FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT

PROVINCE OF BRITISH COLUMBIA
Ministry of Environment
Water Management Branch

A DESIGN BRIEF ON THE

Floodplain Mapping Study

Lakelse River and Lake

An Overview of the Study Undertaken
to Produce Floodplain Mapping for
Lakelse River and Lake

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Victoria, British Columbia
August, 1989

File: 42-0001-S.1

TABLE OF CONTENTS

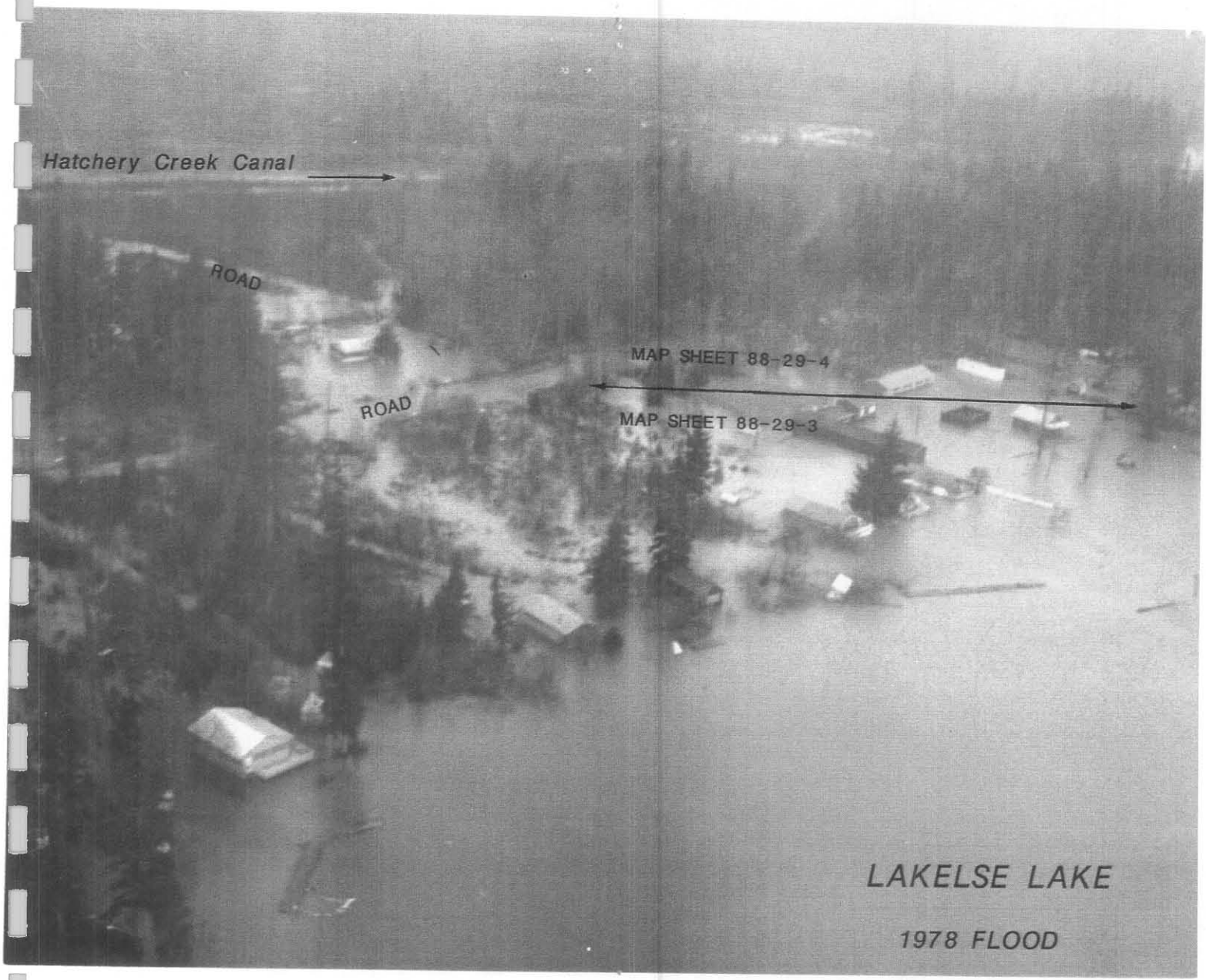
Title Page i
Table of Contents ii
Cover Photo 1978 Flood iii
Preface. 1
1. Location. 1
2. Background. 1
2.1 General 1
2.2 Present Studies 3
3. Flood Magnitudes 3
3.1 Lakelse Lake Peak Flows 3
3.2 Lakelse Lake Inflow Hydrographs 3
3.3 Flood Routing (Previous Studies). 4
4. Lakelse River and Lake (1989 Studies). 4
4.1 General 4
4.2 Calibration of River Model. 5
4.3 Stage-Discharge 5
4.4 Flood Routing 5
4.4.1 General. 5
4.4.2 Sensitivity Analysis 6
4.4.3 Lakelse Lake Flood Level 7
4.5 Lakelse River Flood Profile Study 7
4.5.1 General. 7
4.5.2 Sensitivity Analysis 7
5. Floodplain Mapping 8
5.1 General 8
5.2 Tributary Alluvial Fans. 8
6. Recommendations 9

Figures and Tables

Figure 1 - Study Area Location
Figure 2 - Key Map
Figure 3 - 1:200 year Flood Routing Lakelse Lake
Figure 4 - Lakelse River at Lakelse Lake Outlet, Plan Showing Cross Section Location, Thalweg Profile, and 1:200 Year Flood Construction Level (freeboard included)

Appendices

Appendix 1 - Detailed Information Sources
Appendix 2 - Photos of 1978 Flood, Lakelse Lake
Appendix 3 - Lakelse River Cross Sections at Herman Creek Fan 1979 and 1988
Appendix 4 - Floodplain Mapping - Lakelse River and Lake, Dwg No. 88-29, Sheets 1 to 6


Hatchery Creek Canal
ROAD
ROAD
MAP SHEET 88-29-4
MAP SHEET 88-29-3
LAKELSE LAKE
1978 FLOOD

FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT

FLOODPLAIN MAPPING STUDY

LAKELSE RIVER AND LAKE

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 floodplain for Lakelse River and Lake, Drawings 88-29, Sheets 1 to 6, Appendix 4.

1. Location

The study area is located (Figure 1) approximately 15 km south of Terrace, in the Coast Mountain System, one of the six main physiographic regions of the Province. Mean annual precipitation in the study area exceeds 250 cms (Appendix 1.1).

Lakelse Lake is located west of Highway 37 which connects Terrace and Kitimat in the Regional District of Kitimat-Stikine. Figure 2 is a key map which shows the location of the 6 floodplain mapping sheets produced for the study area.

2. Background

2.1 General

Lakelse Lake, at normal (mean) lake levels, has a surface area of approximately 14.3 km^2 and a total drainage basin of nearly 400 km^2. Major inflows are provided by Williams Creek and Schulbuckhand Creek with Hatchery and Furlong Creeks contributing to a lesser extent. Outflows are conveyed by Lakelse River into the Skeena River.

Major flooding events generally occur in the fall after the initial snowfall. Warming trends introduced by heavy rainstorms raise the freezing level melting the snowpack and result in a sharp rise in lake levels.

Staff of the Regional District of Kitimat-Stikine obtained information with respect to historic flood levels of Lakelse Lake (Appendix 1.2) in the summer of 1974 as part of a documentation of flood data within the Skeena River watershed. Data for the floods which occurred in 1935, 1958 and 1965 are contained in the documentation.

The Ministry adopted a 1:200 year flood level (freeboard included) for Lakelse Lake of 75.0 m G.S.C. datum in August of

1975, based on information available at that time. This level has since been utilized in floodproofing requirements related to the Provincial Flood Damage Reduction Program.

High levels were again experienced in November 1978 on Lakelse Lake. A report entitled "1978 Terrace Area Flooding" (Appendix 1.3) documents this flood event. The report states that Lakelse Lake is a shallow warm water recreational lake surrounded by two private resorts, about 75 private homes and 175 summer cottages.

During the November 1978 flood, the lake level increased within 3 days from a normal elevation of approximately 71.5 metres to 74.2 metres by November 2. Approximately 60% of the homes and cottages around the lake were flooded. Appendix 2 provides photos of the 1978 flood event at Lakelse Lake.

A report entitled "Lakelse Lake Flooding Preliminary Study" (Appendix 1.4) was completed by the Special Projects Section in January 1988. This study examined the effect of changes of the Lakelse River bed at Herman Creek fan on lake flood levels. The study utilized 1979 river survey data and 1:5000 scale, 1 metre contour mapping (Appendix 1.5). Peak lake levels are as follows:

	Year	Elevation (1)	Rainfall (2)	Source
	1935	74.4 m	-	Appendix 1.2
	1958	73.7 m	-	Appendix 1.2
	1965	73.2 m	-	Appendix 1.2
Nov. 2	1978	74.2 m	212.3 mm	Appendix 1.4
Sept. 21	1987	73.3 m	162.6 mm	Appendix 1.4

(1) Designated Flood level adopted in August 1975 = 75.0 m.
(2) Total three day rainfall at Terrace Airport.

The report concluded that maximum lake levels are relatively insensitive to minor accretion or excavation of the bed of Lakelse River at the Herman Creek confluence. It was recommended that Lakelse River be resurveyed to monitor the rate of bed change since the 1979 survey. Metering of the lake outlet was also recommended to assist in confirming the outlet rating curve.

As background information to the 1988 report, the hydrology of the Lakelse Lake system was analysed by the Water Management Branch (Appendix 1.6).

2.2 Present Studies

The studies undertaken to produce floodplain mapping for the Lakelse Lake area utilized the information as outlined in Section 2.1 and listed in Appendix 1. In addition, the river cross section and discharge data obtained by the Water Management Branch in 1988, Project 88-FDC-3, was utilized in this study (Appendix 1.7).

3. Flood Magnitudes

3.1 Lakelse Lake Peak Inflows

The study by the Hydrology Section (Appendix 1.6) determined peak inflows into Lakelse Lake. A preliminary flood routing study was also undertaken by the Hydrology Section based on a 1954 stage-discharge relationship for Gauge 8EG007 on Lakelse River.

Gauge 8EG007 was operated on a seasonal basis from 1948 to 1950 and 1954 to 1955; no high peak flows were measured. The nearby gauged watershed, Zymagotitz River (8EG011) has good peak flow records (27 years of data to 1986) and a watershed size similar to Lakelse River.

Flow data from the Zymagotitz gauge was used to estimate inflows to Lakelse Lake taking into account differences in basin size and shape. Frequency analysis was carried out on the annual maximum instantaneous discharge for the Zymagotitz River. The resulting estimate values for the inflow to Lakelse Lake, based on the Pearson III distribution are as follow:

Return Period (Years)	Maximum Inflows to Lakelse (cms)
20	603
200	838
1000	986

3.2 Lakelse Lake Inflow Hydrographs

Based on the data available in the Terrace-Kitimat area concerning the flood of November 1978, including the hydrographs available for the Zymagotitz River, the 1978 inflow hydrograph for Lakelse River was estimated. A peak inflow of 716 cms was determined with a return period of about 70 years.

The results that were obtained are summarized as follows:

Condition	Date	Time	Inflow (cms)
Storm begins	78/10/30	1600	14
First Inflow peak	78/10/31	1600	230
Max. Inflow	78/11/01	2200	716
Max. Outflow	78/11/02	0800	258
Recession	78/11/02	2400	127
Recession	78/11/03	2400	44

To produce the 200 year peak inflow hydrograph for Lakelse Lake with a peak of 838 cms, a factor of 1.40 was applied to the base inflow hydrograph resulting in a 1:200 year inflow as indicated in Figure 3.

3.3 Flood Routing (Previous Studies)

Preliminary food routing studies to confirm the observed flood levels that occurred using the estimated 1978 flood inflow hydrograph to Lakelse Lake were undertaken by the Hydrology Section. The flood routing was based on the old stage discharge data for Gauge 8EG007. Storage volume information based on the 1 metre contour, 1:5000 scale mapping, was provided by the Special Projects Section.

Further flood routing studies based on 1979 river survey information to provide a stage-discharge relationship at the lake outlet (Appendix 1.4 and 1.8) confirmed the 1978 observed levels using the estimated 1978 inflow hydrograph provided by the Hydrology Section (Section 3.2).

4. Lakelse River and Lake (1989 Studies)

4.1 General

Figure 4 is a reduction of Drawing 89-2-1 showing the location of the 31 river cross sections obtained in 1988 along Lakelse River, a distance of 5.1 km downstream of the lake outlet. Also shown are water level and thalweg profiles of the area. The May 18, 1988 water level profile was metered and amounted to 28.3 cms.

The HEC-2 Water Surface Profile Computer Program and the HEC-1 Flood Routing Program developed by the Hydrologic Engineering Centre, U.S. Army Corp of Engineers, was utilized in the 1989 studies. The profile calculations, which assumed open channel conditions, were used to determine the 1:200 year flood levels for Lakelse River and to provide information on the stage-discharge relationship at the lake outlet required for the flood routing calculation.

A comparison of survey data at 5 cross section locations on Lakelse River in the vicinity of the Herman Creek Fan obtained during the river surveys conducted in 1979 and 1988 is shown on Appendix 3. The drawing indicates that only minor accretion or degradation of the bed of Lakelse River in this area has occurred during the 9 year period.

4.2 Calibration of River Model

A computer plot of the river cross sections was obtained to assess the river cross section data input and the extensions of the sections obtained from the existing topographic mapping in the study area. Output from the plot run was also used to review the flow regime, loss coefficients, reach lengths, overbank information and relative Manning's "n" values.

Based on the level data obtained at the 31 river cross sections on May 18, 1988, the model was calibrated to average within 0.05 metres of observed levels for the 28.3 cms flow. Channel Manning's "n" values varied between 0.037 to 0.050, averaging approximately 0.040 for the model area.

4.3 Stage-Discharge Relationship at Lake Outlet

Using the calibrated river model, stage-discharge relationship at the lake outlet was determined to be as follows:

Stage (m)	Flow (cms)
72.2	28.3
72.5	50.0
73.4	150.0
74.1	250.0
74.4	300.0
74.6	350.0

4.4 Flood Routing

4.4.1 General

The inflow hydrographs developed by the Hydrology Section, the stage-discharge data listed in Section 4.3 and an elevation-storage curve for Lakelse Lake comprise the basic data required for the HEC-1 flood routing program. The lake storage data was calculated for the 1:5000 scale,

1 metre contour mapping (Appendix 1.4). The lake elevation vs area and storage are as follows:

Elevation (m)	Area ($10^6 m^2$)	Storage ($10^6 dam^3$)
70.8	12.7	0
71.0	13.0	2.6
71.5	13.9	4.5
72.0	14.6	16.4
73.0	17.2	32.3
74.0	20.9	51.4
75.0	23.5	73.6
76.0	24.9	85.7

The results of the flood routing study are outlined below:

Flood Event Frequency	Maximum Inflow(cms)	Maximum Outflow(cms)	Assumed Lake Level at Start(m)	Maximum Lake Level(m)	Comments
1:20 Year	603	182	71.7	73.6	1:20 year event
1:200 Year	838	290	71.7	74.3	1:200 year

Figure 3 indicates in graphical form the flood routing results for a 1:200 year inflow of 838 cms. As shown, the maximum outflow is 290 cms and the storage volume utilized is 60 x 10^6 dam^3 corresponding to a lake elevation of 74.3 metres.

4.4.2 Sensitivity Analysis

Following are the results of flood routing calculations undertaken to determine the lake level which would result from the following assumptions.

	Assumption	Maximum Lake Level(m)	Increase In Lake Level(m)
1.	Base Case (1:200 year)	74.3	0
2.	20% increase in "base case" flood	74.7	0.4
3.	Increase in lake level at start of flood to 1.3 m above "base case" (i.e. starting elevation = 73.0)	74.7	0.4
4.	Decrease in lake outlet capacity (increase river channel Mannings "n" value by 30%)	74.4	0.1

The lake levels resulting from the assumptions noted above are below the existing 1:200 year flood level of 75.0 m (freeboard included) for Lakelse Lake as noted in Section 2.1.

4.4.3 Lakelse Lake Flood Level

The 1:200 year daily flood level of Lakelse Lake has been determined to be 74.3 meters. The maximum recorded lake level based on available information is 74.4 meters (1935, Appendix 1.2).

As stated in Section 2.1, the 1:200 year flood level (including freeboard) established by the Ministry of 75.0 meters is 0.6 meters above the maximum recorded level (1935 to date). The level of 75.0 meters has been utilized under the Flood Damage Prevention Program for administration purposes since August of 1975.

A freeboard of 0.70 meters above the estimated 1:200 year flood level has been provided as an allowance for meteorological effects (wave and wind setup), wave runup impacts and hydrological uncertainties. Wind and wave setup and wave runup effects are site specific, depending on fetch distance, depth of water and wind direction.

Given the above-noted factors, it is recommended that the designated flood level of 75.0 meters be retained for administrative purposes.

4.5 Lakelse River Flood Profile

4.5.1 General

The calibrated river model (Section 4.2) was used to calculate flood levels based on the outflows determined in the flood routing study (Section 4.4).

The 1:200 year flood profile (freeboard included) is shown on Figure 4. In keeping with Ministry practice, a freeboard allowance of 0.6 m was used based on the daily (24 hour) outflow of 275 cms. The 1:20 year flood levels (freeboard included) for Lakelse River were also calculated and are shown on the Floodplain Mapping Sheet Number 6.

4.5.2 Sensitivity Analysis

Sensitivity studies for Lakelse River indicate that an increase in flow of 22% (i.e. to 350 cms) above the daily flow results in an average flood level of approximately 0.3 metres, which is within the freeboard allowance noted above. Similarly, an increase in Manning's "n" value of 30% results in flood level increases which are within the freeboard allowance.

5. Floodplain Mapping

5.1 General

The flood levels determined in the study were used to delineate the floodplain limits onto the existing 1 metre contour mapping of the study area. The floodplain mapping for Lakelse Lake, Drawings 88-29, Sheets 1 to 6 indicates the location of river cross sections and survey monuments, the floodplain limits and the flood levels determined in the study.

5.2 Tributary Alluvial Fans

Several of the tributary alluvial fans in the study area are known to be active based on documented information on flooding problems related to sediment deposition, channel avulsion and bank erosion.

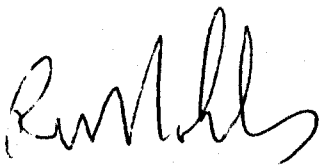
Following is a list of fans noted on the mapping sheets which are known to be active. The limits of these fans have not been delineated due to a lack of detailed topography or limited background study information. These are:

Furlong Creek	- Sheet 2	Appendix 1.3
Hatchery (Granite) Creek	- Sheet 3	Appendix 1.9, 1.3
Herman Creek	- Sheet 6	Appendix 1.3
Williams and Sockeye Creeks	- Sheet 1	Appendix 1.3

6. Recommendations

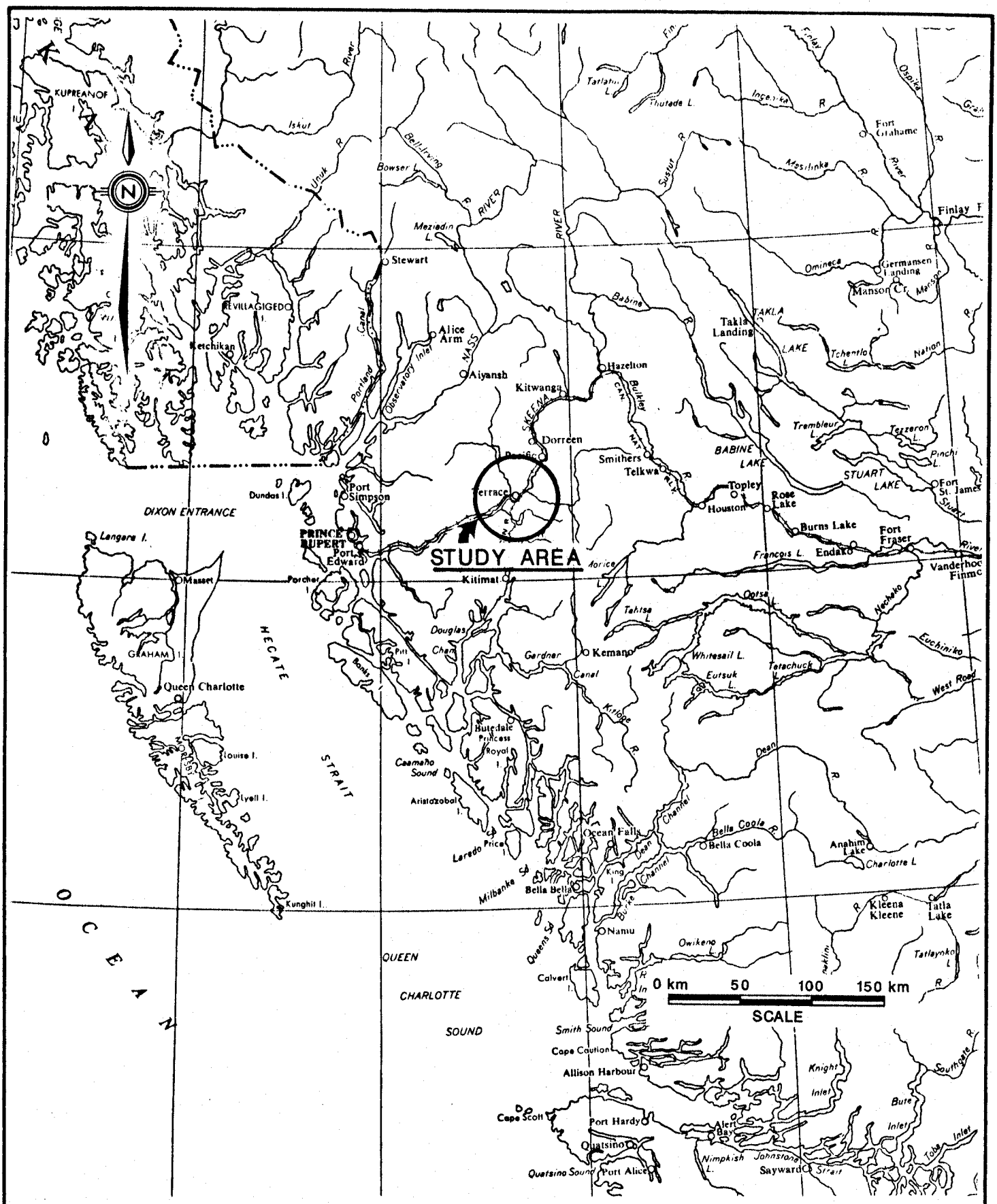
1. Pursuant to the terms of the Federal Provincial Floodplain Mapping Agreement, it is recommended that the floodplain delineated on Drawings 88-29, Sheets 1 to 6, be designated.

2. The floodplain mapping may be used for administrative purposes related to the preparation of hazard map schedule for official plans; floodproofing requirements in zoning and building bylaws; and the identification of floodable lands by Subdivision Approving Officers.



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Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE FLOODPLAIN MAPPING STUDY
LAKELSE LAKE

STUDY AREA LOCATION

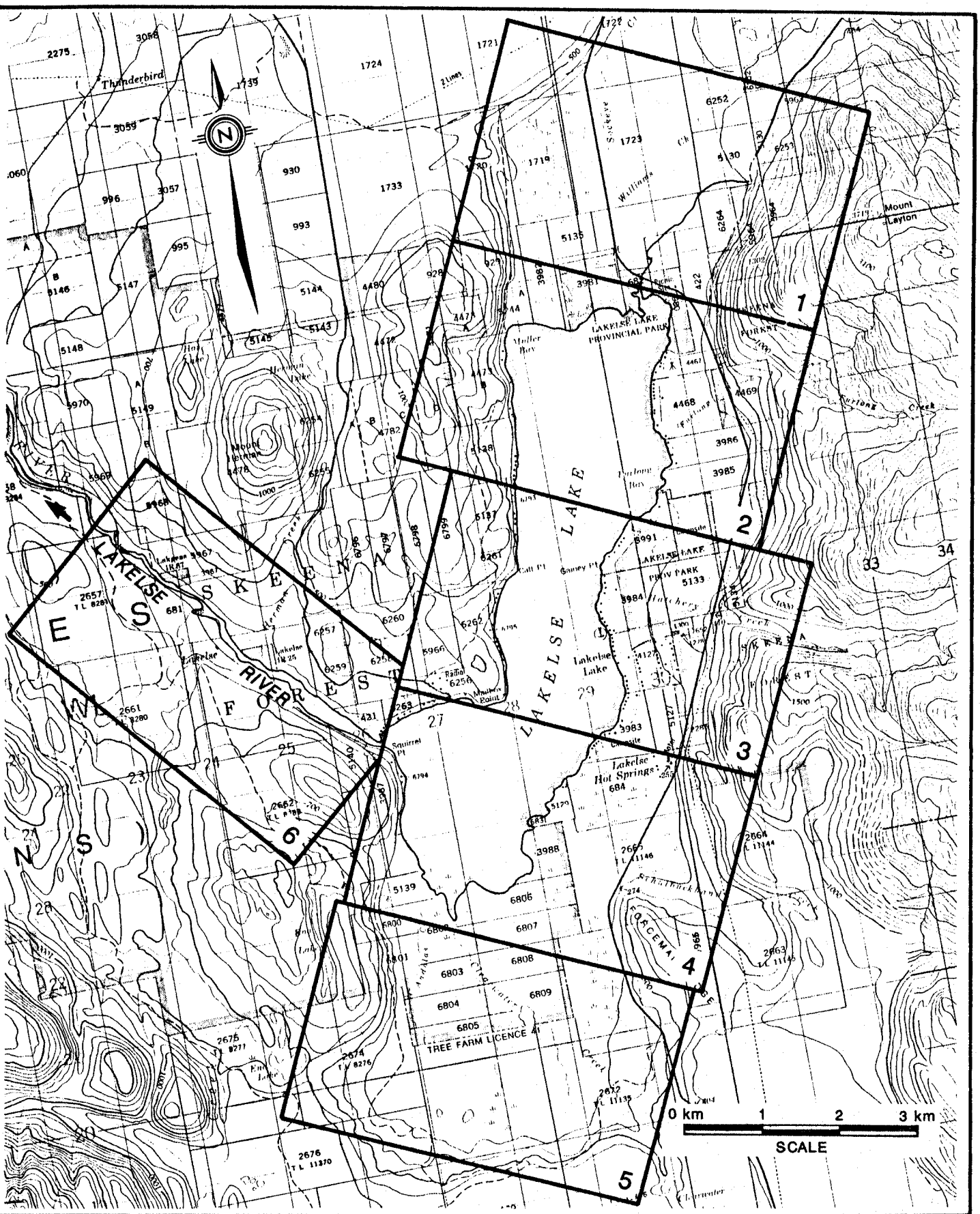
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DATE: APRIL, 1989

R.W. NICHOLS ENGINEER

FILE No. 42-0001-S.1 DWG. No. FIGURE 1

VAN CAL 15712



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE FLOODPLAIN MAPPING STUDY

LAKELSE LAKE

KEY MAP

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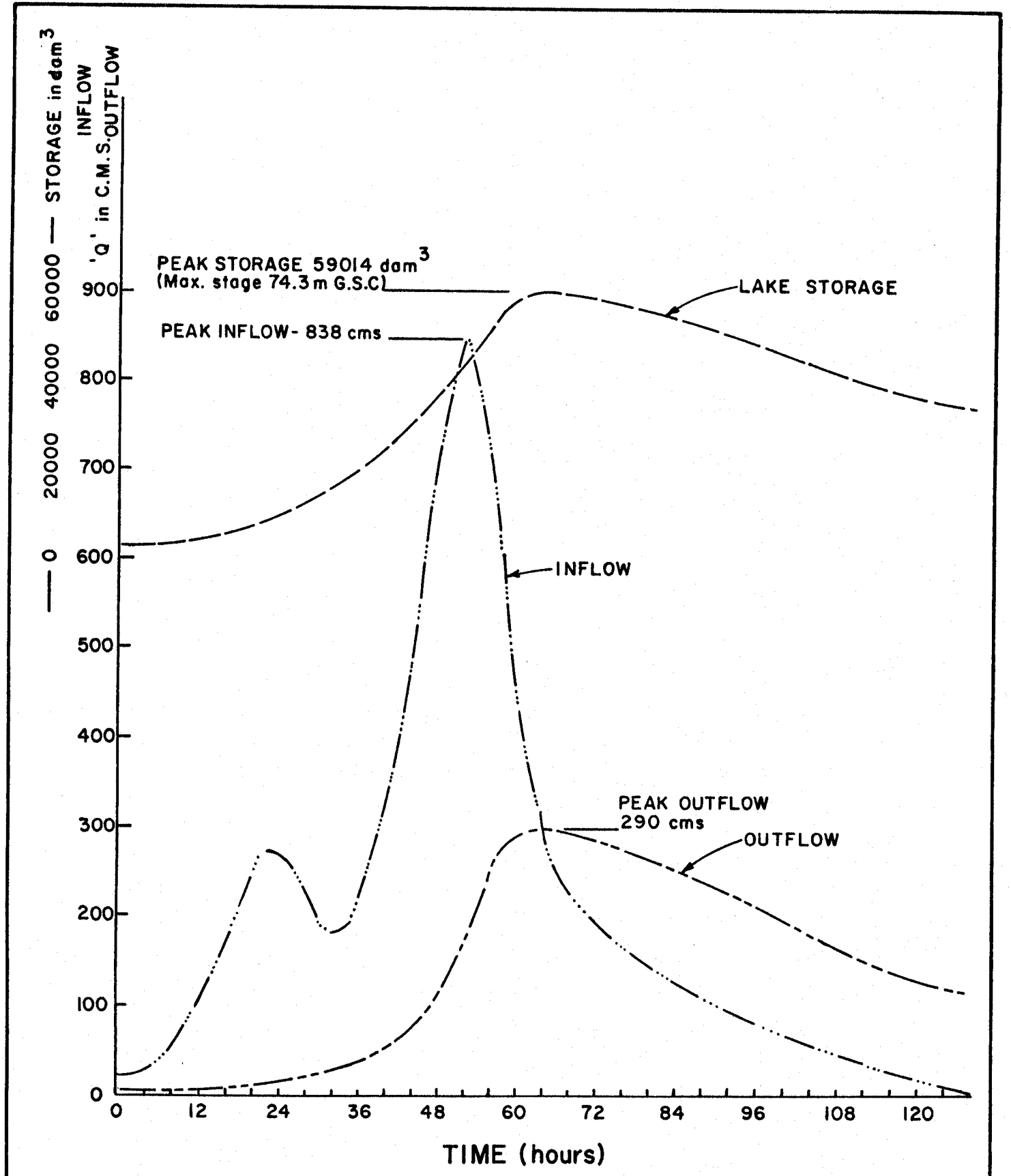
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MAY, 1989

R.W. NICHOLS ENGINEER

FILE No. 42-0001-S.1 DWG No. FIGURE 2

VAN CAL 15712



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON
FLOODPLAIN MAPPING STUDY
LAKELSE RIVER AND LAKE
1:200 YEAR FLOOD ROUTING

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R.W. NICHOLS ENGINEER

FILE No. ..... DWG No. FIGURE 3

VAN CAL 15712

APPENDIX 1

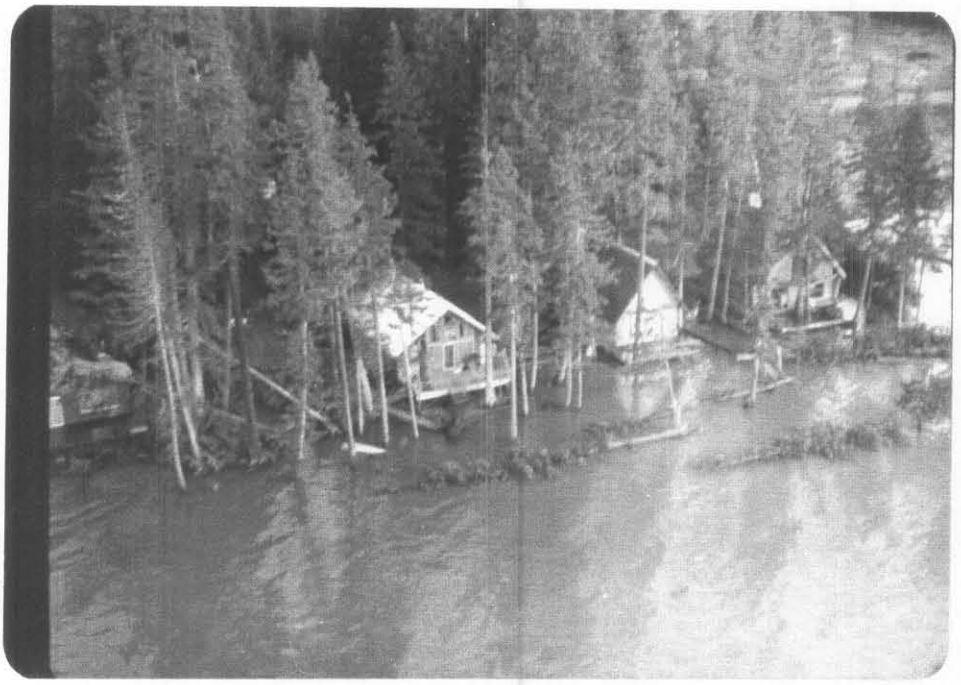
Detailed Information Sources

NO.	1 SOURCE	CONTENTS
1.	"Atlas of British Columbia," U.B.C. Press W.R. 912.711 F23IC.4.	General information on the people, environment and resources in British Columbia.
2.	"Regional District of Kitimat-Stikine Floodplain Study," 1974 by R.B. Marcellin and Anwar Beg.	A documentation of flood level data for specified areas.
3.	"1978 Terrace Area Flooding" by B.R.W. McMullen, R.J. Talbot, P.J. Woods, Water Investigations Branch, January 1979, File P78-42.	Inspection of known areas of significant stream damage resulting from the November 1978 floods in northwestern B.C.
4.	"Lakelse Lake Flooding Preliminary Study" by P.J. Woods, P. Eng., January 1988, File: 42-0001-S.1.	Overview report on a study to examine the sensitivity of the system to changes in the Lakelse River bed at Herman Creek fan.
5.	Map Production Division, Surveys and Resource Mapping Branch, Project No. 83-147, 1985 Air Photography.	1:5000 scale, 1 metre contour mapping of the study area, base completed February 1987.
6.	"Lakelse River Peak Flow" by Hydrology Section, Water Management Branch, File: S2103, Study 251, October 10, 1987.	Hydrology study to determine peak inflows and outflows, Lakelse Lake.
7.	Lakelse River, Cross Sections 1 to 31, Project No. 88-FDC-3, May 1988, Surveys Section, Water Management Branch.	River cross section data including photographs at each section; thalweg and water level profiles; discharge measurements at lake outlets; Drawing 89-2-1 showing profile and cross section locations.
8.	"Technical Report on Lakelse River - Herman Creek Fan Flooding Study" by W.J. Wyngaards, A. Sc. T., Special Projects Section, December 1987, File: 42-0001-S.1.	Technical aspects related to flood routing and backwater calculations to evaluate flooding conditions on Lakelse Lake.
9.	"Granite Creek at Lakelse Lake Near Terrace", Situation Report, July 1980, R.J. Talbot, Inventory and Engineering Branch, Files: P76-27, P78-54.	Report on the status of channel improvements and riprap work for properties adjacent to Granite Creek.

APPENDIX 2

Photos of 1978 Flood

Lakelse Lake





APPENDIX 2 (Continued)

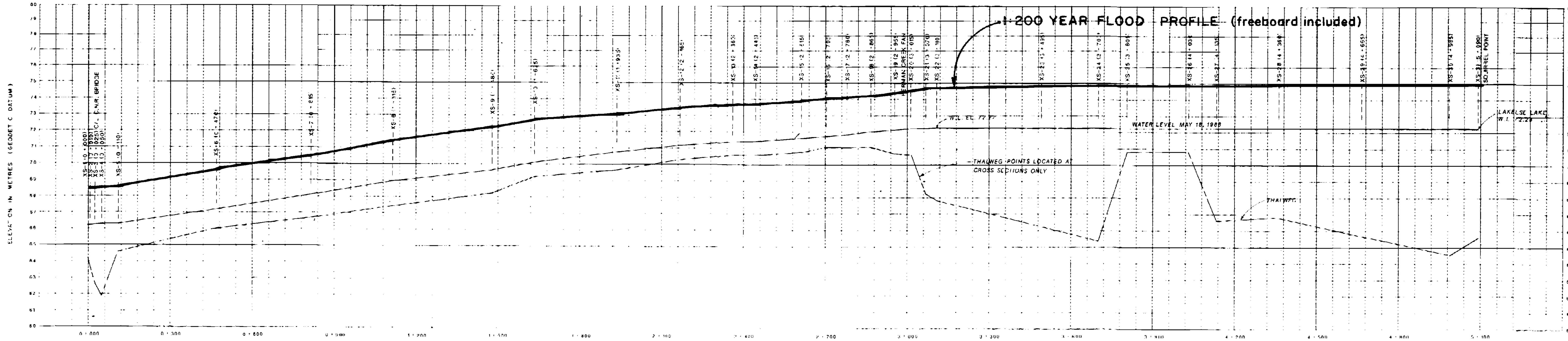
Photos of 1978 Flood

Lakelse Lake





FIGURE 4



PROFILES

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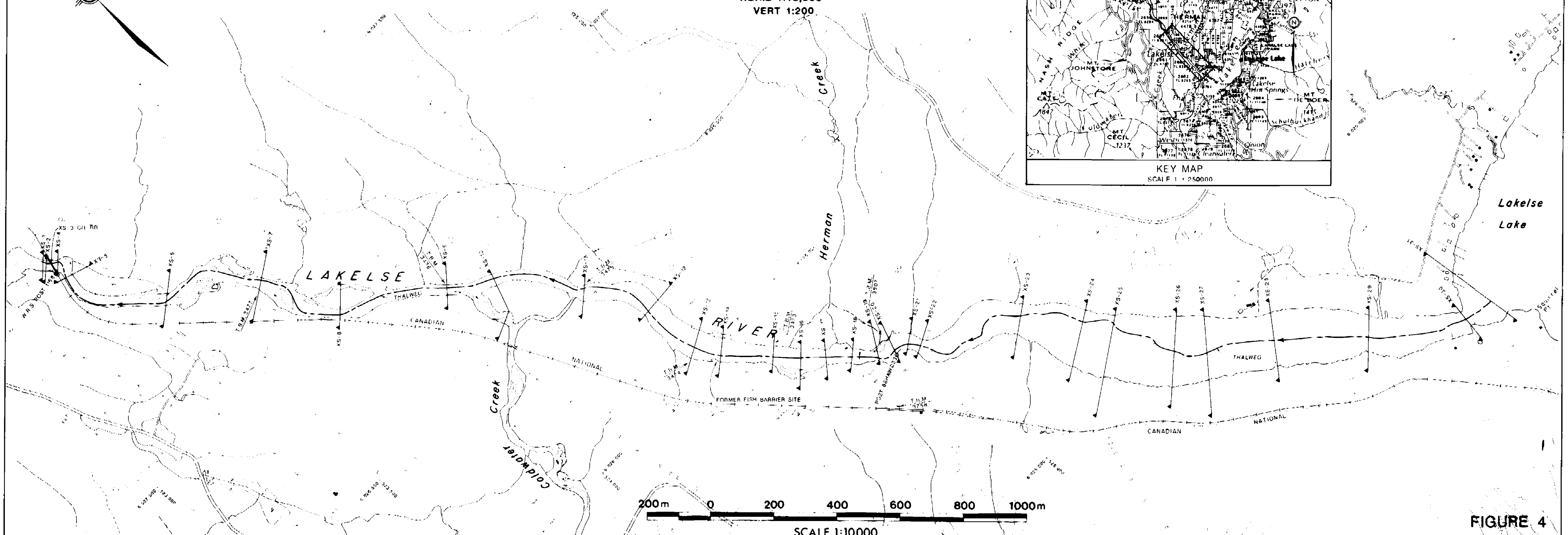


FIGURE 4

NOTES

1) This plan was prepared by the Ministry of Environment, Province of British Columbia.

2) SURVEY DATA:
a) Field surveys were carried out by the Surveys Section, Water Management Branch. This survey repeats parts of Project No. 79FDC 2, June 1979.
b) Horizontal control for cross sections 18-31 was established by EDM traverse using a total station theodolite. Locations of cross sections 1-17 were established by air photograph identification in the field then transferred to this plan and are only approximate.
c) Vertical control was established by differential levelling and confirmed by water level transfer across Lakelse Lake.
d) Cross section data was obtained using a total station theodolite. Where necessary bathymetric data was obtained using an echo sounding depth recorder.
e) Chainage for profiles shown was established graphically from this plan.

3) DATUM:
a) Horizontal and vertical control is based on reference points established by Water Management Branch in 1979, under Project No. 79FDC-2.
b) Horizontal control was based on survey control stations "EATMOR"(74HNO39), "ADAY"(74H2687), and "GETSAI"(74H2657) established by Surveys and Resource Mapping Branch in 1974, from Data Bank listing dated May 1979.
c) Vertical control was based on Bench Mark 1874 J established by Geodetic Survey of Canada as listed in Vertical Control Data publication Quad No. 54120. Revision Original, November 1972.
d) Coordinates shown are Universal Transverse Mercator, Zone 10, Central Meridian 123 degrees, NAD 1927.
e) Elevations are in metres and referred to Canadian Geodetic datum.

4) MAPPING:
A compilation of British Columbia Geographic System mapsheets produced by Surveys and Resource Mapping Branch under Project No. 83-147T. Topographic Mapsheets 103I.037.4.2, 103I.037.4.4 and 103I.038.3.1, scale 1:5000.

5) AIR PHOTOGRAPHS:
Roll No. BC 83006
Frames 130-135 inclusive
Date of Photography July 17, 1983
Photo Scale 1:10000 approximately

6) REFERENCE POINTS
Water Management Branch

	Elevation
BM WRS 1168	71.650
BM 88HAW033	75.886

(Temporary Bench Marks)

	Elevation		Elevation
TBM 3473	73.867	TBM 3477	69.911
TBM 3474	75.880	TBM 3758	80.020
TBM 3475	72.100	TBM 3907	73.576
TBM 3476	70.535		

REFERENCES		
DWG. No.	DESCRIPTION	DATE

REVISIONS		
No.	DESCRIPTION	DATE

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DATE MAY 1988
COMPILED I. STEWART
CHECKED [signature]
DATE JAN. 1989
DRAWN P. T. DIXON
APPROVED [signature]
HEAD, DRAFTING SECTION
DATE JAN. 1989
ENGINEER

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

LAKELSE RIVER AT LAKELSE LAKE OUTLET

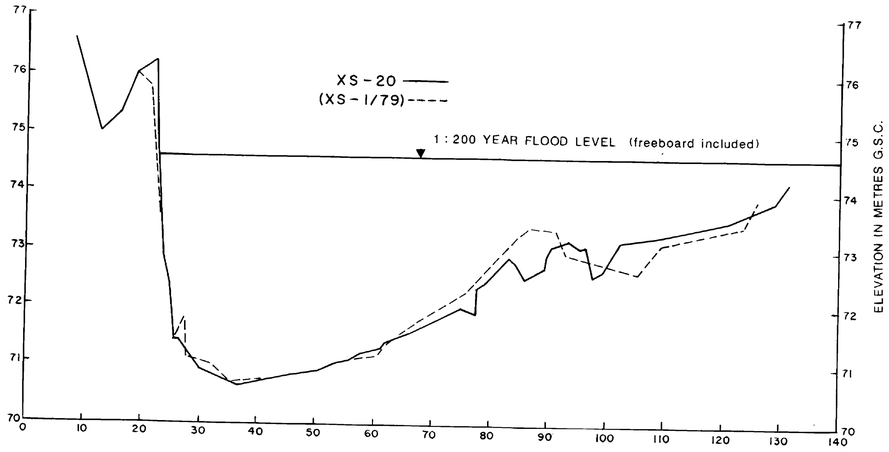
WATER LEVEL AND THALWEG PROFILES AND PLAN SHOWING LOCATIONS OF CROSS SECTIONS

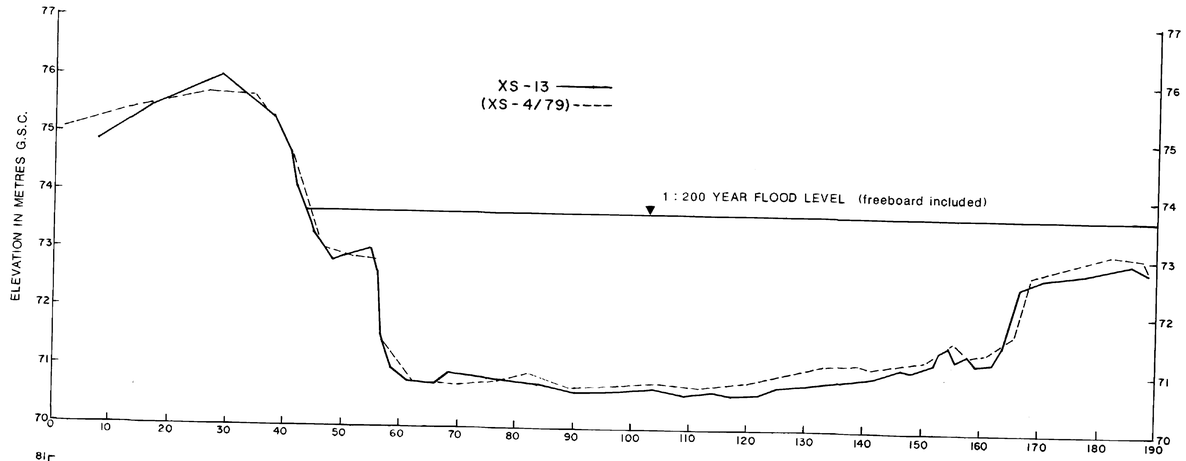
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DATE MARCH 1989

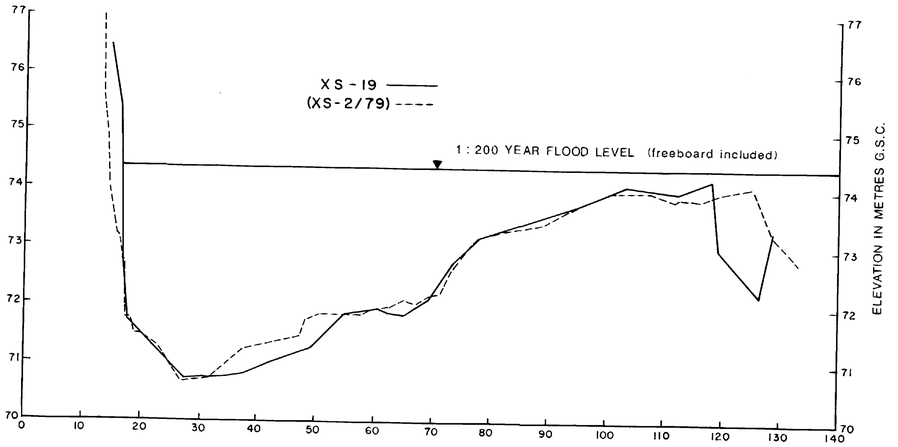
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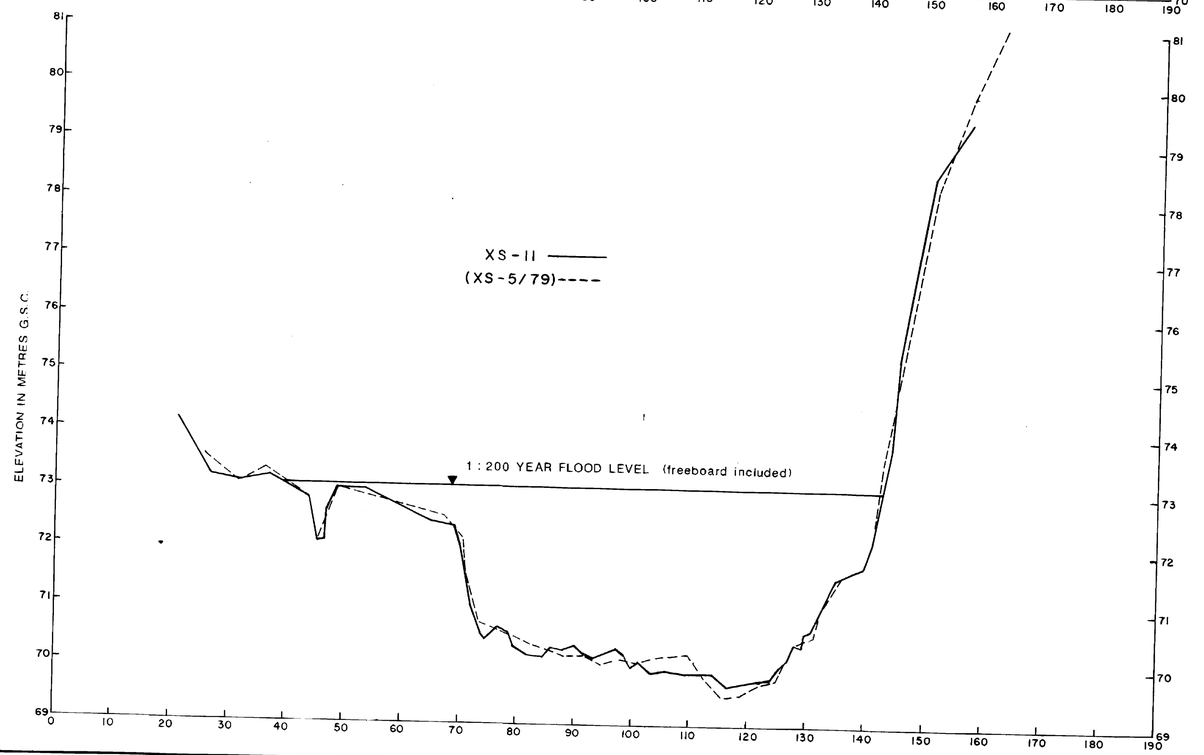
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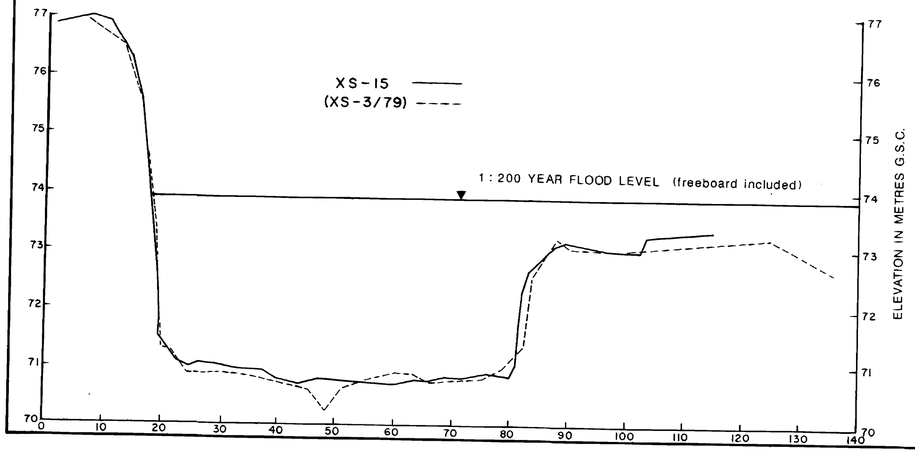
APPENDIX 3











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REVISIONS		
No.	DESCRIPTION	DATE

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DATE 1979 / 1988
DESIGNED
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DATE
DRAWN S.C.
CHECKED
DATE

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

FLOODPLAIN MAPPING
LAKELSE RIVER AND LAKE
CROSS SECTIONS AT HERMAN CREEK 1979 AND 1988

ENGINEER DATE
RECOMMENDED DATE
APPROVED DIRECTOR DATE

FILE NO.
ENG. PROJECT NO.
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VERT. 1:50
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SHEET ___ OF ___

VANCAL - 10360

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