FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT
PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT AND PARKS
WATER MANAGEMENT BRANCH

A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING STUDY

ELK RIVER NEAR ELKFORD

An Overview of the Study Undertaken to
Produce Floodplain Mapping
for the Elk River near Elkford

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FLOODPLAIN MAPPING STUDY
ELK RIVER NEAR ELKFORD

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, Drawings 87-30, Sheets 1 to 7 (Appendix 2).

1. STUDY AREA

The study area is located in the southeast corner of the Province (Figure 1), approximately 65 km via Highways 3 and 43 north of the City of Fernie. The study covers 41 km of the Elk River in the East Kootenay Regional District of which 12 km are within the boundaries of the District of Elkford. The study area is within the Rocky Mountain Division of the Eastern System, one of the six main physiographic regions in the Province. Mean annual precipitation averages 100 to 150 cm and mean daily temperatures range from a low of -20°C in January to a a high of +14°C in July (Appendix 1.1).

The Elk River has an average gradient of 0.43% in the study area and rises a total of approximately 175 metres in the 41 km reach under study. The drainage area of the Elk River is 1030 km^2 at the downstream limit of the study area decreasing to 494 km^2 at the upstream limit. Major tributaries in the study area include Boivin Creek, Bingay Creek and Forsyth Creek, having drainage areas of approximately 91, 77 and 188 km^2, respectively.

The Elk River is an alluvial meandering river with a history of bank erosion and course changes during high flows. The floodplain in the study area is broad, averaging 550 metres in width.

Elevations in the watershed vary from 1420 metres (GSC datum) in the District of Elkford to over 3260 metres at the peaks of the Rocky Mountains. There are several glaciers located in the northern limits of the watershed.

2. BACKGROUND

Elkford was incorporated as a Village in 1971 to serve as a townsite for workers employed at the Fording Coal Mine, located 29 km to the north.

A report dated June, 1979 by D.R. Haughton (Appendix 1.2) of the Provincial Ministry of Transportation, Communications and Highways provides a geotechnical evaluation of the terrain which was proposed for urban expansion in the Elkford area. Previous studies in the Elk River valley noted in Table II of the Haughton report are as follows:

Year	Author	Agency	Remarks
1956	Kelly and Sprout	B.C. Ministry of Agriculture	Soil survey completed in the Upper Kootenay and Elk River valleys, primarily to assess the agricultural values of the land. Map scale 1:50,000.
1962	Price	Geological Survey of Canada	Geological map and report covering the east half of NTS area 82G.
1969	Runka	B.C. Ministry of Agriculture	Canada Land Inventory Program Capability maps for recreation forestry, agriculture, waterfowl and wild ungulates.
1975	Van Dine	Thurber Consultants for B.C. Department of Lands, Forests and Water Resources	This letter report describes a investigation of the existing Elkford Slide and a potential slide problem on the east bank of the Elk River near Elkford.
1978	Holm	Ministry of Forests	This report describes the Elkford Slide and evaluates soil conditions, slope stability and the effect of logging practices on slopes near the Elkford Slide.
1978	Walmsley (Editor)	B.C. Ministry of the Environment	A provisional report presenting a re-inventory of the physical and biological landscape in the Elk River valley.
1978	ELCO Mining Ltd.		A report including a broad assessment to establish general urban development suitability at Forsyth Creek and Elkford.

A drawing produced by Haughton entitled "Surficial Geography of the Elkford Area" includes information on alluvial fan deposits and a recent (1969) flow slide opposite the sewage lagoons in the Elk River floodplain, downstream of the Boivin Creek confluence.

Preliminary information available from the Ministry of Environment and Parks regarding the limits of the Elk River floodplain was included in the above noted drawing. The Ministry recommended floodplain management policies to the Village of Elkford in October of 1978 (Appendix 1.3).

An inspection report (Appendix 1.4) by P.J. Woods, P. Eng., Ministry of Environment and Parks, was made of the flood which occurred in June of 1974 in the District of Elkford. High flows in Boivin Creek resulted in debris and bedload plugging culverts. The water backed up behind Fording Drive and eventually washed out 90 metres of road. Emergency efforts to channelize and clean out Boivin Creek were undertaken to avoid additional damage. The culverts under Fording Drive were replaced by an 8 metre span timber bridge.

Bank protection works were constructed along Boivin Creek in 1975 under the River Improvement Assistance Program. A dyke was subsequently constructed by the District of Elkford along the lower southern bank of Boivin Creek.

Reports by consultants concerning the evaluation of possible unstable slopes (Appendix 1.12) and potential landsliding (Appendix 1.13) at Elkford were issued in July and November of 1979, respectively.

The above noted sources provided background information which is reflected in development policies to avoid or mitigate the risk of natural hazards in the Village of Elkford. These policies were adopted in an Official Community Plan for Elkford on October 14, 1980. The Plan was subsequently updated to reflect the subsequent boundary expansion and change in status from Village to District (District of Elkford Bylaw No. 123, Appendix 1.5).

The most recent update of the Community Plan was prepared for the District of Elkford in January of 1984 (Appendix 1.6). Development consideration policies reflect general floodplain concerns and the potential for the dislocation of the Elk River that may result from a land slide on the east side of the river in the vicinity of the sewage treatment plants.

In connection with the preparation of background data for the Official Community Plan, river survey data was obtained by the Ministry of Environment and Parks in Elkford in 1975. The river surveys were extended upstream in 1979 in connection with a proposed townsite upstream of Elkford near Forsyth Creek. The available river survey data does not cover the expanded boundary of the District which extends approximately 5 km south of the floodplain mapping study area.

The above noted river survey data along with updated hydrological studies and contour mapping based on 1983 air photos formed the basis for the 1988 floodplain mapping study.

3. DESIGNATED FLOOD

In accordance with the policy of the Ministry of Environment and Parks, the flood levels and floodplain limits shown on the floodplain mapping sheets are based on a 1:200 year frequency flow, plus

an allowance for freeboard of 0.6 metres. At the downstream end of the study area the designated mean daily flow is 280 m^3/s.

4. SURVEY AND MAPPING DATA

Topographic base mapping for the study area (2 metre contour interval, 1:5000 scale) was based on air photographs obtained in 1983. The mapping was produced by the Surveys and Resource Mapping Branch of the Ministry of Environment and Parks (Appendix 1.7).

A total of 9 river cross sections were surveyed by the Surveys Section of the Ministry of Environment and Parks in the District of Elkford in August of 1975. An additional 33 cross sections were surveyed upstream of the District of Elkford, a distance of 36 km, to near the confluence of Britt Creek (Appendix 1.8) in August of 1979. Figures 2 and 3 indicate the location of the river cross sections and the water surface and thalweg profiles for the study area.

5. FLOOD MAGNITUDES

The Surface Water Section, Water Management Branch of the Ministry of Environment and Parks carried out a study in April of 1987 (Appendix 1.9) to estimate the required 1:20 and 1:200 year flows for the study area.

The peak flow estimates were based on a detailed peak flow regionalization study carried out for the Elk River basin and presented in a report by W. Obedkoff (Appendix 1.10) in September, 1985. The peak flow regional curves from the 1985 study were updated and used to estimate peak flows for selected reaches in the study area.

There are no hydrometric stations located in the study area. Data used in the study consisted of annual maximum discharges from Water Survey of Canada hydrometric stations in the Elk River basin. The closest stations on the Elk River to the study area are located approximately 16 km downstream of the District of Elkford (08NK016) and 14 km upstream (08NK027) of the study area. Annual maximum discharges occur in the May-June period as a result of the melting of the seasonal snow pack.

Frequency analyses were updated to 1986 using records of annual maximum daily discharges and the results plotted as unit peak flows against drainage area. Envelope curves were defined for the floodplain study area for the 1:20 year and 1:200 year recurrence intervals. Instantaneous peak flow records were examined and used to convert the daily peak flow estimates to instantaneous.

The study area was divided into selected reaches and drainage areas measured on a digitizer. The results of the peak flow estimates for the study area are summarized as follows:

ELK RIVER SITE	DRAINAGE AREA	RATIO OF MAXIMUM INSTANTANEOUS TO DAILY DISCHARGE	ESTIMATED PEAK DISCHARGE					
			20-year			200-year		
			Daily		Instantaneous	Daily		Instantaneous
	km^2		$L/s/km^2$	m^3/s	m^3/s	$L/s/km^2$	m^3/s	m^3/s
at upper floodplain boundary	494	1.13	215	106	120	320	158	179
below Forsyth Creek	682	1.12	201	137	154	299	204	228
below Bingay Creek	759	1.12	197	150	167	292	222	248
above Mickelson Creek	840	1.11	192	161	179	285	239	266
below Crossing Creek	929	1.11	189	176	195	280	260	289
below Boivin Creek	1020	1.11	184	188	208	272	277	308
at lower floodplain boundary	1030	1.11	183	188	209	272	280	311

6. HYDRAULIC ANALYSIS

6.1 General

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

6.2 Cross Section Plot Run

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, bridge information, reach lengths, overbank information and Manning's "n" values.

6.3 Model Calibration

Highwater data corresponding to measured flows from a specific flood occurrence was not available in order to calibrate Manning's "n" values in the study area. Attempts to obtain highwater mark data by staff of the Special Projects Section, in cooperation with the District of Elkford, were not successful due to the low runoff which occurred on the Elk River during the 1987 and 1988 freshets.

Manning's "n" values were estimated using available air photos and by observations made during a field reconnaissance trip to the study area in May of 1987, combined with experience gained in other studies. A review of the information available in a book published by the U.S. Department of the Interior entitled "Roughness Characteristics of Natural Channels" (Appendix 1.11) was also utilized in estimating Manning's "n" values. A value of 0.035 was selected for the main channel of the river in the study area.

6.4 Calculated Flood Levels

Flood levels were calculated for the 1:20 year and 1:200 year daily and instantaneous flows listed in Section 5.

The 1:20 year and 1:200 year flood levels shown on the floodplain mapping sheets were based on the daily flows and include a 0.6 metre freeboard allowance. It was determined that the daily flow levels plus 0.6 metres freeboard slighty exceeded the instantaneous flow levels plus 0.3 metres freeboard for both the 1:20 and 1:200 year flood events.

lhe water surface profile for a 1:200 year daily flow (0.6 metre freeboard included) is shown on Figures 2 and 3.

6.5 Sensitivity Studies

6.5.1 General

The Elk River floodplain in the study area is relatively flat and broad. The average floodplain width is 550 metres which is approximately 20 times the bank full width of the main channel. The floodplain contains numerous abandoned river channels which become active when the floodplain is inundated during high flow periods.

The sensitivity studies outlined below indicate that flood levels are relatively insensitive to assumed Manning's "n" values and to increased flow magnitudes once inundation of the full width of the floodplain occurs.

6.5.2 Effect of Manning's "n" on Flood Levels

Flood profile calculations indicate that an increase in "n" values by a factor of 1.6 for a 1:200 year flood results in an average level increase of only 0.22 metres, which is within the freeboard allowance of 0.6 metres.

6.5.3 Effect of Flow on Flood Levels

As indicated on the attached floodplain mapping sheets the average difference in flood levels between a 1:20 year and 1:200 year flood (flow increase of approximately 50%) averages 0.20 metres.

Flood profile calculations were undertaken to determine the effects of flows in excess of a 1:200 year event on flood levels. It was determined that an increase of flow of 40% above a 1:200 year daily flood results in an average flood level increase of approximately 0.23 metre, which is within the freeboard allowance of 0.6 metres.

7. FLOODPLAIN MAPPING

7.1 General

The flood levels determined in the study were used to locate the floodplain limits onto the existing 2 metre contour mapping of the study area.

Floodplain mapping of the Elk River, Drawing 87-30, Sheets 1 to 7 (Appendix 2) was produced and provides the following information:

- The location of river cross sections, the floodplain limits, the flood levels determined in the study, the location of existing survey monuments and the boundary of the District of Elkford are indicated;

- The study area covers a distance of 41 km from the District of Elkford to upstream of the confluence of Britt Creek;

- The Elk River has an average gradient of 0.37 percent for the first 23 km of the study area (XS-109 to XS-15) which increases to 0.51 percent for the remaining 18 km (XS-15 to XS-33);

- The Elk River in the study area is an alluvial meandering river subject to bank erosion and possible channel avulsion during high flood periods. Old channels located in the floodplain are evident on air photos and on the topographic mapping of the study area.

7.2 Alluvial Fans and Slide Areas

The delineation of the geomorphic limits of the alluvial fan of Boivin Creek are indicated on Drawing 87-30-7. The limits of the fan were determined as a result of a field visit to the area, a review of the existing reports and topographic mapping and a report on alluvial fans prepared by Thurber Consultants Ltd. for the Ministry (Appendix 1.14).

The Boivin Creek fan has a telescopic structure with the lower fan surface, as outlined in the Drawing, being active. A portion of the fan area is protected by dykes as discussed in Section 2.

As noted on the Drawing, the entire active area of the tributary fan is subject to special flood hazards due to possible channel avulsion and erosion caused by channel accretion, and/or debris jamming.

The location of the previously mentioned slide (1969) area opposite the sewage lagoons is also noted on the Drawing.

The above noted areas (Boivin Creek fan and 1969 slide area) were outlined on the floodplain mapping Drawings as there was a considerable volume of documentation available covering the problems associated with these areas.

There are undoubtedly other fan areas (eg. Britt Creek and Bingay Creek) and possibly unstable slopes in the study area. The indentification of such areas is beyond the scope of the Elk River floodplain mapping study.

8. CONCLUSIONS

(1) This report presents an overview of the studies undertaken to produce the floodplain mapping sheets of 41 km of the Elk River from the District of Elkford upstream to near the Britt Creek confluence. The study area does not cover approximately 5 km of the southern portion of the floodplain in the District of Elkford.

(2) The floodplain mapping is deemed to be preliminary as it is based on 2 metre contour mapping. In addition, the river survey cross section information is based on 1975 and 1979 surveys and information on observed high water levels and recorded flows was not available for the study.

(3) Problems related to flooding, bank erosion and land slides in the District of Elkford, have been observed and documented. Development policies adopted in the Official Community Plan (1980) have taken cognizance of the known natural hazards in order to avoid or mitigate potential damages to new developments in the District of Elkford.

9. RECOMMENDATIONS

(1) It is recommended that the Elk River floodplain be interim designated under the terms of the Federal Provincial Floodplain Mapping Agreement.

(2) The floodplain mapping may be used for administration purposes related to the preparation of floodplain mapping schedules for official plans; floodproofing requirements in zoning and building bylaws; and identification of floodable lands by Subdivision Approving Officers. As noted in the Official Community Plan (January 1984 update) future development should take cognizance of the potential for landslides in the study area which may affect flood levels and cause major relocation of the Elk River channel.

(3) Consideration should be given to extending the floodplain mapping for the District of Elkford, a distance of approximately 5 km to the southern boundary of the District. Extension and updating of river cross section information is required in order to undertake this study. The priority for the study should be determined in consultation with the District of Elkford.

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APPENDIX 1

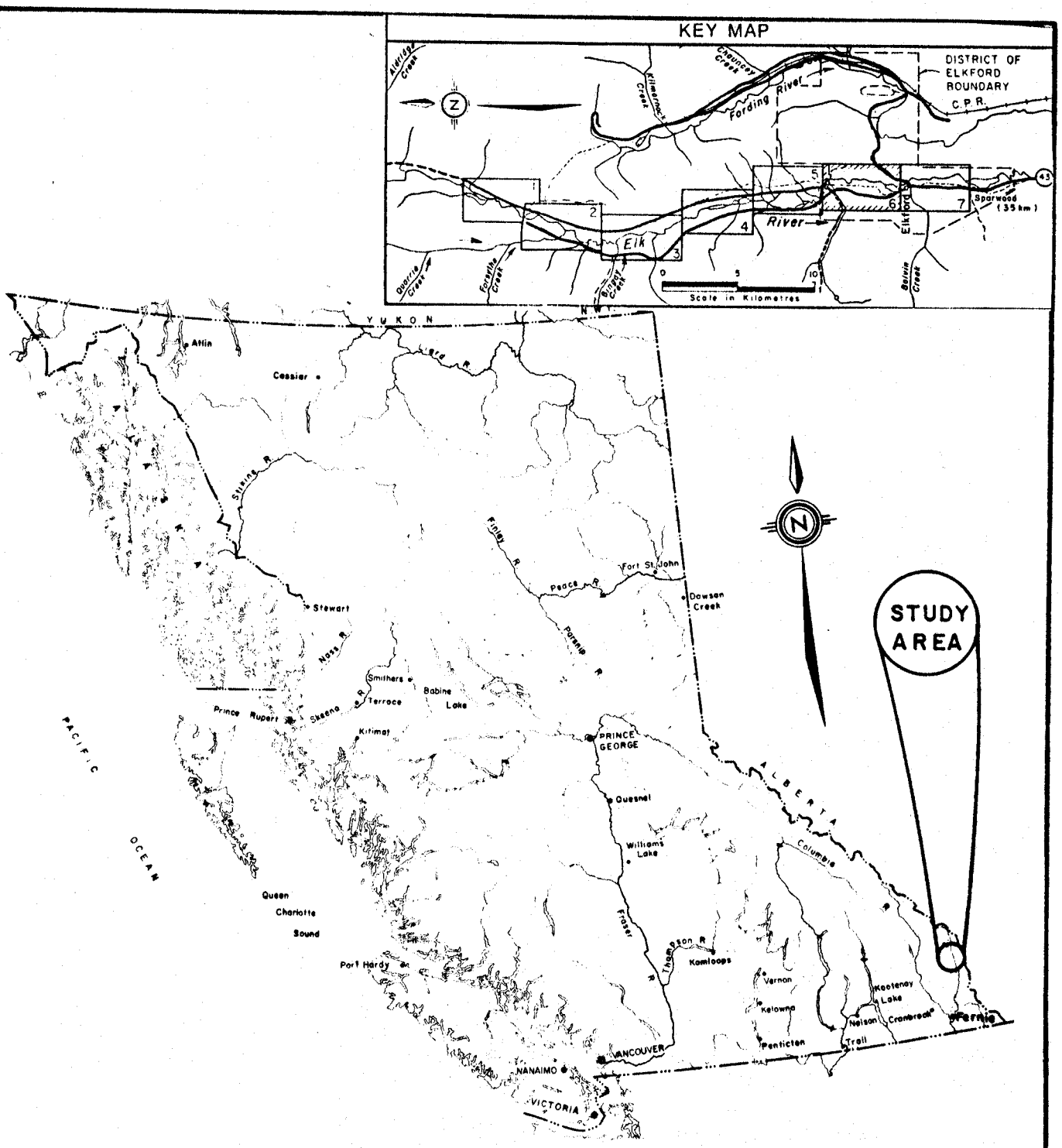
Detailed Information Sources used in the Floodplain Mapping Study - Elk River near Elkford

No.	Source	Contents
1.	Atlas of British Columbia, U.B.C. Press W.R. 912.711 F231 C.4	General Information on the people, environment and resource use.
2.	Ministry of Transportation, Communications and Highways, Victoria, B.C. "Preliminary Geotechnical Evaluation for Urban Expansion at Elkford" by D.R. Haughton, P. Eng., June, 1979	Geotechnical evaluation of terrain proposed for urban expansion - Elkford area.
3.	Memo dated October 6, 1978 from G.E. Simmons, A.D.M., Ministry of Environment to R.A. Miles, Clerk-Treasurer, Village of Elkford, regarding "Floodplain Management Policies"	Suggested policies with respect to floodplain development.
4.	Memorandum to P.M. Brady dated November 26, 1974, File No. P-74-51, 0273270 "Village of Elkford - Boivin Creek Preliminary Inspection Report" by P.J. Woods, Water Management Branch	Inspection report on damages as a result of a flood on June 17, 1974.
5.	District of Elkford Bylaw No. 123, Part 5, Special Provisions (Approved Feb. 2, 1981)	Flood control regulations, District of Elkford.
6.	District of Elkford Community Plan update, January 17, 1984 R.A. Rabnett and Associates	Policies and objectives to guide future development.
7.	Surveys and Mapping Branch, Ministry of Environment and Parks, Project No. 83-117-TC	1:5000 scale, 2 metre contour mapping of study area based on 1983 air photos.
8.	Surveys Section, Water Management Branch, Ministry of Environment and Parks, Project Nos. 75-F3, August, 1975 and 79-F3, August, 1979	Cross sections of Elk River in study area.

Appendix 1 continued.....

APPENDIX 1 (continued)
Detailed Information Sources used in the Floodplain Mapping Study - Elk River near Elkford

No.	Source	Contents
9.	Hydrology Section, Water Management Branch, Ministry of Environment and Parks, File No. 52105, Project No. 244, April, 1987	Peak flow estimates, Elkford Floodplain Study.
10.	"Elk River Study", Hydrology Division Report by W. Obedkoff, Hydrology Section, Water Management Branch, September, 1985	Peak Flow Regionalization Study - Elk River Basin.
11.	U.S. Department of the Interior, Geological Survey Water Supply Paper 1845 "Roughness Characteristics of Natural Channels", by H.M. Barnes, Jr., 1967	Colour photos and descriptive data for 50 stream channels for which roughness coefficients have been determined.
12.	"Geotechnical Evaluation of Possible Unstable Slopes at Elkford, B.C.", Piteau and Associates, July, 1979	Evaluation of potential slope hazards at Elkford.
13.	"Preliminary Assessments of Potential Landsliding near Riverview Mobile Home Park, Elkford, B.C.", Golder Associates, November, 1979	Potential for landsliding near mobile home park assessed.
14.	"Floodplain Management on Alluvial Fans", Report to Ministry of Environment by Thurber Consultants Ltd., April 15, 1983	Report provides basis for assessing low flood hazard on alluvial fans.



STUDY AREA LOCATION

100 0 100 200 300 KILOMETRES

Province of British Columbia
Ministry of Environment and Parks
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON
FLOODPLAIN MAPPING STUDY
ELK RIVER NEAR ELKFORD

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

DATE: JUNE 1988

R. W. NICHOLS ..... ENGINEER

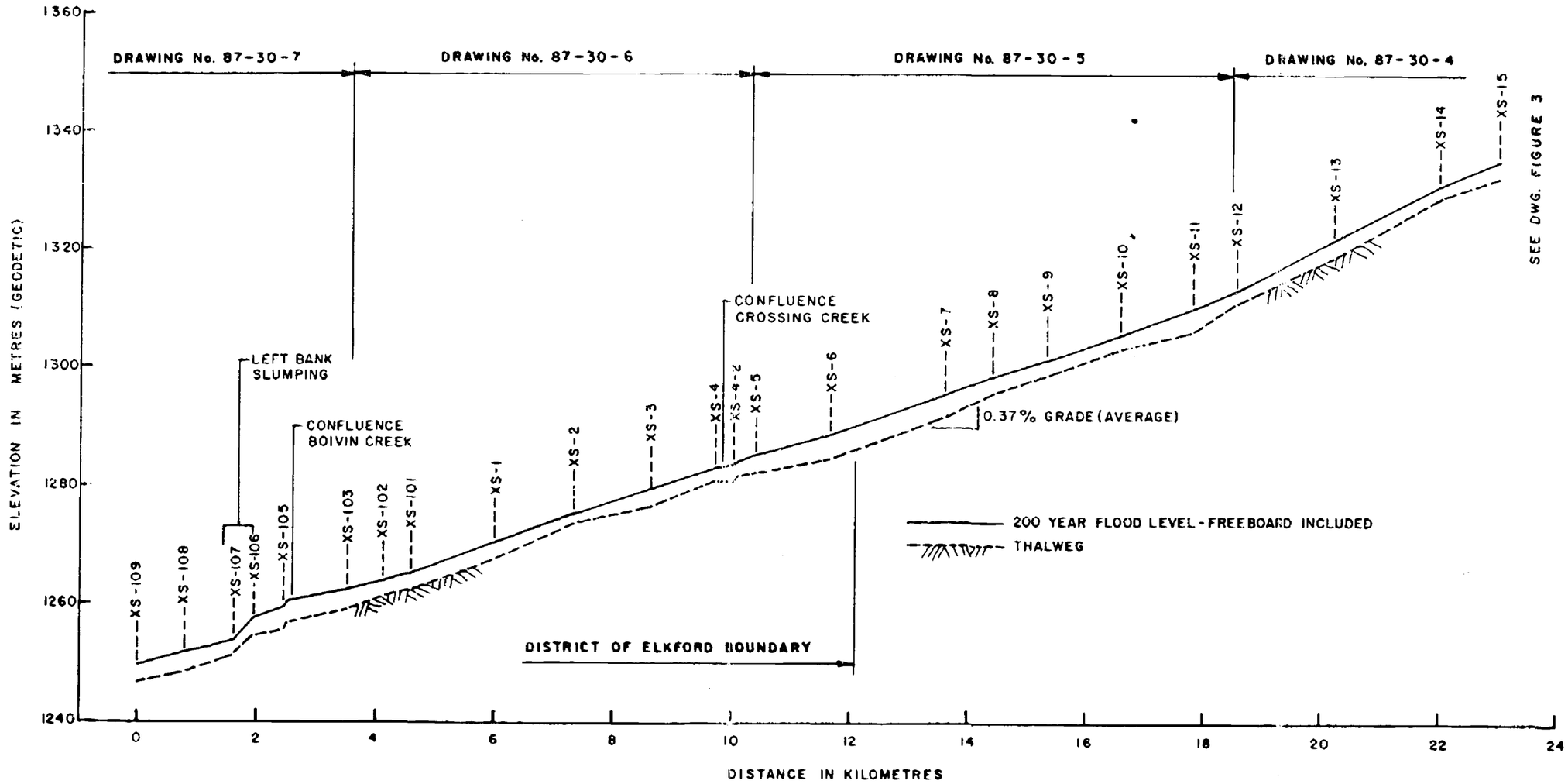
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FIGURE 1

ELK RIVER NEAR ELKFORD

WATER SURFACE AND THALWEG PROFILES

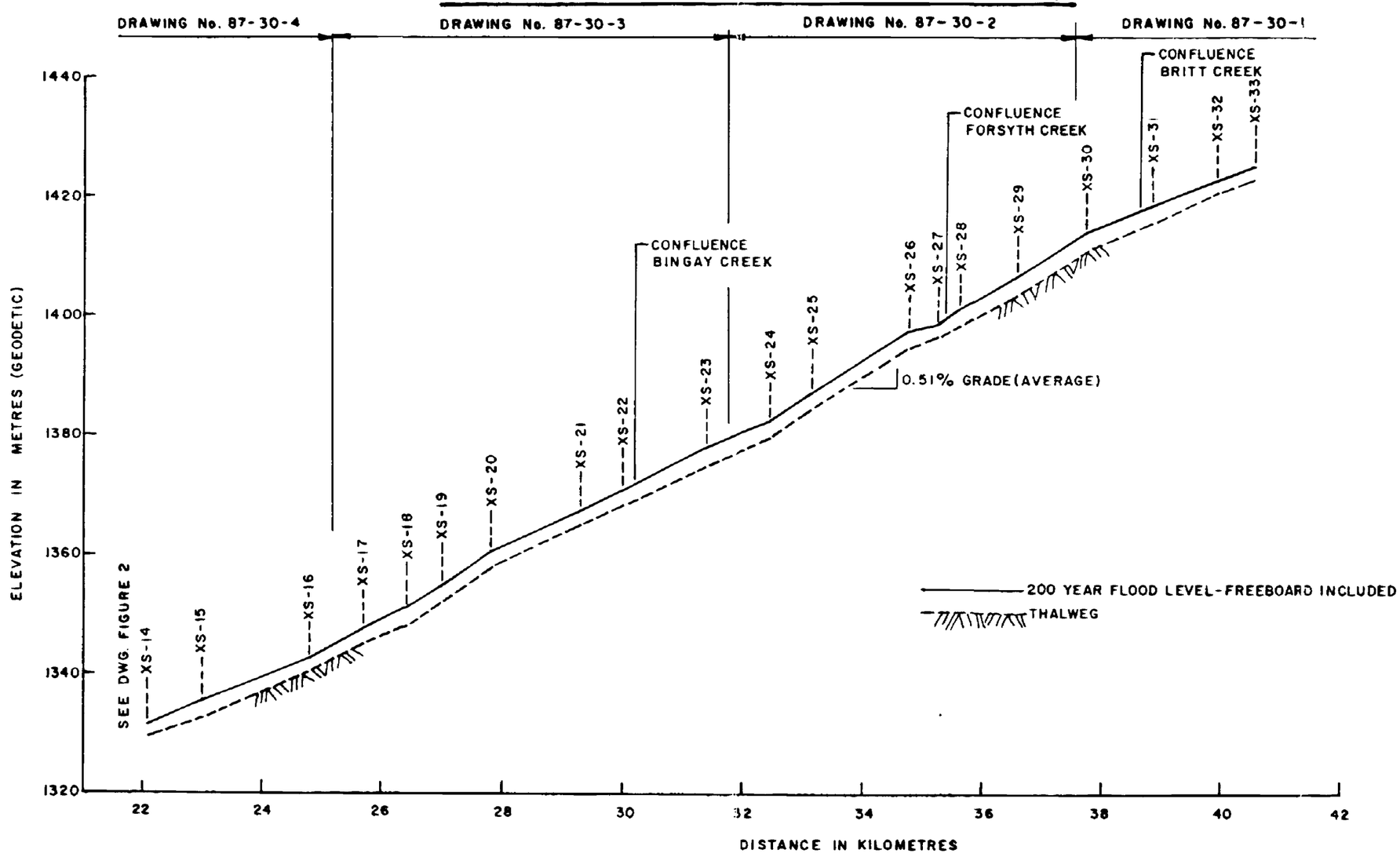


	Province of British Columbia Ministry of Environment and Parks WATER MANAGEMENT BRANCH	TO ACCOMPANY REPORT ON FLOODPLAIN MAPPING STUDY **ELK RIVER NEAR ELKFORD**	SCALE: VERT. AS SHOWN HOR. AS SHOWN R.W. NICHOLS ENGINEER FILE No. 35-0700-S.1 DWG No. 87-43-2 DATE JUNE 1988

FIGURE 2

ELK RIVER NEAR ELKFORD

WATER SURFACE AND THALWEG PROFILES



	Province of British Columbia Ministry of Environment and Parks Water Management Branch	TO ACCOMPANY REPORT ON FLOODPLAIN MAPPING STUDY **ELK RIVER NEAR ELKFORD**	SCALE: VERT. AS SHOWN HOR. AS SHOWN R.W. NICHOLS ENGINEER FILE No. 35-0700-S.1 DWG No. 87-43-3 DATE JUNE 1988

FIGURE 3