Section of the Water Management Branch. Elevations were obtained by ground survey during the week of June 15 to 20, 1987. (Appendix 1.14)

The high water mark data that was utilized throughout the study area was distributed as follows:

River	Reach	Number of Cross Sections	Number of High Water Marks
Nicola River	Thompson River confluence to Canford (47 Km)	127	29
Nicola River	Canford to Nicola Lake (51 Km)	119	33
Spius Creek	Upstream of Nicola River Confluence (1.5 Km)	9	4
Coldwater River	Upstream of Nicola River Confluence (4.9 Km)	30	10

The Hydrology Section estimated the peak flows for the study area for the May 1, 1987 event. (Appendix 1.15). Observed peak discharges were obtained from Water Survey of Canada for hydrometric stations on the Nicola River, Coldwater River, Guichon Creek and Spius Creek.

The Hydrology Section Report "Nicola River Peak Flow" of December 15, 1986 (Appendix 1.6) was used as a reference for a procedure in which the May 1, 1987 observed peaks were estimated at ungauged sites in the study area.

The water level data and peak flow estimates from the May 1, 1987 flow were used in the model calibration. Figure 7 is a stage discharge curve for the Nicola River near Spences Bridge (08LG006) located at cross section 44 on Drawing 87-22-3. As indicated on Figure 3, the gauge is located in the steeper portion of the Nicola River (0.70% grade) and is approximately 15.5 km upstream of the Thompson River confluence.

The calibrated flow (182 m^3/s) at the gauge has a 1:2 year return period and is approximately one half the estimated 1:200 year daily flow of 375 m^3/s at the gauge. As indicated on Figure 7, the May 1, 1987 high water level was approximately one metre below bank level. The channel is incised and the floodplain (see Drawing 87-22-3) is narrow at this particular location.

6.4 Calculated Flood Levels

6.4.1 General

Flood levels were calculated using Manning's "n" values for the river channel obtained from the model calibration studies for the 1:20 year and 1:200 year flows listed on Table 2. Mannings "n" values for the channel varied throughout the study area as follows:

River	Reach	Channel Manning's "n" value
Nicola River	Thompson River confluence to Canford (47 km)	0.032 to 0.046
Nicola River	Canford to Nicola Lake (51 km)	0.030 to 0.046
Spius Creek	Upstream of Nicola River confluence (1.5 km)	0.038 to 0.046
Coldwater River	Upstream of Nicola River confluence (4.9 km)	0.030 to 0.040

Manning's "n" values for the overbank areas were estimated from color photos of the river cross sections provided by the Surveys Section (Appendix 1.5); color air photography of the study area (BC245 series); experience gained in other studies and a review of the information available on roughness characteristics including a publication by the U.S. Department of the Interior (Appendix 1.16).

It is the policy of the Ministry that the 1:200 year designated flood level is equal to the daily flood level plus 0.6 metres freeboard. In cases where instantaneous flood estimates are available, the instantaneous flood level plus 0.3 metres freeboard is used when this elevation exceeds the daily flood level plus 0.6 metre freeboard criteria.

Experience in other studies has shown that the designated flood levels based on the daily and instantaneous calculated levels, plus the freeboard noted above, are essentially equal

for rivers in which instantaneous flows are significantly (approximately 30% to 60%) greater than daily flows.

In the study of the Nicola River, analysis of the calculations indicates that the difference between the daily flood level plus 0.6 m and the instantaneous flood level plus 0.3 m averages to less than 0.1 metres. In the 24 km reach between XS-1 and XS-60 (0.70% gradient) the difference averaged 0.09 metres; in the 23 km reach between XS-65 and XS-127 (0.47% gradient) the difference averaged 0.03 metres.

6.4.2. Thompson River Confluence Area

High water data for the C.P.R. bridge (X-Section 1 and 2) at the confluence of the Nicola River and the Thompson River was provided for the 1948 flood by Mr. A. M. Wilson, Division Engineer, C.P. Rail in Vancouver (Appendix 1.17). The high water mark of 225.8 metres at the bridge was a result of the flood levels on the Thompson River.

The modelling unit of the Hydrology Section undertook a frequency study of the Fraser River (Appendix 1.18) in June of 1985. The 1:20 year and 1:200 year flood flows and stage for the Thompson River at Spences Bridge (08LF022) are as follows as determined by averaging the log-Normal, Pearson Type III and log-Pearson Type III distributions:

Gauge 08LF022
Thompson River near Spences Bridge (1)

Q(2) (m^3/s)	Stage (3) (m)	Flood Level (Freeboard Included)
4120 (1:20 year)	222.6	223.2
5160 (1:200 year)	223.9	224.5
	Difference = 1.3(m)	

1) Period of record November, 1911 to September, 1951; Drainage Area 54,600 km^2.
2) From Hydrology Section (Appendix 1.18)
3) From Stage-Discharge Table provided by W.S.C.

The 1948 recorded flow at the above noted guage was 4130 m^3/s or virtually equal to the estimated 1:20 year flow. The difference in flood levels of 1.3 metres noted above also applies for the new gauge (08LF051) located downstream on the Thompson River which has a drainage area of 54,905 km^2.

For the purpose of the floodplain mapping study of the Nicola River, a flood level at the confluence of 225.8 metres for the 1:20 year flood and a level of (225.8 + 1.3) 227.1 metres for the 1:200 year flood was established.

6.4.3 1948 High Water Levels

As stated in Section 5.1, the high water mark data provided by the C.P.R. (Appendix 1.17) indicates that the 1948 flood on the Nicola River was the highest on record, based on water level information dating back to 1906. None of the streamflow gauges shown on Table 1 were in operation in 1948 so that the Nicola River 1948 flood magnitude is not known.

Table 3, provides a comparison of the 1948 high water level as measured from C.P.R. bridges over the Nicola River and the 1:200 year calculated flood levels. The 1948 flood level is approximately equivalent to the calculated 1:200 year flood level.

6.4.4 Winter Flood Levels

As stated in Section 5.1, peak flows in the study area normally occur in the April to June period. Table 1 indicates that the highest recorded flood occurred in December of 1980 on the Coldwater River.

Information provided by Ministry staff from Region 1 (Southern Interior) in Kamloops (Appendix 1.19) indicated 3 stable ice jam locations which occurred in 1984 on the Nicola River. The flooded areas resulting from the 3 winter ice jams were located on the right bank at X-Sections 154, 165, 173 and 174 shown on Drawing 87-22-10 to 87-22-12. Backwater at the upstream and downstream jam sites is estimated to have been about 1 metre above bank top, while it was less than that at the middle jam site. Accurate water levels were not obtained.

A comparison of bank elevations (Table 4) with the designated flood level (freeboard included) indicates that the 1984 ice jam flood levels were approximately equal to the designated flood levels at the cross sections noted above.

Damage was caused by ice jams to highway bridges and fill slopes in 1984 (Appendix 1.20). Reports of damage to bridge structures in the floodplain mapping study area include the Gavelin Bridge on the Sunshine Valley Road just off Highway 8, 12 miles west of Merritt; the Canford Bridge on Petit Creek

Road, just off Highway 8, 19 kilometres west of Merritt and the Curnow Bridge on Highway 8, 2 kilometres east of Spences Bridge.

On Highway 8, 23 kilometers west of Merritt, a 1984 ice jam redirected the flow up against a normally stable fill slope and undermined the roadway shoulder.

Net cost of flood repair from the four above noted areas amounted to over 27,000 dollars. Discussion with Ministry of Highways staff in Merritt indicated that winter ice jam flood damages of this nature are not uncommon.

6.5 Nicola Lake Designated Flood Level

The former Nicola Lake flood construction level (freeboard included) adopted by the Ministry of Environment in January, 1975, was equal to 627.9 metres (Appendix 1.21).

As indicated on Section 5.2, studies in connection with the new dam operating plan determined a 1:200 year flood level of 626.9 metres for Nicola Lake, assuming a 25% error in flood forecasting, a situation which may happen in reality.

A wave and wind set up study was undertaken in February of 1988 by the Special Projects Section (Appendix 1.23) to determine the meteorological effects on lake level elevations. For a 60 kilometres per hour wind, the wave runup and wind setup for Nicola Lake was determined to be a maximum of 1.3 metres along the shoreline in areas over which waves can travel unobstructed. A freeboard allowance of 1 metre is deemed adequate for buildings setback a minimum of 15 metres from the natural boundary of the Lake.

The designated flood level for Nicola Lake based on these studies is a matter of judgement. There are a total of about 40 waterfront homes around the lake (Appendix 1.22). Consideration should be given to administrative practicality with respect to previous decisions regarding floodproofing requirements along the lakeshore lands. In addition, cognizance should be given to operational concerns related to the need to restrict lake outflows during the time in which the uncontrolled Coldwater River flood peak passes through Merritt. Published data (Appendix 1.8 and 1.9) indicates that the annual peak lake levels may coincide with annual peak flows on the Coldwater River.

It is recommended that a designated flood level of 627.9 metres be retained for administrative purposes. Assuming a 1:200 year lake level of 626.9 metres (25% error in flood forecasting), a freeboard of 1.0 metre will meet the operational concerns and meteorological effects noted above.

6.6 Sensitivity Studies

Calculations were undertaken to indicate the sensitivity of the model to flood level increases resulting from flows which exceed the 1:200 year estimates and to increases in Manning's "n" values over the values used in the model.

6.6.1 Nicola River - Spences Bridge to Canford

This reach is 47 km in length and has an average gradient varying from 0.70% from XS-1 to XS-60 and 0.49% from XS-61 to XS-127. Flood levels rise an average of 0.36 metres when the flow magnitude increases above the 1:200 year daily flow by approximately 33% (i.e. to the 1:200 year instantaneous flow). Photo 6 is a view of the Nicola River, downstream of Canford.

An increase in flow of approximately 55% above the 1:200 year daily flow (i.e. 20% above the 1:200 year instantaneous flow) results in an average increase in flood level of 0.62 metres in this reach. The designated flood level is exceeded in 44 of the 127 X-sections by an average of 0.05 metres.

Using the 1:200 year daily flow, a study was carried out to determine the effect of an increase on Manning's "n" values on flood levels. An increase in "n" value of 20% results in an average flood level increase of 0.22 metres and the designated flood level is not exceeded. An increase in "n" values of 40% results in the designated flood level being exceeded in only 3 of the 127 X-sections; the level increase averaged less than 0.6 metres in this reach.

6.6.2 Nicola River - Canford to Merritt and Coldwater River at Merritt

Sensitivity studies of the above noted reach of the Nicola River and of the Coldwater River at Merritt indicate a similar order of magnitude as outlined in Section 6.6.1 with respect to increased flood levels with increased flow and Manning's "n" values. Photos 4 and 5 provide a view of the Coldwater and the Nicola Rivers in this portion of the study area.

6.6.3 Nicola River - Coldwater River Confluence to Nicola Lake

As stated in Section 5.2, the 1:20 year and 1:200 year flows for this reach adopted for the floodplain mapping study was 70 m^3/sec and 93 m^3/sec, respectively.

Studies indicated that an increase in flow of 40% above the 1:200 year daily flow results in an average increase of 0.35 metres in flood levels in this reach. An increase in Manning's "n" value of 40% results in an average flood level increase of 0.36 metres.

Photo 2 provides a view of the Nicola River and Photo 3 shows a floodproofed home in the Merritt area.

7. Floodplain Mapping

7.1 General

The flood levels determined in the study were used to locate the designated floodplain limits onto the existing contour mapping in the study area. The location of river cross sections, designated floodplain limits, flood levels, survey monuments and a note with respect to 1984 winter ice jam flooding (Section 6.4.4) is included on the Drawings.

A field trip was made on September 22, 1987 (Appendix 1.24) and March 12, 1988 to verify the floodplain boundary shown on Sheets 1 to 15 by visual observations.

Sheets 1 to 9 have a contour interval of 2 metres; Sheets 9 to 15 have a contour interval of 1 metre. Comparison of river cross sections with existing 2 metre contour mapping during the course of the office studies indicated errors in the mapping from Sheets 12 to 15. The 2 metre mapping was subsequently replaced by 1 metre contour mapping by the Surveys and Mapping Branch from Sheets 9 to 15.

Experience indicates that floodplain limits based on 2 metre contour mapping is conservative (i.e. the floodplain is generally wider than would be the case for 1 metre contour mapping). The calculated flood levels, based on river cross sections obtained by ground surveys which frequently extend beyond the river banks, would not be significantly affected by more detailed mapping data in the overbank areas.

7.2 Nicola River - Spences Bridge to Canford (Sheets 1 to 8)

The floodplain limits and flood levels of the Thompson River are indicated on Sheet 1 based on the available information concerning flows and flood levels outlined in Section 6.4.2. Flood levels on the Thompson River have a backwater effect to just upstream of X-Section 6 on the Nicola River.

The floodplain is narrow in the lower reach of the Nicola River, averaging approximately 90 metres in width on Sheets 1 to 4 where the gradient averages 0.70%. The floodplain widens to average approximately 230 metres in width on Sheets 5 to 8 where the gradient averages 0.49%.

7.3 Nicola and Coldwater Rivers - Canford to Merritt (Sheets 9 to 13)

The report by McMullen (Appendix 1.3) identified the Spius Creek alluvial fan and indicated historic channel locations (1874, 1948 and present day) in the fan area. Profile studies based on the available channel cross sections on Spius Creek (Section 4) indicate that the banks would be overtopped at several locations in the study area.

The limits of the Spius Creek alluvial fan are shown in Sheet 9. As noted, the fan is subject to special flood hazards due to possible channel avulsion and erosion caused by channel accretion and/or debris jamming.

The Spius Creek average gradient of 1.1% (Figure 5) is considerably steeper and average channel velocities are higher than the Nicola River upstream of the Spius Creek confluence. In this reach the Nicola River gradient averages 0.38%.

The Nicola River floodplain averages approximately 380 metres in width between the confluence of Spius Creek and the Coldwater River confluence. The average floodplain width measures from 290 metres (Sheet 9) to 630 metres (Sheet 12).

The Coldwater River floodplain averages 280 metres in width in the study area. Granular fill berms (See Photo 4) have been constructed over the years along the banks of the Coldwater River (Appendix 1.26) and are shown on Sheet 13. The berms are overgrown with trees and generally have very limited erosion protection.

7.4 Nicola River - Coldwater River Confluence to Nicola Lake - (Sheets 13 to 15)

This 26 kilometre reach varies in slope from 0.18% near the vicinity of the confluence with the Coldwater River to 0.05% as shown in Figure 6. As indicated on Drawing 87-22, Sheets 12 to 15, the floodplain of the Nicola River between Nicola Lake and the confluence of the Coldwater River averages 440 metres in width.

8. Conclusions

1. This design brief presents an overview of the studies undertaken to produce floodplain mapping for the Nicola River from Spences Bridge to Nicola Lake and of the Coldwater River at Merritt.

2. Floodplain Mapping Sheets 1 to 9 are based on 2 metre contour intervals.

3. Floodplain Mapping Sheets 9 to 15 are based on 1 metre contour intervals.

9. Recommendations

1. Under the terms of the Federal Provincial Floodplain Mapping Agreement, it is recommended that the floodplain shown on Drawing 87-22, Sheets 1 to 9 be interim designated (2 metre contour interval) and on Sheets 9 to 15 be designated (1 metre contour interval).

2. The floodplain mapping of the Nicola River may be used for administrative and planning purposes related to the preparation of hazard map schedules for official plans (Municipal Act, Section 711 and 810); the designation of floodplains in bylaws and the preparation of floodplain management plans (Municipal Act, Section 969); the administration of floodproofing requirements established by bylaws; and the identification of floodable land by subdivision approving officers (Land Title Act, Section 82(1)).

3. Highwater mark data should be obtained to verify the existing floodplain mapping when significant floods (including winter ice jam events) occur in the future in the study area.

4. The river corridor study (Appendix 1.3) should be updated taking cognizance of the new information available as a result of this floodplain mapping study.

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DETAILED INFORMATION SOURCES

NO.	SOURCE	CONTENTS
1.1	Atlas of British Columbia, U.B.C. Press W.R. 912.711 F231C.4	General information on the people, environment and resource use.
1.2	"Nicola Basin Strategic Plan Summary Document", July 1983, Planning and Assessment Branch and Thompson-Nicola Region. Ministry of Environment & Parks.	Purpose is to provide the Ministry with an organized information system in the allocation and management of the environmental resource.
1.3	"Nicola River Study River Corridor" dated June 1983 by B.R.W. McMullen, P. Eng., File: P75-21, Water Management Branch, Ministry of Environment & Parks.	The river corridor zone of probable erosional activity of the Nicola River from Spences Bridge to Nicola Lake is delineated.
1.4	Ministry of Environment & Parks, Surveys and Resource Mapping Branch, Project No. 82-059T and 86-034T. 2 metre contour mapping issued in May, 1983; 1 metre contour mapping issued in March, 1988.	Topographic base mapping, 1:5000 scale, 2 metre contours from Spences Bridge to Canford and 1 metre contours from Canford to Nicola Lake.
1.5	Ministry of Environment & Parks, Water Management Branch, Surveys Section, Project Number 74-F-1-B dated September, 1976; Project Number 80-RPP-2, July to October, 1980. Project Number 84-RPP-14, August, 1984.	285 cross sections in the study area, bridge details, photographs of river cross sections.
1.6	Hydrology Section, Water Investigations Branch, Ministry of Environment & Parks, "Nicola River Peak Flow" dated Dec. 15, 1986. File S2105, Project 233.	Peak flow estimates for the study area based on updated Regional Study (Appendix 1.7)
1.7	"Regional Hydrology Study for the Nicola Basin", Hydrology Section, February 15, 1984, File: S2107.	Regional hydrology study for the Nicola Basin.

NO.	SOURCE	CONTENTS
1.8	"Historical Streamflow Summary British Columbia to 1984", Environment Canada, Water Survey of Canada.	Published summary of historic streamflow data.
1.9	"Historic Water Levels Summary British Columbia to 1985", Environment Canada, Water Survey of Canada.	Published summary of historic water level data.
1.10	"Nicola Lake Storage Feasibility Study and Preliminary Design", Crippen Consultants, North Vancouver, B.C., 1982.	Study prepared for Water Management Branch, Ministry of Environment & Parks.
1.11	"Nicola Lake Dam Operation and Maintenance Manual", Water Supply and Drainage Section, Water Management Branch, Ministry of Environment & Parks, March 31, 1987 File: 0242512-164.	General description of Nicola Lake dam and associated works.
1.12	"Nicola Lake Operating Plan", Modelling Unit, Hydrology Section, Water Management Branch, Ministry of Environment & Parks, February, 1987; File: 0242512-164.	Planned operation of Nicola Lake dam.
1.13	Memo Re: "Nicola Lake Levels" to R.W. Nichols from R.Y. McNeil, Modelling Unit, Hydrology Section, Water Management Branch dated December 24, 1986, File: S5111.	Results of modelling studies in connection with the operation of Nicola Lake dam.
1.14	"Nicola Valley H.W.M.'S", Project No. 87-FDC-3, June 1987 by Surveys Section, Water Management Branch, Ministry of Environment & Parks.	Field survey to obtain elevations of May 1, 1987 high water marks in the study area.
1.15	"Nicola River May 1, 1987 Peak Flow Estimates" memo dated June 30, 1987 from C.H. Coulson Hydrology Section. Files: S2105, 02-2500-S.1.	Peak flow estimates for the study area of the May 1, 1987 flow.

NO.	SOURCE	CONTENTS
1.16	U.S. Department of the Interior, Geological Survey Water Supply Paper 1845, "Roughness Characteristics of Natural Channels", by H.H. Barnes, Jr., 1967.	Color photographs and descriptive data for 50 stream channels and selected overbank areas for which roughness co-efficients have been determined.
1.17	Letter to F. Danks, Special Projects Section, from A.M. Wilson, C.P. Rail dated May 27, 1987 regarding CPR H.W.M.	1948 flood levels indicated as the highest levels on record at a number of CP Rail bridges on the Nicola River.
1.18	Report entitled "Flood Frequencies on the Fraser Basin" by R. Wyman. Hydrology Section, dated May 24, 1985.	Covering memo dated June 8, 1985 from R. McNeil, File 0323545.
1.19	Memo to P.J. Woods, Head, Special Projects Section from P.F. Doyle, Head, Engineer Section, Kamloops dated June 19, 1987. File SS.4807.	1984 ice jam observations.
1.20	Report entitled "Flood Emergency (1984)" Ministry of Highways and Transportation by D.L. Byers, P. Eng., District Highways Manager.	Outlines erosion and flooding problems related to ice jams during 1984.
1.21	Memo from H. I. Hunter, Hydrology Division, to J. D. Watts, Planning and Surveys Division, Water Management Branch dated January 23, 1975. File: 0305030-29.	1:200 year flood level determined for Nicola Lake.
1.22	"Notes From Nicola Lake Boat Trip". File: 0242512-164, April 12, 1983 by L. Bergman, P.Eng., Water Supply Section, Water Management Branch.	Outlines storage water license requirements related to proposed dam on Nicola Lake.

NO.	SOURCE	CONTENTS
1.23	Memo on "Wind Setup and Wave Runup Study of Nicola Lake" by B. J. Holden, P. Eng., Special Projects Section, February 1988, File: 02-2500-S.2.	Study of wind setup and wave runup.
1.24	Memo to file: 02-2500-S.1 dated September 1987, "Field Trip to Verify Floodplain Boundary by Visual Observations", by R. W. Nichols, P.Eng.	Review of floodplain boundary, Sheets 1 to 8.
1.25	"Nicola and Coldwater River Erosion and Flooding Study", November, 1967 by J. H. Doughty-Davies, P.Eng., Water Management Branch; File: 0262862.	Studies related to flood damage prevention in the Merritt area.
1.26	"Merritt and Area Flood Reduction Study" by B.R.W. McMullen, P.Eng., File: P72-11, dated June, 1985.	Studies related to flood damage prevention works in the Merritt area.

APPENDIX 2

INDEX TO PHOTOS

NICOLA RIVER FLOODPLAIN MAPPING STUDY

Photo Sheet Number	Photo Number	Drwg 87-22 Sheet No.	Description
1	1	15	Nicola Lake Dam, looking upstream, May 5, 1987.
1	2	13	Nicola River from XS-26, looking southwest towards Merritt, May 5, 1987.
2	3	13	Floodproofed home on Nicola River floodplain in Merritt, downstream of XS-22, May 4, 1987.
2	4	13	Coldwater River looking towards right bank berm at XS-32, May 5, 1987.
3	5	11	Nicola River at XS-171, looking downstream.
3	6	8	Nicola River near XS-125, looking downstream from left (south) bank.

APPENDIX 2 Photo Sheet 1 of 3

PHOTOS OF STUDY AREA

NICOLA RIVER FLOODPLAIN MAPPING STUDY

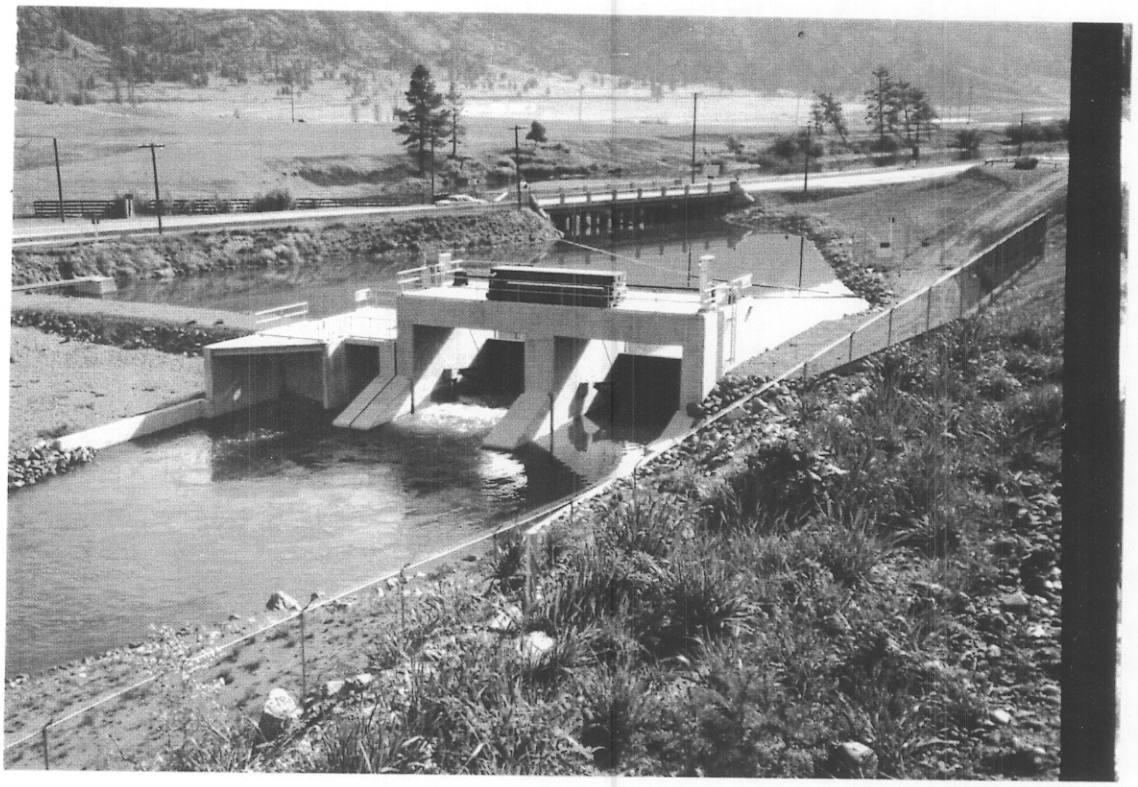


Photo 1

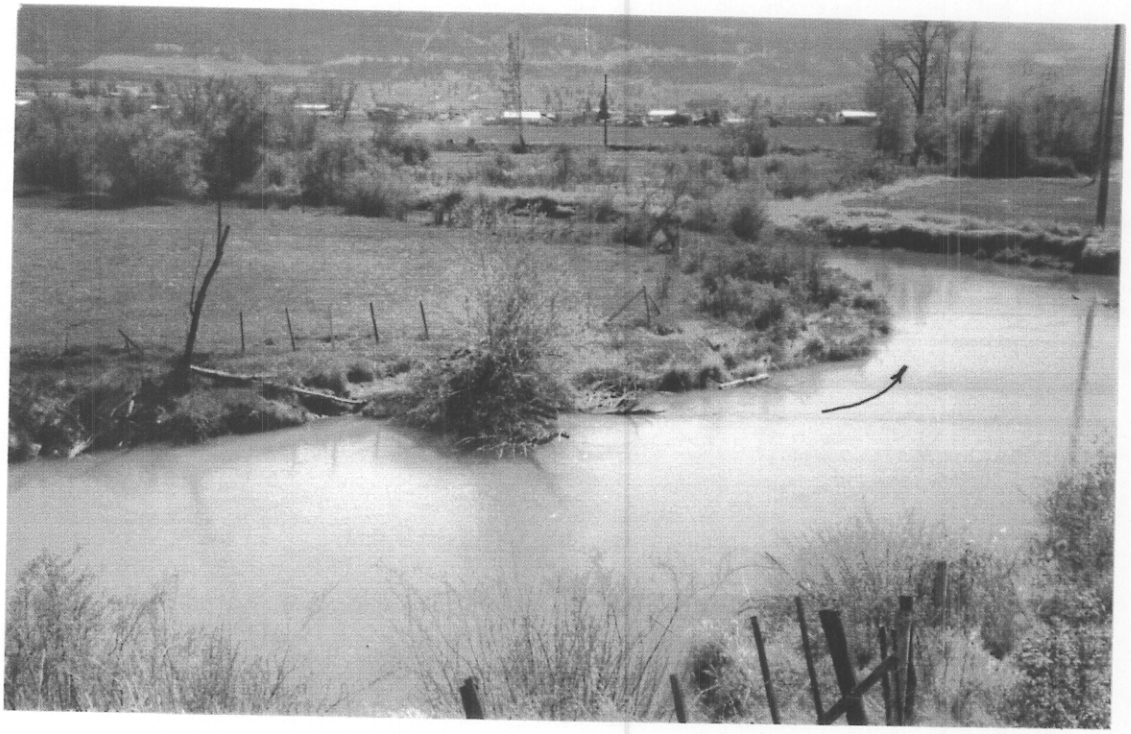


Photo 2

APPENDIX 2 Photo Sheet 2 of 3

PHOTOS OF STUDY AREA

NICOLA RIVER FLOODPLAIN MAPPING STUDY

Photo 3

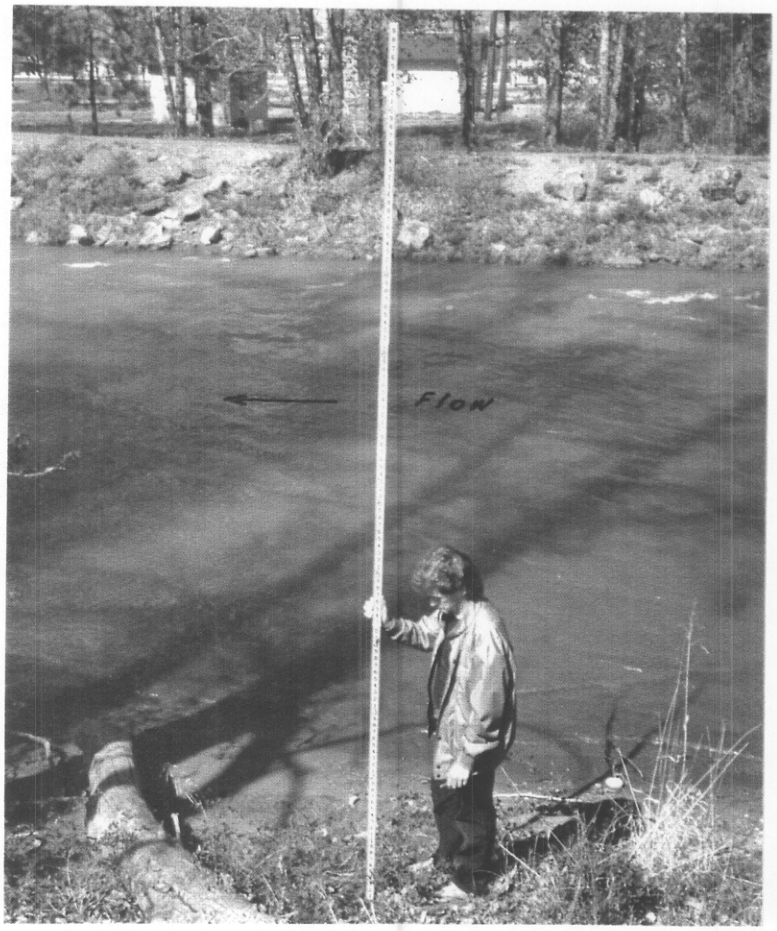


Photo 4

PHOTOS OF STUDY AREA

NICOLA RIVER FLOODPLAIN MAPPING STUDY

Photo 5

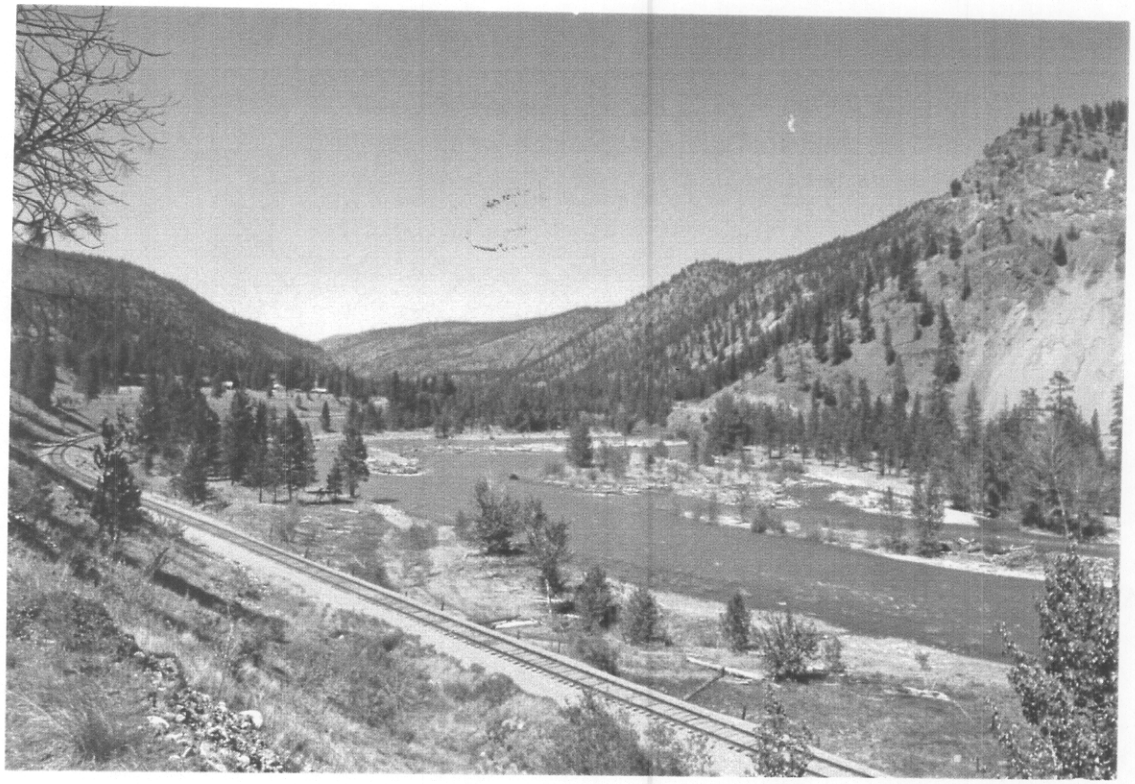
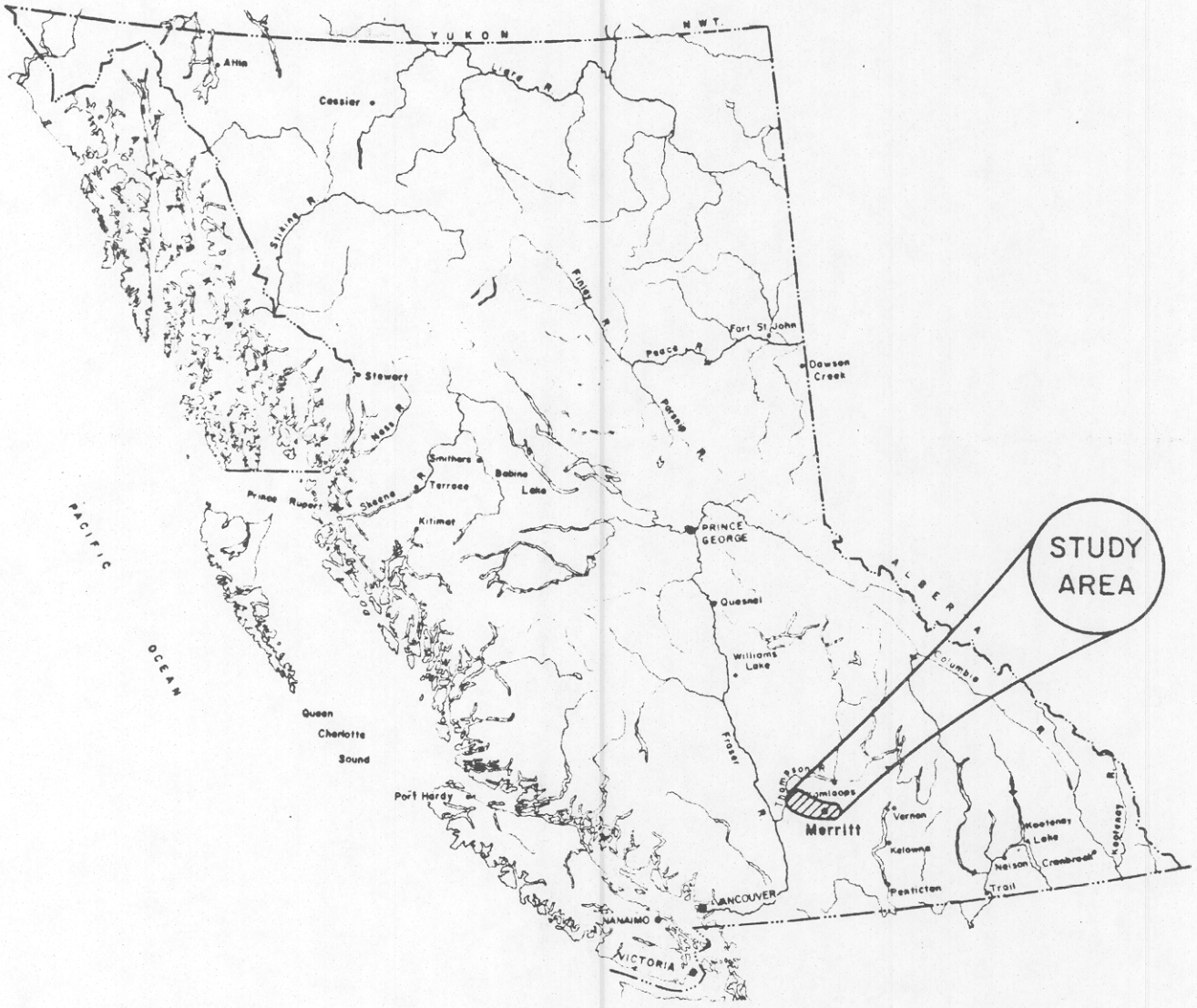


Photo 6



STUDY AREA LOCATION

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

FLOODPLAIN MAPPING STUDY
NICOLA RIVER

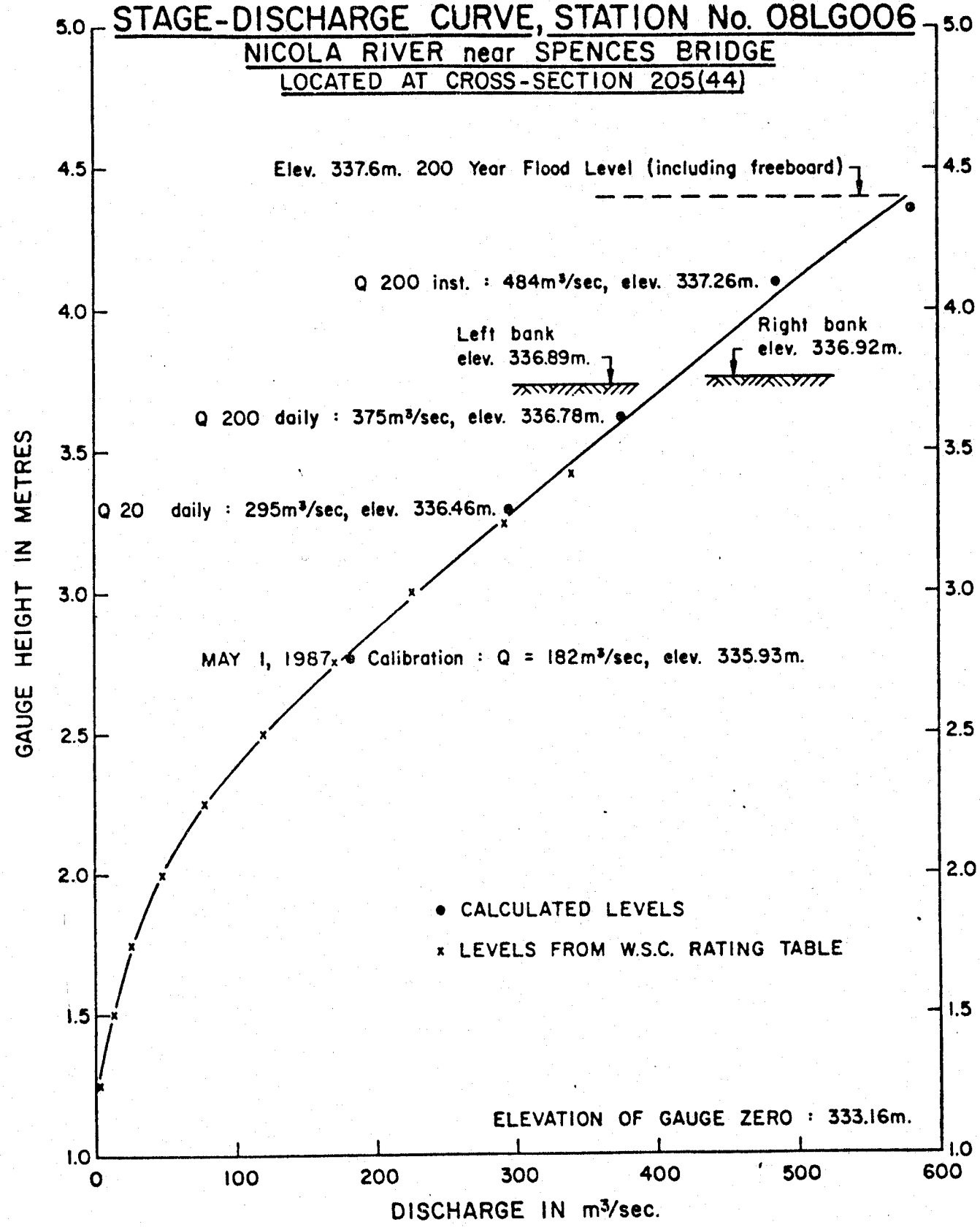
SCALE: VERT.		DATE	R. W. NICHOLS, ENGINEER
HOR.	AS SHOWN	JULY, 1988	FILE No. 02-2500-S.1 FIG. No. 1

BCIL 7673-M E

STAGE-DISCHARGE CURVE, STATION No. 08LG006

NICOLA RIVER near SPENCES BRIDGE

LOCATED AT CROSS-SECTION 205(44)



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

FLOODPLAIN MAPPING STUDY
NICOLA RIVER

SCALE: VERT. AS SHOWN
HOR. AS SHOWN

DATE
JULY, 1988

R. W. NICHOLS ENGINEER

FILE No. 02-2500-S.1 FIG. No. 7

BCIL 7673-M E

TABLE 1

HISTORICAL STREAMFLOW SUMMARY

Watercourse	W.S.C. Gauge	Years of Record (to 1984)	No. of Times Recorded Peak In April to June Period	Maximum Recorded Annual Daily Flow		1:200 Year (1) Estimated Flow	
				m^3/s	Date	D. m^3/s	I. m^3/s
Nicola River	08LG006	36 (1912 to 1920; 1957 to 1984)	34	337	May 13/71	375	484
Spius Creek	08LG008	21 (1914;1915;1917 to 1920; 1971 to 1984)	20	165	May 13/71	200	320
Guichon Creek	08LG004	31 (1912;1922 to 1928; 1961 to 1984)	30	27	May 11/69	38	42
Nicola River	08LG007	30 (1912 to 1915; 1957 to 1984)	29	161	June 3/67	172	237
Coldwater R.	08LG010	32 (1913 to 1921; 1961 to 1984)	29	122	Dec.27/80	135	212

(1) See Table (2)

Reference: Appendix 1.8

TABLE 2

SUMMARY OF PEAK FLOW ESTIMATES

SITE	LOCATION	DRAINAGE AREA	MAXIMUM DAILY DISCHARGE				MAXIMUM INSTANTANEOUS TO DAILY DISCHARGE RATIO	MAXIMUM INSTANTANEOUS DISCHARGE	
			20-year		200-year			20-year	200-year
		km^2	$L/s/km^2$	m^3/s	$L/s/km^2$	m^3/s		m^3/s	m^3/s
1	Nicola R. at mouth	7670	39	300	49	380	1.3	390	490
2	Nicola R. at 08LG006	7280(1) 7670	39.1	295	49.7	375	1.29	381	484
3	Nicola R. below Spius Cr.	6484	37	240	47	300	1.4	340	420
4	Spius Cr. at mouth	781	190	150	260	200	1.6	240	320
5	Spius Cr. at 08LG008	780	189	147	258	201	1.59	234	320
6	Nicola R. above Spius Cr.	5703	26	150	32	180	1.4	210	250
7	Nicola R. below Guichon Cr	5580	26	150	32	180	1.4	200	250
8	Guichon Cr. at mouth	1230	22	27	31	38	1.1	30	42
9	Guichon Cr. at 08LG004	1230	22.1	27.2	31.0	38.2	1.1	30	42
10	Nicola R. above Guichon Cr	4350	32	140	39	170	1.4	200	240
11	Nicola R. at 08LG007	4350	32.5	141	39.4	172	1.38	195	237
12	Nicola R.below Coldwater R.	4233	32.8	140	39.6	170	1.4	190	230
13	Coldwater R. at mouth	914	117	110	148	140	1.6	170	220
14	Coldwater R. at 08LG010	914	117	107	148	135	1.57	168	212
15	Nicola R. below Nicola L.	2900(2)	--	70.0(3)	--	93.0(3)	--	--	--

(1) Station relocated in 1974, use 7540 km^2.
(2) 08LG013 and 08LG065, respectively, use 2920 km^2.
(3) Based on new dam operating plan (Section 5.2)

TABLE 3

1948 Flood Levels

CPR Bridge Location			Levels (m)			
CPR Mileage	Floodplain Mapping Drawing No.	River Cross Section No.	Measured by CPR (3)	Calculateed 1:200 Year		Designated Flood Level (freeboard included)
				D	I	
169.7	87-22-3	35/36*	311.6	311.7 (+0.1)	312.1	312.4(1)
163.4	87-22-5	65/66*	395.0	395.6 (+0.6)	396.0	396.3(1)
159.8	87-22-6	87/88	427.6	427.4 (-0.2)	427.9	428.0(1)
156.5	87-22-7	103/104*	453.3	452.8 (-0.5)	453.1	453.4(1)(2)
149.4	87-22-9	138/139*	518.8	518.6 (-0.2)	519.1	519.4(1)
147.1	87-22-10	149/150*	534.3	534.2 (-0.1)	534.5	534.8(1)(2)
144.2	87-22-11	163/164*	557.4	557.5 (+0.1)	557.8	558.1(1)(2)

(1) Instantaneous +0.3 m.
(2) Daily +0.6 m.

*Calibrated to May 1, 1987 observed levels

(3) Reference: Appendix 1.17

TABLE 4

Bank Elevations and Flood Levels at
1984 Ice Jam Locations
Nicola River Downstream of Merritt

Location of 1984 Ice Jam Site	River Cross Section	Right Bank Elevation (m)	Designated Flood Level (freeboard included) (m)	Difference* (m)
downstream site	154	541.5	542.3	0.8
middle site	165	557.3	558.3	1.0
upstream site	173	575.5	576.5	1.0
	174	577.9	578.3	0.4

*1984 maximum backwater from ice jams were approximately 1 metre above bank top elevations (See Section 6.4.4)

Reference: Appendix 1.19

APPENDIX 3

FLOODPLAIN MAPPING, NICOLA RIVER
DRAWING NO. 87 - 22
SHEETS 1 to 15