Environment Canada
Environmental Conservation

Environnement Canada
Conservation de l'environnement

# FLOOD OF JULY 1982

# ON THE WAPITI RIVER

# BRITISH COLUMBIA

MAY 1983

TD
227
B74
PE83-1
c.2

Inland Waters Directorate
Pacific and Yukon Region
Vancouver, B.C.

EL 30158669

BVAE North Van. Env. Can. Lib./Bib.

36 002 240

TD
227
B74
PE 83-1
c.2

# FLOOD OF JULY 1982

# ON THE WAPITI RIVER

# BRITISH COLUMBIA

A.G. SMITH

LIBRARY
ENVIRONMENT CANADA
PACIFIC REGION

Planning and Studies Section
Water Resources Branch
Vancouver May 1983

ID 2098

# TABLE OF CONTENTS

# TABLE OF CONTENTS

## Crue de Juillet 1982, Rivière Wapiti, Columbie-Britannique

RESUME

Le 14 juillet 1982, une forte précipitation a provoqué une crue, ayant une période de récurrence estimeé à 35 ans, sur la rivière Wapiti en Columbie-Britannique. La division des relevés hydrologiques du Canada y opérait une station de jaugeage appeleé "Wapiti River above Mistanusk Creek". Il a été estimé, par la méthode "pente-surface", que le débit maximum instantané a atteint 700 $m^3$/sec à cet endroit. Cette estimation doit être considerée approximative, parce que la pente de l'écoulement a été obtenue à l'aide des marques laissées par les hautes eaux et le coefficient de rugosité a été estimé, par similarité, avec d'autres cours d'eau ayant une rugosité connue. Lors du débit de pointe, des conditions de refoulement ont été causées soit par un affluent en aval, un embâle, ou la configuration de la rivière.

Les installations de la division des relevés hydrologiques ainsi que la graphique indicatif du niveau d'eau ont été perdus.

De sévères inondations et érosion se sont produites à plusieurs endroits, en aval, dans la province de l'Alberta.

# Flood of July 1982 on the Wapiti River, British Columbia


## ABSTRACT

On July 14, 1982 runoff from heavy precipitation produced an estimated 35 year flood on the Wapiti River in British Columbia. An instantaneous maximum discharge of 700 $m^3$/sec was estimated by the slope-area method at the Water Survey of Canada gauging station "Wapiti River above Mistanusk Creek". The estimate is at best an approximation because the water surface slope is obtained from highwater marks and a roughness coefficient is estimated from similarity with other streams of known roughness. Backwater conditions were present at the time of peak discharge and were caused either by a downstream tributary, log jam or the channel configuration.

Water Survey's cableway and recorder were lost with the recorder chart of river stage. Severe flooding and erosion were caused in many locations downstream in Alberta.


## 1. INTRODUCTION

The Wapiti River rises on the eastern slopes of the Rocky Mountains in Central British Columbia northeast of Prince George and near the Alberta border. The gauging site is located 84 kilometers downstream from the source, and contains a basin with a drainage area of 2,400 square kilometers. After crossing into Alberta, the Wapiti River flows approximately 150 kilometers until it joins the

Smoky River near Grande Prairie. The location of the basin is shown on Figure 1.

Streamflow records have been collected in the British Columbia portion of the basin above Mistanusk Creek since September 1977. The station located downstream near Grande Prairie, Alberta was established in November 1960, the drainage area of this site is 11,300 square kilometers. The available data on high flows at this station are used in the flood estimates for the B.C. site.

The purpose of this report is to help provide an understanding of the causes of floods in this region, to estimate the peak discharge through indirect means, to estimate the frequency of the flood and to present an analysis of the basic data.

The report provides a brief description of the physiography and climate of the area, the events leading up to the flood, the extent of flooding and flood damage in British Columbia.

## 1.1 PHYSIOGRAPHY

The basin consists of three main physiographic subdivisions: the mountains, the foothills and the plains. Refer to Figure 2, Physiographic Regions. The front ranges of the Rocky Mountains extend from the divide east to the foothills. The gradient is steep, the rivers dropping from 2,150 meters to 1,200 meters in less than 16 kilometers. The area contains many rugged peaks but none over 2,290 meters in elevation. There are few glaciers with only one supplying some meltwater to Belcourt Creek, a tributary of the Wapiti.

The foothills, composed mainly of rounded hills contain outlying mountain ridges nearly as high and rugged as the front range. The gradient changes drastically, the rivers dropping from 1,200 meters to 900 meters in 50 kilometers.

The plains region is characterized by buttes and mesas. The gradient is very flat, the rivers dropping less than 0.25 meters per kilometer. The drainage pattern consists of parallel stream systems flowing east and transecting the regional physiographic trends.

Stream profiles are shown on Figure 3, for the Wapiti River and its main tributaries upstream of the British Columbia-Alberta border.

## 1.2 CLIMATE

The climate of the basin is dominated by continental influences. The winter continental Arctic air masses move down from the Mackenzie Valley for periods of varying length. These cold anticyclone air masses create conditions which are unfavourable to precipitation, cold and dry in winter and warm and dry in summer.

The basin is characterized by semi-arid conditions in the plains and by progressively higher precipitation in the foothills and mountains.

The tracts of the various pressure systems are not fixed and vary considerably throughout the year. In winter many depressions, caused by the Aleutian Low, enter British Columbia from the ocean and drift eastward over the western mountains, and if dominant, on across the plains. As the land warms in the spring the frontal zones shift to the north and the depressions travelling across British Columbia are less affected by the cold Arctic air mass.

### 1.2.1 Precipitation

Annual precipitation is generally less than 500 millimeters to the east of the Rocky Mountain foothills but increases westward through the foothills and into the mountains to over 1,500 millimeters. Precipitation has an even distribution from September to May but has a pronounced summer maximum. The winters are relatively dry because of the low moisture content of the Arctic air which covers the area during this period. Summer precipitation is predominantly of the convection type so that spotty distribution within the area is characteristic as are high intensities for short periods. In general precipitation in the form of hail is infrequent.

### 1.2.2 Snowfall

The mean annual snowfall in the area ranges from 150 centimeters on the plains to over 350 on the highest mountain ranges. Snowfall starts in October, reaches a peak in January and February, recedes in March and has a pronounced drop in April decreasing as summer approaches. Snow course locations are shown in Figure 4 and snow course data for 1982 are shown in Table 1.

TABLE 1 Snow Course Data for Selected Stations
(Snow Survey Bulletins, 1982)

| Course Number | Snow Course Name | Elevation in Meters | Date (1982) | Snow Depth in cm | Water Eqiv-alent in mm | Period of Record |
|---|---|---|---|---|---|---|
| 4A20 | Monkman Creek | 1550 | Mar 1 | 209 | 622 | 4 yrs |
| | | | Apr 1 | NM | - | - |
| | | | May 1 | NM | - | - |
| | | | May 15 | NM | - | - |
| | | | Jun 1 | 148 | 689 | 8 yrs |
| 4A22 | Sukunka River | 1140 | Mar 1 | 109 | 235 | 5 yrs |
| | | | Apr 1 | 131 | 347 | 7 yrs |
| | | | May 1 | 102 | 327 | 8 yrs |
| | | | May 15 | NM | - | - |
| 4A02 | Pine Pass | 1430 | Mar 1 | 300 | 932 | 20 yrs |
| | | | Apr 1 | 296 | 1106 | 20 yrs |
| | | | May 1 | 282 | 1193 | 21 yrs |
| | | | May 15 | 251 | 1173 | 14 yrs |
| | | | Jun 1 | 203 | 1066 | 12 yrs |
| 4A18 | Mount Sheba | 1490 | Mar 1 | 258 | 803 | 12 yrs |
| | | | Apr 1 | 240 | 884 | 13 yrs |
| | | | May 1 | 238 | 923 | 13 yrs |
| | | | May 15 | 220 | 945 | 7 yrs |
| | | | Jun 1 | 183 | 901 | 7 yrs |
| 4A25 | Ft. St. John | 690 | Mar 1 | 84 | 191 | 8 yrs |
| | | | Apr 1 | 76 | 210 | 8 yrs |
| | | | May 1 | 0 | 0 | 8 yrs |
| 4A26 | Portage Mountain | 760 | Mar 1 | 75 | 156 | 8 yrs |
| | | | Apr 1 | 68 | 173 | 8 yrs |
| | | | May 1 | 39 | 107 | 8 yrs |

NM - Not Measured

### 1.2.3 Temperature

Temperatures rise rapidly from winter to summer and fall again as fast to winter. The mean daily temperature is below 0°C in all five winter months from November to March and above 10° from May to September. The year may be divided into winter and summer with one month for spring and one month for autumn.

## 1.3 GEOLOGY

The Rocky Mountains consist of a series of parallel ridges and valleys roughly aligned in a northwest to southeast direction. They are underlain by faulted and folded sedimentary rocks. The mountain massifs are formed of the harder rocks, limestone, dolomites and quartzites while the valleys are principally underlain with the softer sediments, shales and sandstone. The Rocky mountian foothills are characterized by series of subparallel ridges and valleys situated between the plateau to the east and the Rocky Mountains to the west. These ridges and valleys are dissected by the larger streams flowing in a northeasterly direction. The streams and their tributaries have entrenched themselves in deeply incised canyons. The foothills are underlain by faulted and folded shales and sandstone.

### 1.3.1 Soil Types

Most of the soils are of glacial origin. Glacial-fluvial and glacial-lacustrine deposits are thin on the higher elevations but tend to be of considerable depth in the larger stream valleys. Where river valleys are broad and subject to periodic flooding the formation of peat bogs and swamps has been promoted.

### 1.3.2 Vegetation

The foothills and Rocky Mountains contain mostly evergreens at the higher elevations and deciduous lower down. The forest cover consists of Fir, Spruce, Lodgepole Pine, Cottonwood, Birch and Aspen; some of these species can be found at elevations 1,800 meters above sea level.

## 1.4 WAPITI RIVER BASIN IN BRITISH COLUMBIA

The Wapiti River Basin at the Water Survey of Canada gauging site comprises three basins of comparable size originating in the Rocky Mountains and flowing through the foothills with their confluence near the edge of the Alberta plateau. Wapiti River itself extends approximately 84 kilometers above the measuring site; Red Deer Creek is 70 kilometers and Belcourt Creek is 84 kilometers long respectively above their confluence. Refer to Figure 5 for detailed map of basin.

The average annual runoff of the Wapiti River in British Columbia, for the four-year period of record, is 15.8 L/$km^2$. This is the contribution from 2,400 $km^2$. The second station on the Wapiti located in Alberta near Grande Prairie approximately 120 km down-

TABLE 2 Mean Annual and Maximum Run off for Selected Basins

| Station Number | Name | Drainage Area $km^2$ | Years of Record | Mean Annual Flow $m^2$ | Mean Annual Runoff Litres/$km^2$ | Maximum Daily Flow $m^3$ | Maximum Daily Runoff Litres/$km^2$ |
|---|---|---|---|---|---|---|---|
| 07FB001 | Pine River at East Pine | 12100 | 22 | 203 | 16.8 | 3960 | 327 |
| 07FB007 | Sukunka River above Chamberlain Creek | 927 | 5 | 23.9 | 25.8 | 266 | 287 |
| 07FB003 | Sukunka River near the Mouth | 2510 | 5 | 52.5 | 20.9 | 704 | 280 |
| 07FB004 | Dickebusch Creek near the Mouth | 85.5 | 5 | 0.665 | 7.8 | 16.1 | 188 |
| 07FB006 | Murray River above Wolverine River | 2410 | 5 | 57.1 | 23.7 | 423 | 176 |
| 07FB002 | Murray River near the Mouth | 5620 | 5 | 84.6 | 15.1 | 736 | 131 |
| 07FB005 | Quality Creek near the Mouth | 29.5 | 5 | 0.207 | 7.0 | 9.23 | 313 |
| 07FD001 | Kiskatinaw River near Farmington | 3570 | 23 | 11.4 | 3.2 | 413 | 116 |
| 07FD007 | Pouce Coupe River below Henderson Creek | 2850 | 12 | 9.72 | 3.4 | 368 | 129 |
| 07GC001 | Wapiti River above Mistanusk Creek | 2400 | 5 | 38.0 | 15.8 | 650 | 270 |
| 07GE001 | Wapiti River near Grande Prairie | 11300 | 22 | 107 | 9.6 | 3680 | 326 |
| 07GB001 | Cutbank River near Grande Prairie | 842 | 12 | Seasonal | - | 506 | 601 |
| 07GB002 | Kakwa River near Grande Prairie | 3290 | 7 | Seasonal | - | 1680 | 511 |
| 07GA001 | Smoky River below Hells Creek | 3830 | 15 | 78.9 | 20.6 | 1230 | 321 |

Source: Water Survey of Canada Surface Water Data Publications stream, gauges runoff from 11,300 $km^2$. Average annual runoff at this location for the 20-year period of record is 9.5 $L/km^2$. The upper area has a contribution over double that of the lower area. Annual and maximum daily runoff for stations in the region are listed in Table 2.

The physiography of the upper basin would indicate that for any storm centred over the basin the flood wave travel time would be similar for each tributary and would concentrate the flow at their confluence.

Table 3 gives the physiographic location and drainage area for selected stations in the area.

## 2. DESCRIPTION OF FLOOD

The annual maximum discharge of rivers draining the eastern slopes of the Rocky Mountains and foothills usually occurs from early May through July and is the result of snowmelt or rain, or rain on snow. Occasionally summer highs are caused by local convectional disturbances after the snowmelt has dissipated. On rarer occasions in the fall, Pacific Lows manage to penetrate the mountain barriers and deposit high amounts of precipitation.

In the Wapiti basin spring runoff normally commences during the latter part of April and peak snowmelt flows are reached in May or early June. Secondary peaks often occur late in June and July as a

TABLE 3 Physiography of Selected Streamflow Stations Draining Eastern Slopes of Rocky Mountains

| Station Number | Name | Drainage Area $km^2$ | Physiographic Region Represented in Watershed |
|---|---|---|---|
| 07FB001 | Pine River at East Pine | 12100 | Rocky Mountains and Rocky Mountain Foothills |
| 07FB007 | Sukunka River above Chamberlain Creek | 927 | Rocky Mountains |
| 07FB003 | Sukunka River near the Mouth | 2510 | Rocky Mountains and Rocky Mountian Foothills |
| 07FB004 | Dickebusch Creek near the Mouth | 85.5 | Rocky Mountain Foothills |
| 07FB006 | Murray River above Wolverine River | 2410 | Rocky Mountains and Rocky Mountain Foothills |
| 07FB002 | Murray River near the Mouth | 5620 | Rocky Mountains and Rocky Mountain Foothills |
| 07FB005 | Quality Creek near the Mouth | 29.5 | Rocky Mountain Foothills |
| 07FD001 | Kiskatinaw River near Farmington | 3570 | Alberta Plateau |
| 07FD007 | Pouce Coupe River below Henderson Creek | 2850 | Alberta Plateau |
| 07GC001 | Wapiti River above Mistanusk Creek | 2400 | Rocky Mountains and Rocky Mountain Foothills |
| 07GE001 | Wapiti River near Grande Prairie | 11300 | Rocky Mountains, Rocky Mountain Foothills and Alberta Plateau |
| 07GB001 | Cutbank River near Grande Prairie | 842 | Rocky Mountain Foothills |
| 07GB002 | Kakwa River near Grande Prairie | 3290 | Rocky Mountains, Rocky Mountain Foothills and Alberta Plateau |
| 07GA001 | Smoky River below Hells Creek | 3830 | Rocky Mountains and Rocky Mountain Foothills |

result of heavy rains. Occasionally these peaks are greater than the snowmelt peaks. In some years consistent summer rains keep the runoff high throughout the summer period. Streamflow recession is rapid once the cold temperatures appear.

The very high summer flows can be the result of heavy rain that follows a high runoff caused by previous snowmelt or rainfall. Hydrographs illustrating the different causes of peaks are shown on Figures 6 through 9.

## 2.1 Rainstorm of July 13-15, 1982

The flood of July 14, 1982 was caused by heavy rainfall which covered the entire Wapiti River basin. The distribution was uneven, as the storm was centred over the eastern edge of the basin. Table 4 lists the precipitation for the period July 1 to 31, 1982 for selected stations in the area. Figure 10 shows the mass rainfall curves for the month of July for these stations.

### 2.1.1 Meteorological Description of the Rainstorm of July 13-15, 1982 over Smoky River Basin (Wapiti River)

A chronological description of the meteorological occurrences, prepared by the Scientific Support Unit of the Atmospheric Environmental Service (AES), Edmonton, Alberta follows:

1. Most of the precipitation fell over British Columbia on the 13th and 14th of July and over Alberta on the 14th and 15th.
2. Two axes of precipitation, one from the south and one from the

TABLE 4 Daily Precipitation in Millimeters - July 1-31, 1982
(B.C. Air Studies, Victoria & A.E.S. Edmonton)

| Day | Murray Townsite | Wolverine | Quintette 2 | Monkman Camp | Stoney Lake | Duke Mountain | Nose Mountain |
|---|---|---|---|---|---|---|---|
| Elev. | 835 m | 823 m | 1541 m | 1000 m | 1085 m | 1593 m | 1574 m |
| 1 | 4.0 | 6.0 | 2.5 | 4.2 | 5.0 | 0.0 | 0.3 |
| 2 | 3.0 | 3.0 | 6.0 | 1.0 | 5.5 | 2.0 | 0.5 |
| 3 | 16.5 | M | 12.0 | 22.0 | 32.5 | 18.2 | 28.2 |
| 4 | 17.5 | M | 15.0 | 18.2 | 17.0 | 39.5 | 27.0 |
| 5 | 0.5 | M | 20.0 | 3.7 | 3.0 | 7.7 | 3.6 |
| 6 | 3.0 | M | 9.0 | 3.0 | 4.0 | 10.2 | 7.5 |
| 7 | 1.0 | M | 1.0 | 1.0 | 2.0 | 1.0 | T |
| 8 | 0.0 | M | 0.0 | 0.0 | 0.0 | 0.0 | T |
| 9 | 0.0 | M | 0.5 | 0.5 | 2.0 | 0.0 | 1.3 |
| 10 | 0.0 | M | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 0.5 | M | 0.0 | 0.3 | 0.0 | 0.0 | 3.0 |
| 12 | 0.0 | M | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| 13 | 34.5 | 42.0 | 68.0 | 11.7 | 25.0 | 11.0 | 5.1 |
| 14 | 66.0 | 56.0 | 86.0 | 76.0 | 90.0 | 83.0 | 138.9 |
| 15 | 0.5 | 0.0 | 2.0 | 19.7 | 0.5 | 28.5 | 27.9 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 1.0 | T |
| 17 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 0.0 | 0.0 | 4.0 | 1.2 | 1.0 | 0.0 | 0.0 |
| 19 | 4.0 | 1.0 | 0.5 | 1.2 | 0.0 | 3.0 | 0.0 |
| 20 | 7.5 | 12.0 | 9.5 | 4.0 | 5.0 | 5.0 | 0.5 |
| 21 | 42.0 | 37.0 | 40.0 | 12.7 | 5.0 | 21.7 | 6.3 |
| 22 | 2.0 | 2.0 | 1.5 | 2.7 | 1.5 | 1.7 | T |
| 23 | 0.5 | 0.0 | 0.5 | 0.8 | 1.5 | 2.2 | T |
| 24 | 0.0 | 0.5 | 0.0 | 0.0 | 4.5 | 0.0 | 0.0 |
| 25 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | 0.0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.3 | 0.0 |
| 28 | 0.5 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| 29 | 0.0 | 2.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| 30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31 | 26.0 | 4.0 | 20.0 | 13.2 | 13.5 | 8.5 | 15.2 |
| TOTAL | 229.5 | - | 298.5 | 198.3 | 220.2 | 244.5 | 266.3 |

M - Missing

T - Trace (less than 0.2 mm)

west, converged in an area to the west of Nose Mountain Lookout. It is estimated that amounts in excess of 150 millimeters of precipitation could have fallen over British Columbia within a 50 to 75 kilometer radius of Nose Mountain. There are no reporting stations to substantiate these amounts (Figure 11).

3. Main contributors to precipitation include the following:

   a) 500 millibar (cold low) which moved from Georgia Strait at July 14/12Z to 50 n.mi. south of Vernon (15/00Z) to 120 east of Vernon (15/12Z) to 60 southwest of Calgary (16/00Z) to 50 northwest of Lethbridge by 16/12Z (Figure 12).

   b) surface low which moved from near Revelstoke (14/00Z) to 60 n.mi. west of Calgary (14/12Z) to 50 southwest Edmonton (15/00Z) then curled north-westward to 75 west Grande Prairie (15/12Z) and thereafter weakening and moving rapidly eastward to central Saskatchewan by (16/00Z).

   c) combined easterly to northeasterly upslope flow from low to high levels across the Smoky basin as a result of the tracks of the upper and surface low pressure systems.

   d) high surface dew points (12-16°C) across the area for the duration of the storm.

   e) tongue of warm air aloft stretching across the basin.

   f) associated instability.

# 3. ANALYSIS OF FLOOD DATA

## 3.1 Wapiti River above Mistanusk Creek

This station was originally equipped with an automatic recorder, cableway and rain gauge. All of this equipment was lost on July 14, 1982. Figures 13 & 13a show effects of the flood at the gauging site.

A slope area survey was done on October 12, 1982 and established the peak gauge height at an elevation (local levels) of 5.220 meters and a slope of 0.00082.

The highest measured flow prior to July 1982 was 205 $m^3/s$ at a gauge height of 1.920 metres. The maximum daily discharge at this station prior to the flood was 371 $m^3/s$, on June 4, 1980, which corresponds to a gauge height of 2.480 meters. The maximum instantaneous gauge height of 2.620 meters was observed also on June 4, 1980, corresponding to an estimated discharge of 418 $m^3/s$.

## 3.2 Estimation of Flood Discharge

An examination of the hydrographs of neighbouring streams and the precipitation isohyetal map shows that the storm was centred over the extreme lower portion of the upper Wapiti basin in British Columbia and extended over the lower portion of Narraway River in Alberta.

The slope of the water surface at the upper measuring site on the Wapiti River indicates that there was considerable backwater at the time of the flood. The backwater conditions could have been caused from a log jam, from channel constriction, or from the downstream tributary. The only observed phenomenon was that of the downstream tributary being extremely high.

Preliminary information at the downstream station in Alberta indicates a very large ratio between the maximum daily and the instantaneous discharge. The average value for the period of record being 1.14 compared to a value of 1.79 obtained for this flood. The previous high ratio was 1.35 in 1962.

The normal method of estimating peak flow at a stream gauging station when the stage is known is by a log-log extension of the existing rating curve. However this method cannot be used in the case where a high degree of backwater is present. In these situations the only reliable method is that of the slope-area relationship.

After the fact surveys require an accurate interpretation of high water marks to obtain water surface slope and an estimate of the coefficient of roughness. Error can occur in the estimation of both of these values. A roughness factor could be obtained from a measurement at a relatively high stage but at the present time this is impossible. However, reference can be made to Water Supply

Paper 1849 which contains many examples of stream beds for which the roughness coefficients have been established.

The water surface slope as obtained from the high water marks was calculated to be 0.00082 and the coefficient of friction was selected as 0.03. The maximum instantaneous discharge as calculated using the above values is 700 $m^3/s$ and adjusted to 650 $m^3/s$ for the maximum daily.

A more accurate study would require relationships established between stage and the following parameters: area, slope and roughness coefficient.

It is interesting to note that the average channel slope at the measuring site as obtained from contour maps was 0.0043 compared to that of 0.0033 calculated from the highest measurement taken at the site.

## 4. FREQUENCY CHARACTERISTICS OF THE FLOOD

A frequency curve is a graphic representation of the average occurence of events, derived from past experience. Its intended use is to estimate how often, on the average, certain events will occur in the future.

The plotting position for each flow is determined from the formula: T = (N + 0.5)/(m - 0.24). Maximum daily discharges and frequency graphs are shown in figures 14-18 for Wapiti River above Mistanusk Creek, Wapiti River near Grande Prairie, Kakwa River near Grande Prairie, Smoky River above Hells Creek, and Cutbank River near Grande Prairie.

The maximum daily flows for the above named stations have been plotted on Gumbel extremal probability paper. The log-Pearson Type III distribution has been fitted to the flows by the method of moments. This distribution appears to fit the data very well and indicates a trend which can be extrapolated to cover a larger range.

### 4.1 Interpretation of Frequency Curves

The period of record for peak flow discharges is very short on the Wapiti River above Mistanusk Creek and would not be expected to be a good representation of the population of events. However, some information can be derived from the lower station, Wapiti River near Grande Prairie which has 22 years of record. Assuming that the curve is a good representation of the population distribution, the following interpretation can be made. On the average the annual maximum daily flow may exceed the flood of July 16, 1982 at intervals of 35 years in length or a probability of exceedence of 1 in 35. Assuming that records at the two stations are similar the above would hold for the upper Wapiti station also.

An envelope curve of extreme floods is shown in Figure 19.

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Causes of the Flood

The flooding on the Wapiti River at the stream gauging station above Mistanusk Creek was due to several factors:

1. heavy precipitation - rainfall from the storm was concentrated over the lower portion of the basin.
2. backwater - the presence of backwater which could have been caused by one or all of the following conditions: a log jam, an extreme high stage on a downstream tributary (Mistanusk Creek), and channel constriction.

### 5.2 Peak Flow

The survey of the water surface slope has provided the only means of estimating the flood peak at this station and it is only as good as the estimate of the highwater marks and the estimate of the coefficient of friction. The maximum instantaneous discharge was calculated to be 700 $m^3/s$ with probable magnitude of error of ± 25%.

## 6. ACKNOWLEDGMENTS

The author would like to acknowledge the contribution of the

Scientific Support Unit of the Atmospheric Environment Service, Edmonton for their analysis and description of the storm event of July 14, 1982; and the field staff of the Water Survey of Canada, from the sub-office of Fort St. John, who carried out the slope survey and provided the photographs of the stream channel.

## BIBLIOGRAPHY

Barnes, Jr. H.H. 1967. Roughness Characteristics of Natural Channels. Geological Survey Water-Supply Paper, 1849. U.S. Government Printing Office, Washington.

Bostock, H.S. 1965. Physiography of the Canadian Cordillera, with Special Reference to the Area North of the Fifty-fifth Parallel. G.S.C. Memoir 247, Kings Printer, Ottawa, Ontario.

Chapman, J.D. 1952. Climate of British Columbia. Paper presented to the Fifth British Columbia Natural Resources Conference, February 1952, University of British Columbia.

Environment and Land Use Sub-Committee on Northeast Coal Development, 1978. Northeast Coal Study Preliminary Environmental Report 1977-1978, Queens Printer, Victoria, B.C.

Miles, M. 1981. Regional Hydrology of the Northeast Coal Study Area. Prepared for the Environment and Land Use Sub-Committee on Northeast Coal Development.

Ministry of Environment. 1982. Victoria, B.C. Snow Survey Bulletins, for March 1, April 1, May 1, May 15, and June 1, 1982.

Smith, A.G. 1975. Technical Bulletin No. 85, Flood of June 1971 Fort Nelson and Muskwa Rivers, DOE, WRB, Vancouver, B.C.

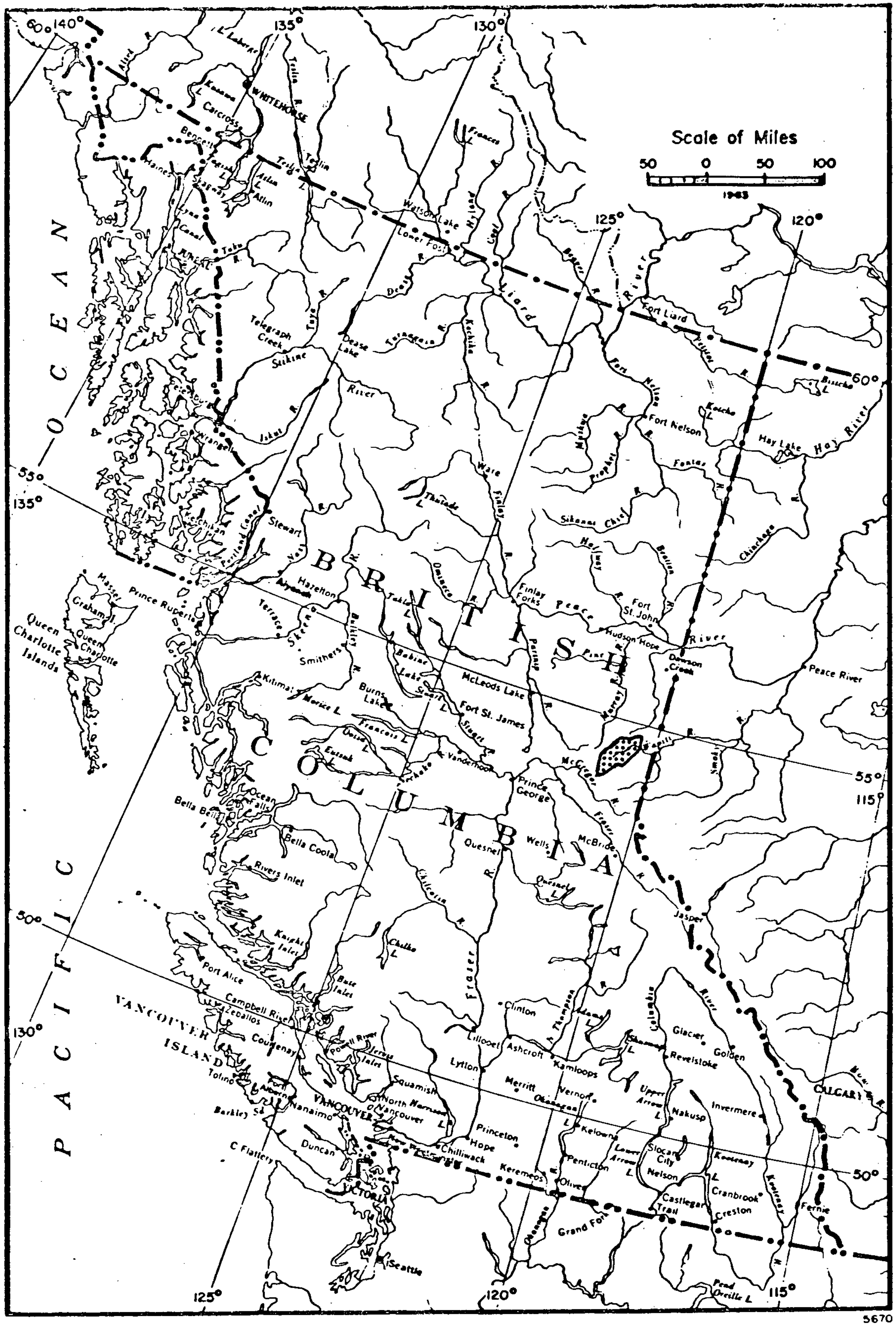



Figure 1 Map of British Columbia with Wapiti River Basin

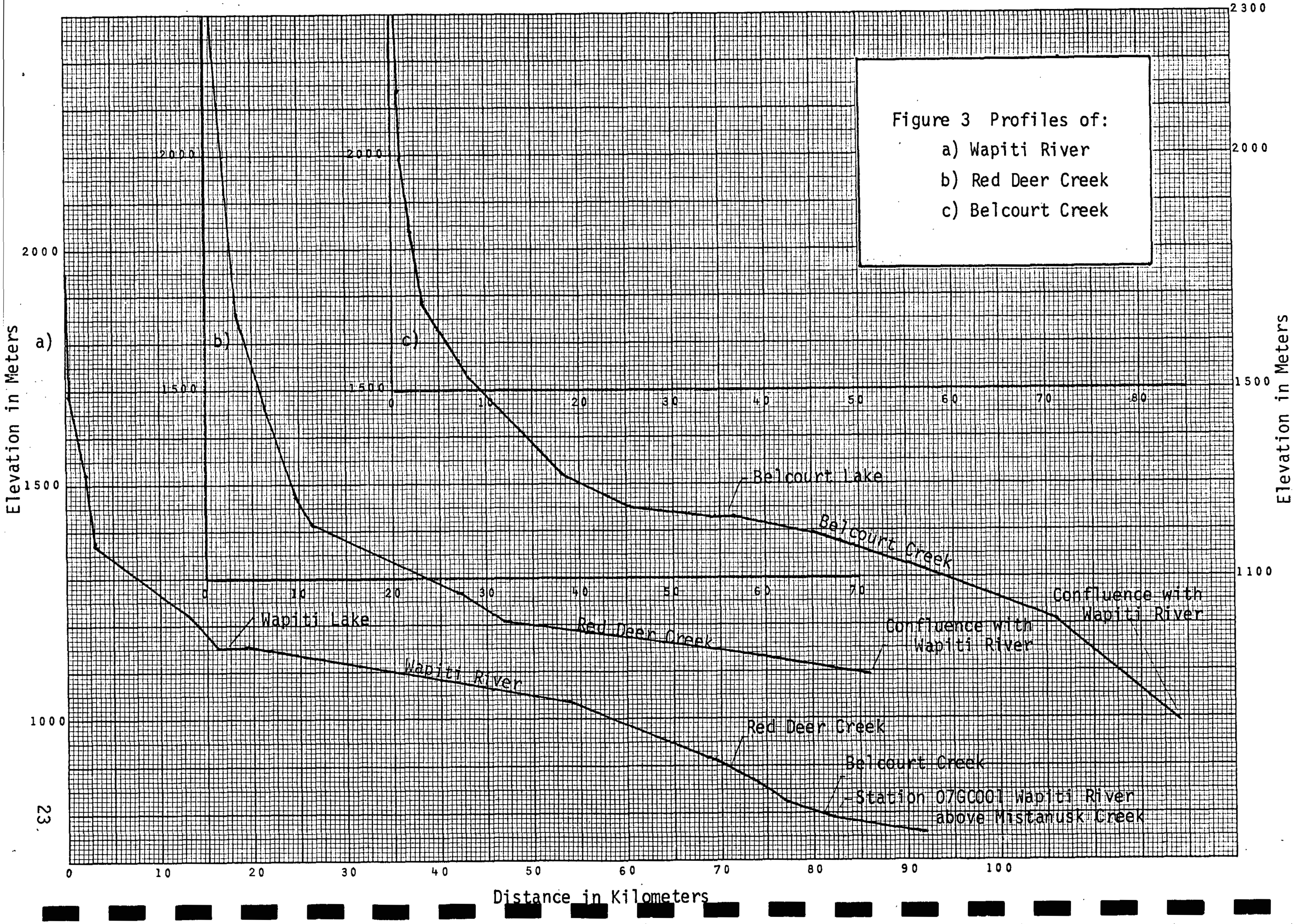


Figure 3 Profiles of:
a) Wapiti River
b) Red Deer Creek
c) Belcourt Creek
Elevation in Meters
Distance in Kilometers
Wapiti Lake
Wapiti River
Red Deer Creek
Belcourt Lake
Belcourt Creek
Confluence with Wapiti River
Station 07GC001 Wapiti River above Mistanusk Creek

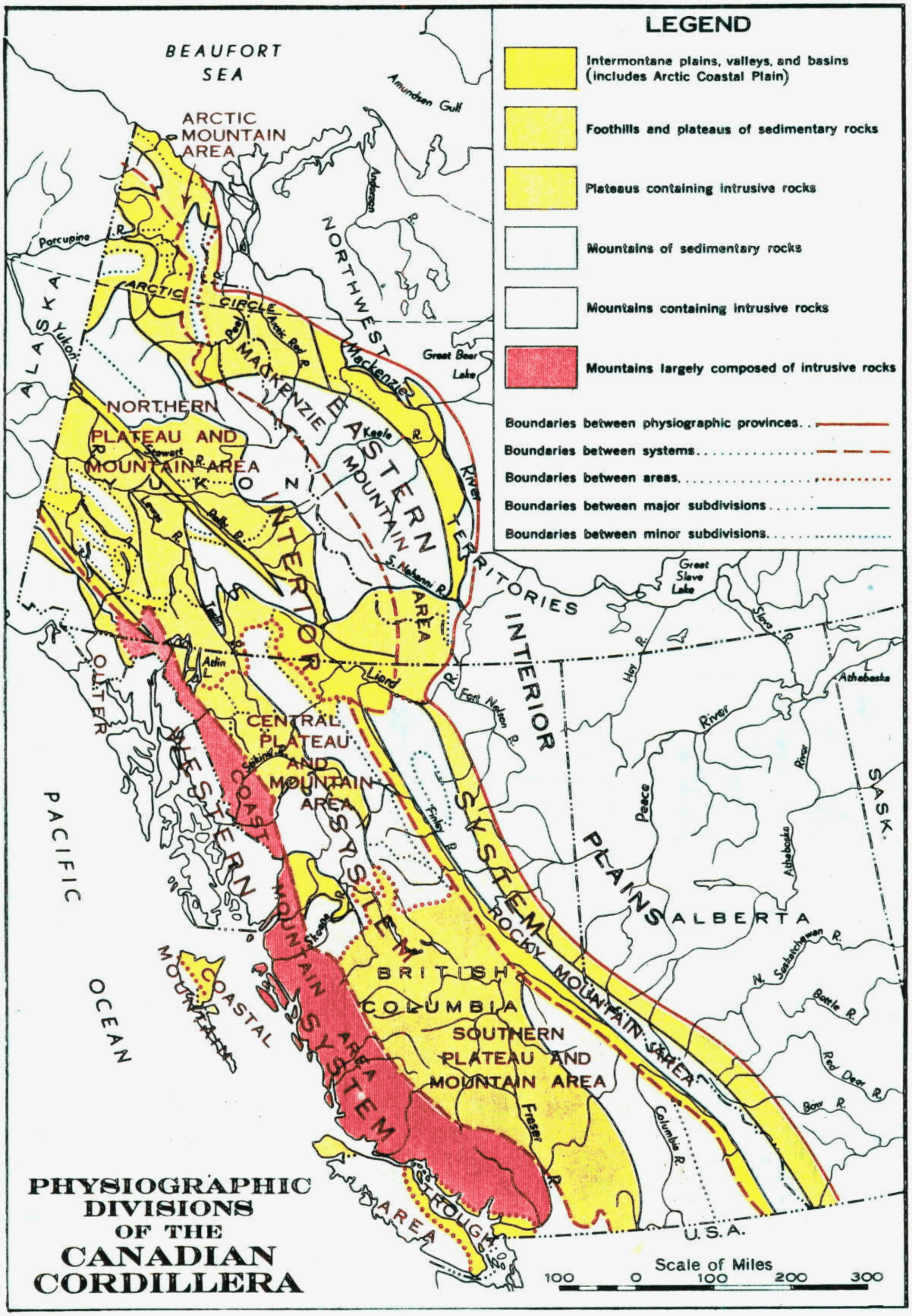



Figure 2 Geological Survey of Canada Memoir 247

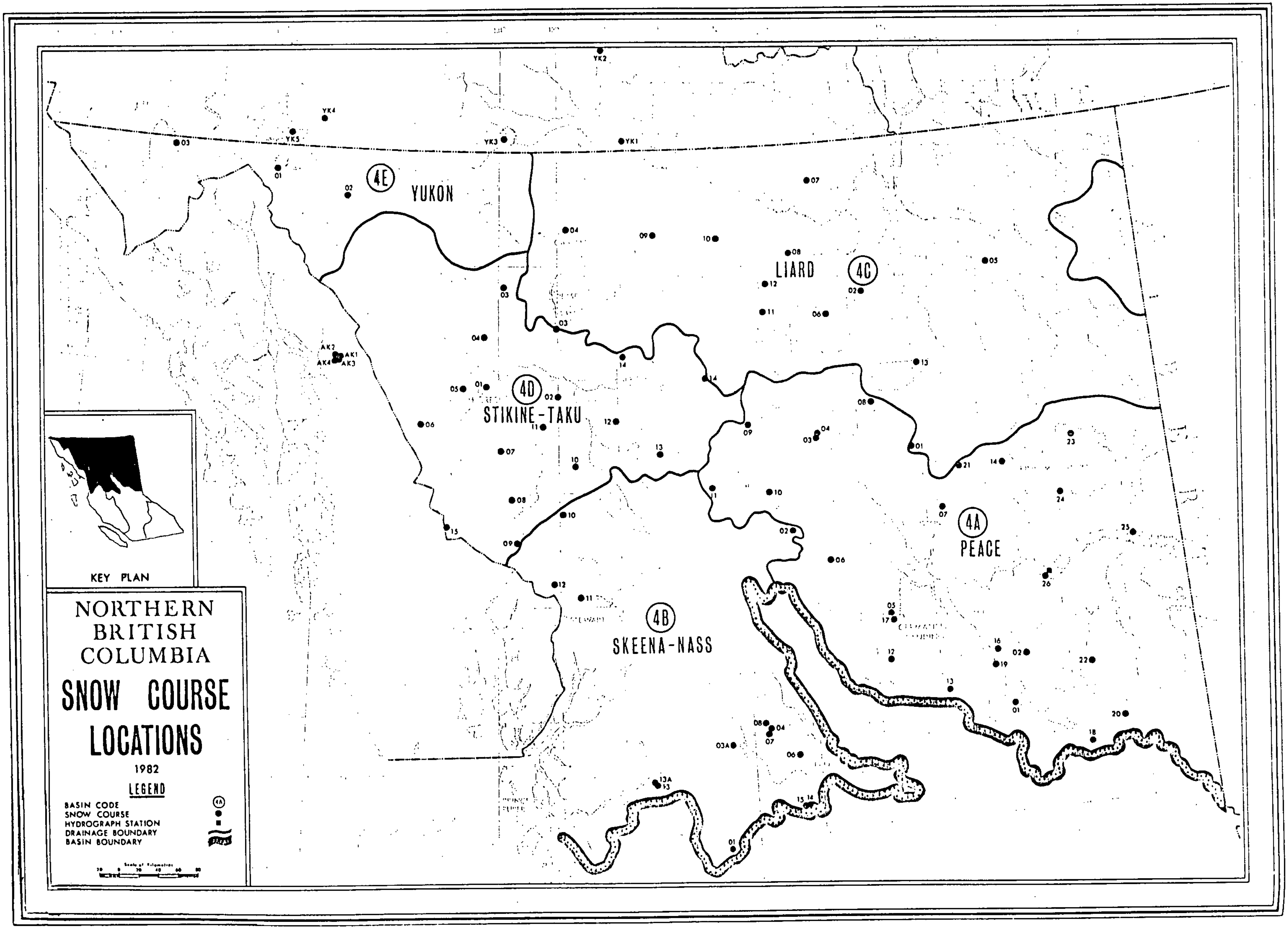



Figure 4 Snow Survey Bulletin - Ministry of Environment, Victoria, B.C.

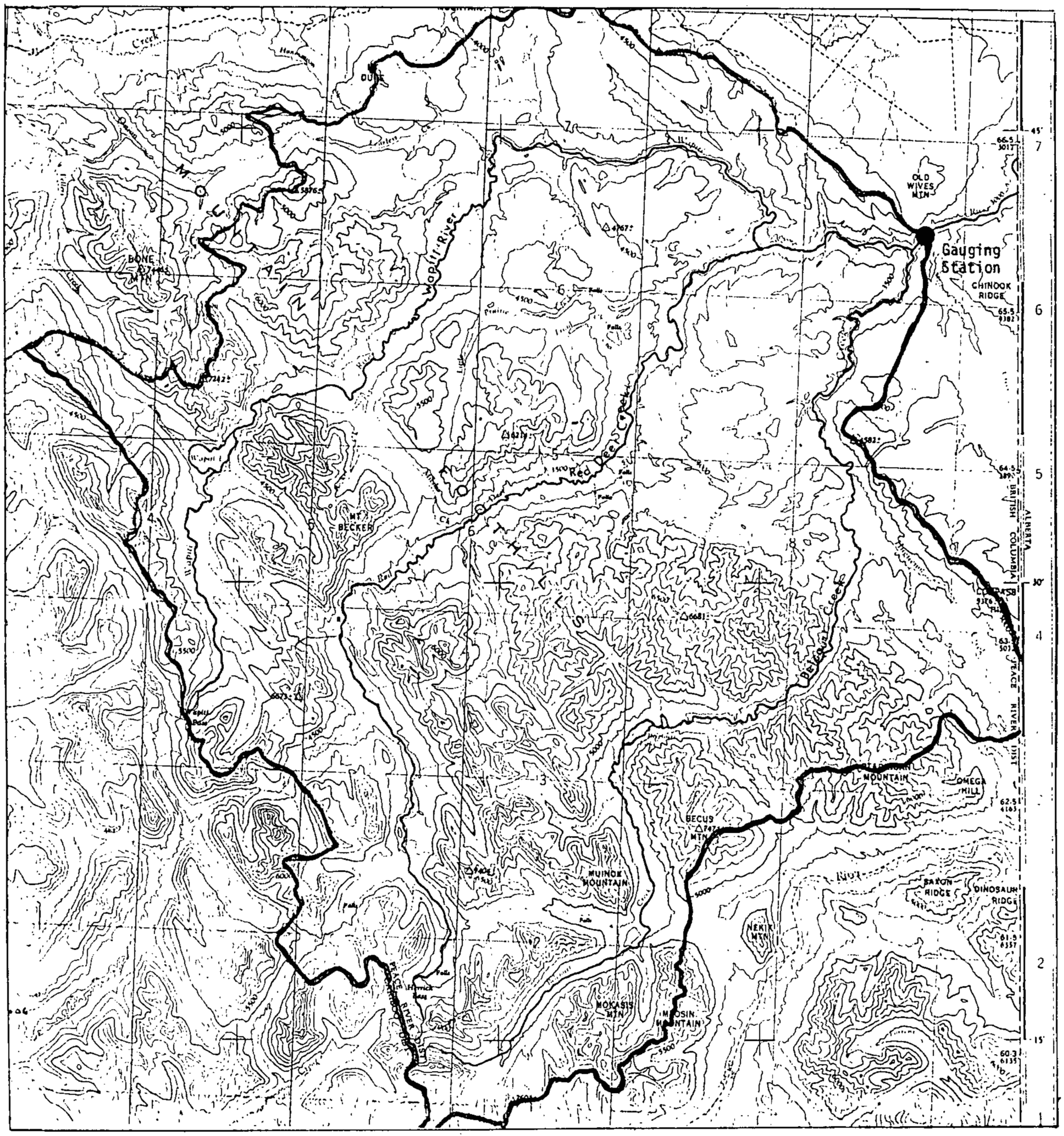
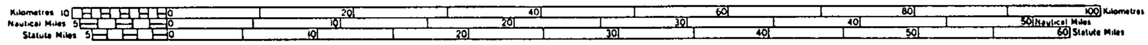



FIGURE 5. WAPITI RIVER BASIN IN BRITISH COLUMBIA




SCALE 1:500,000

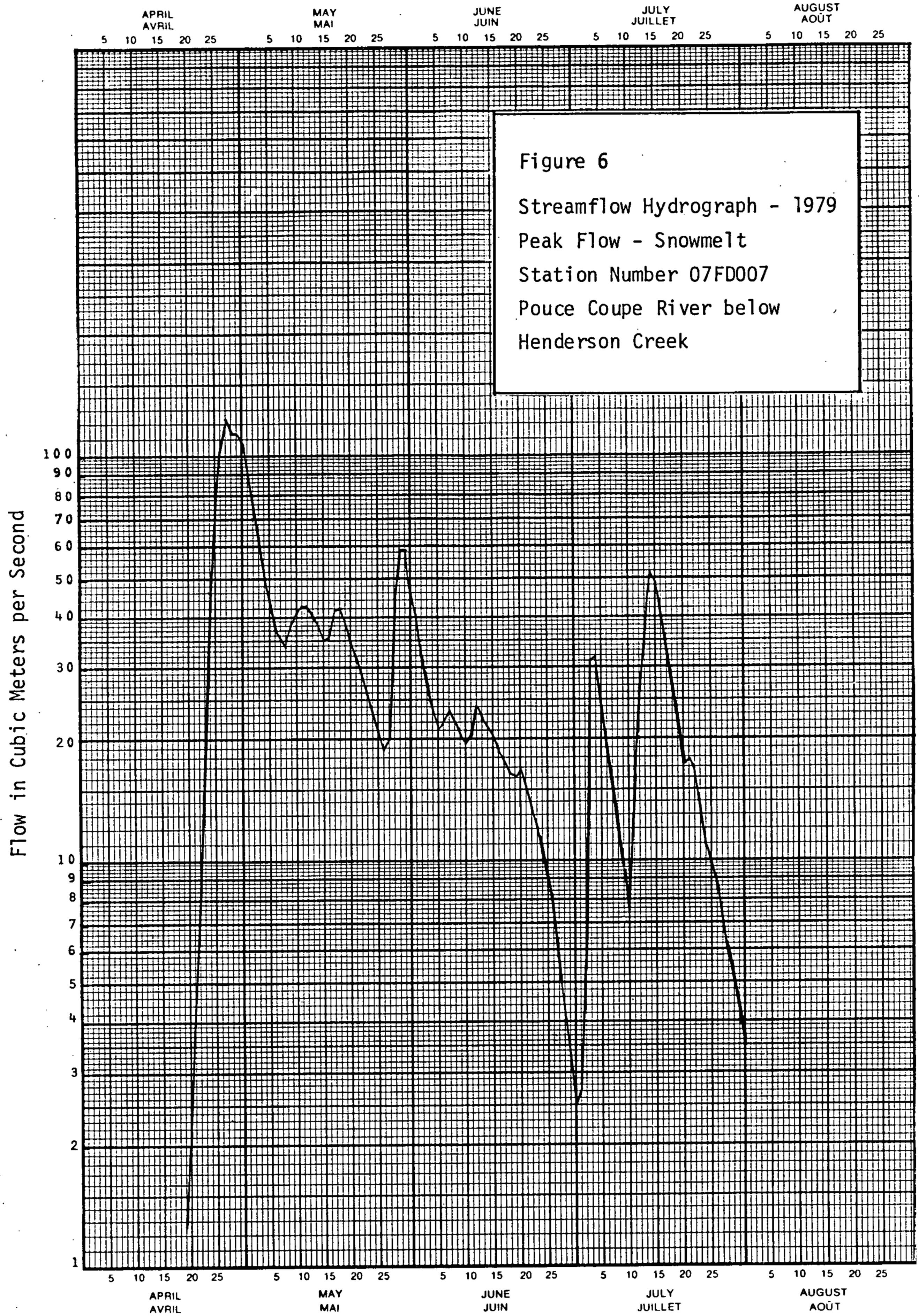



Figure 6

Streamflow Hydrograph - 1979

Peak Flow - Snowmelt

Station Number 07FD007

Pouce Coupe River below

Henderson Creek

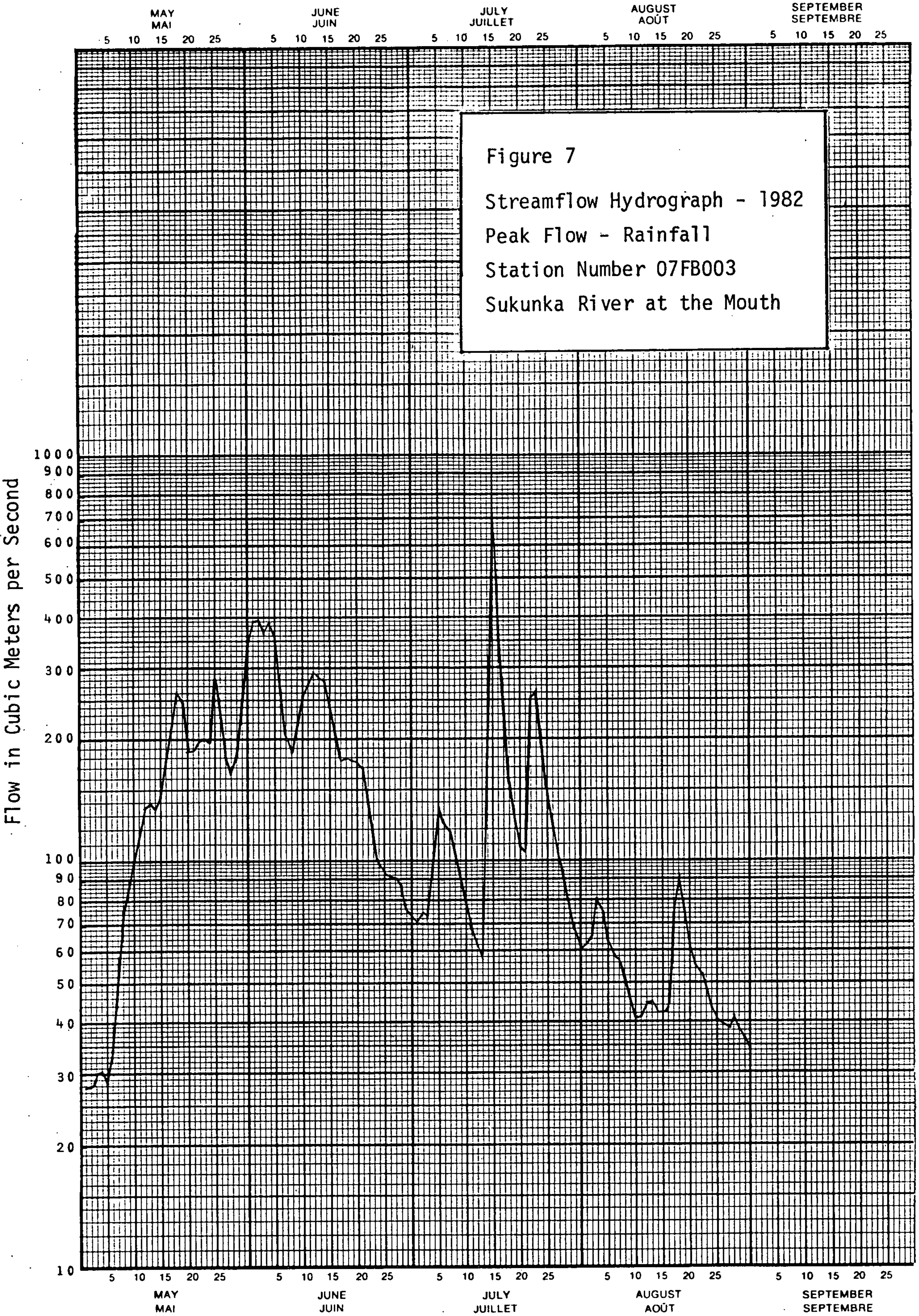


Figure 7
Streamflow Hydrograph - 1982
Peak Flow - Rainfall
Station Number 07FB003
Sukunka River at the Mouth
Flow in Cubic Meters per Second
MAY
MAI
JUNE
JUIN
JULY
JUILLET
AUGUST
AOÛT
SEPTEMBER
SEPTEMBRE
5 10 15 20 25
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10

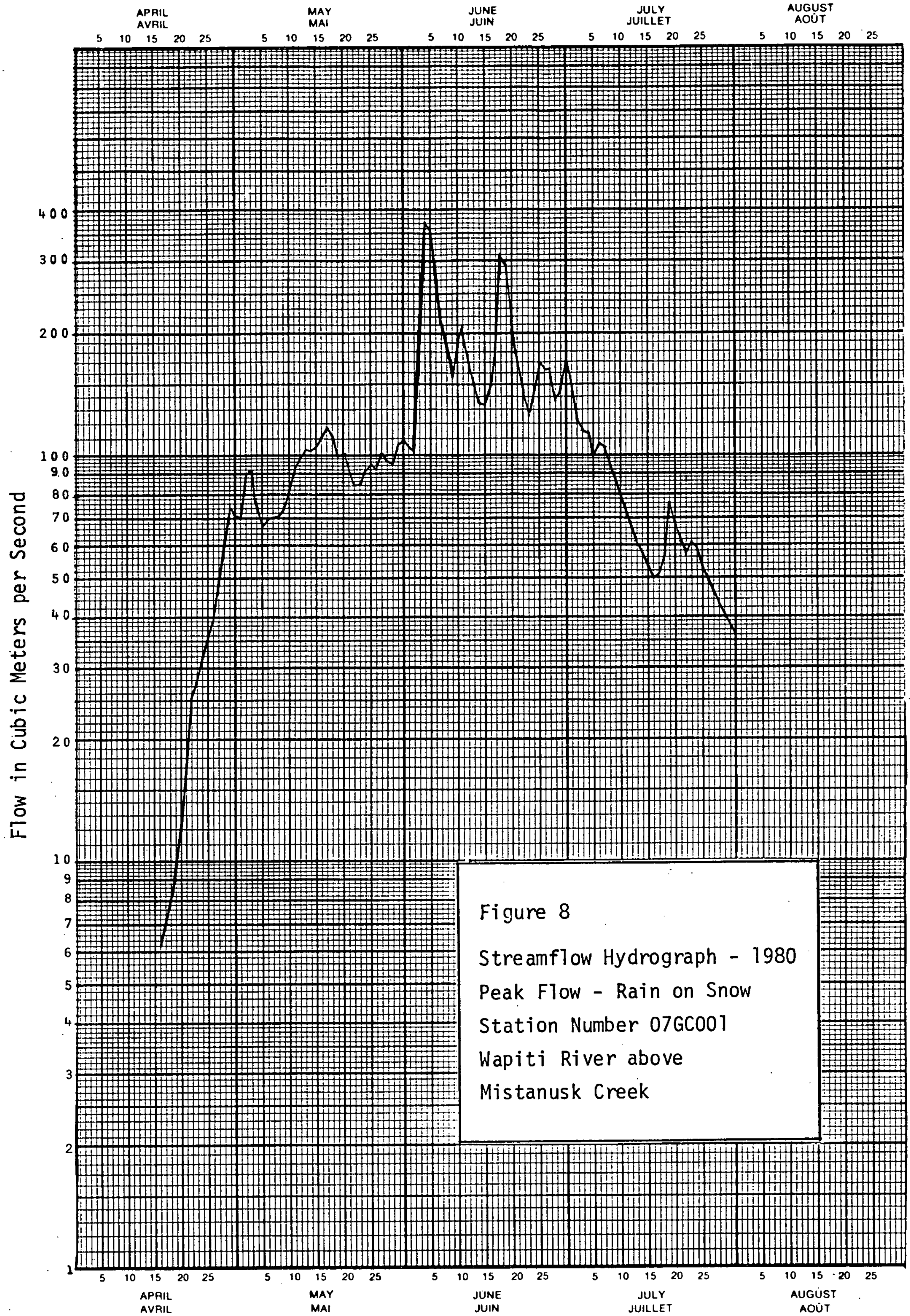



Figure 8

Streamflow Hydrograph - 1980

Peak Flow - Rain on Snow

Station Number 07GC001

Wapiti River above

Mistanusk Creek

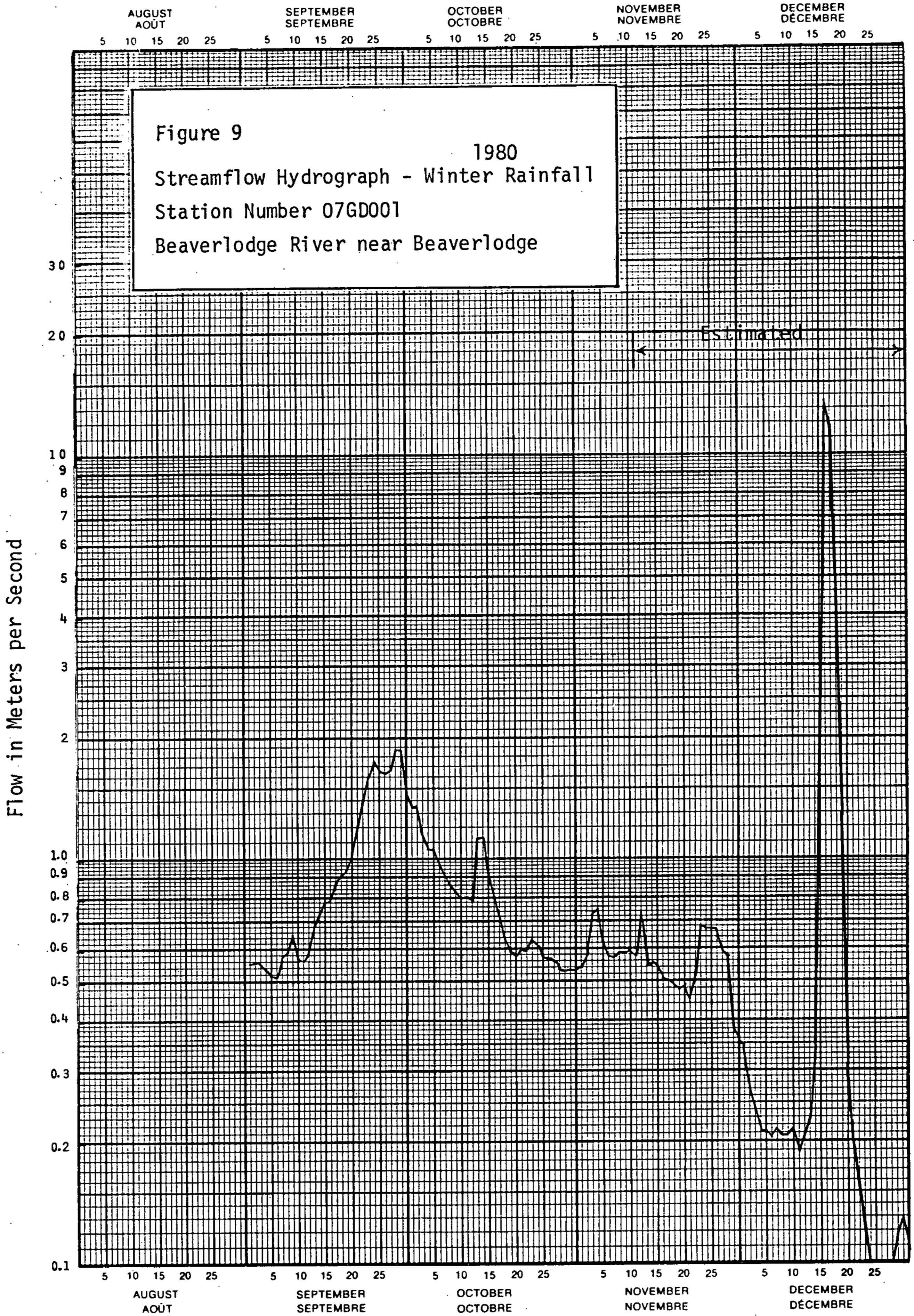



Figure 9

1980

Streamflow Hydrograph - Winter Rainfall

Station Number 07GD001

Beaverlodge River near Beaverlodge

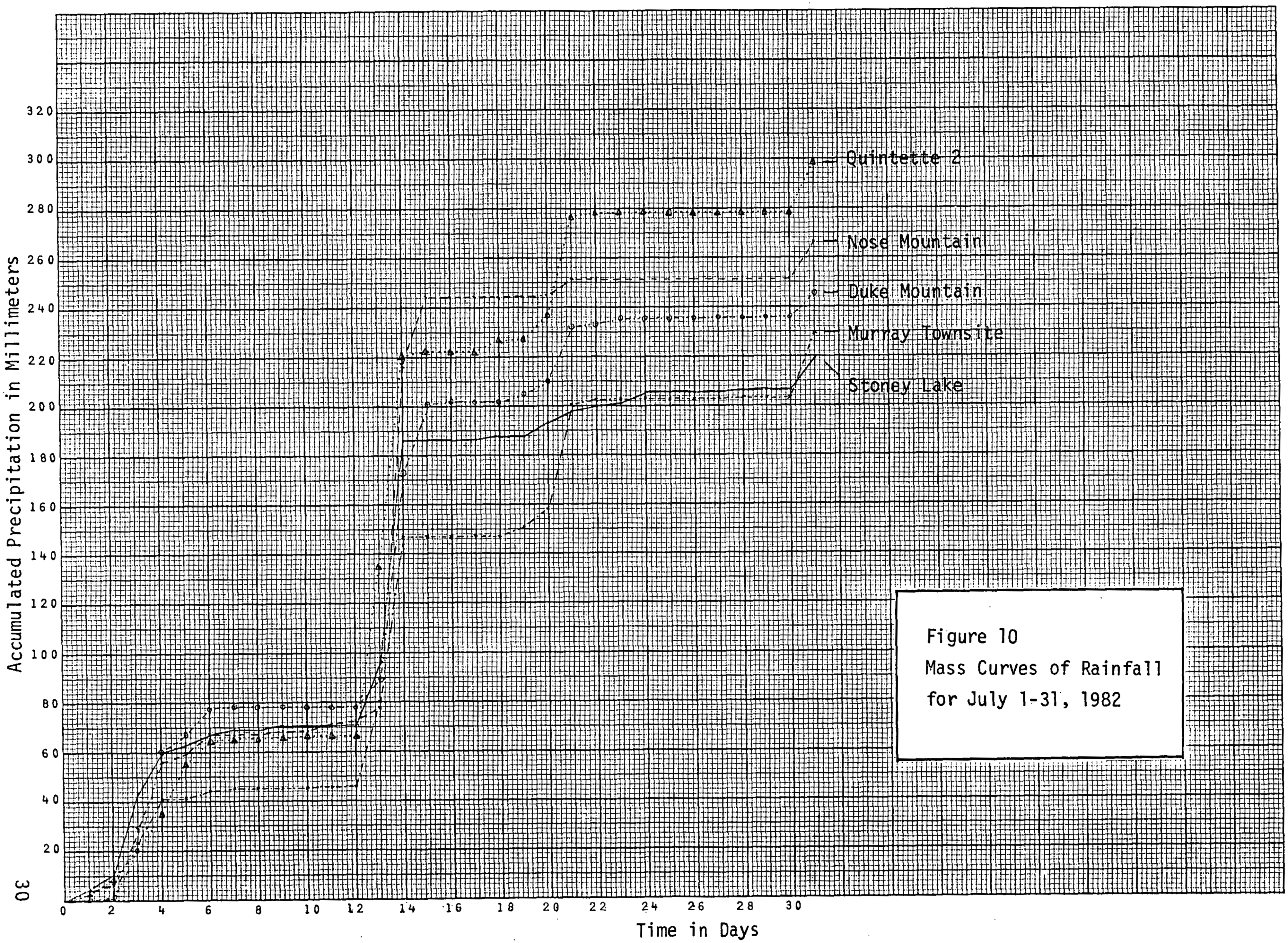



Figure 10
Mass Curves of Rainfall
for July 1-31, 1982

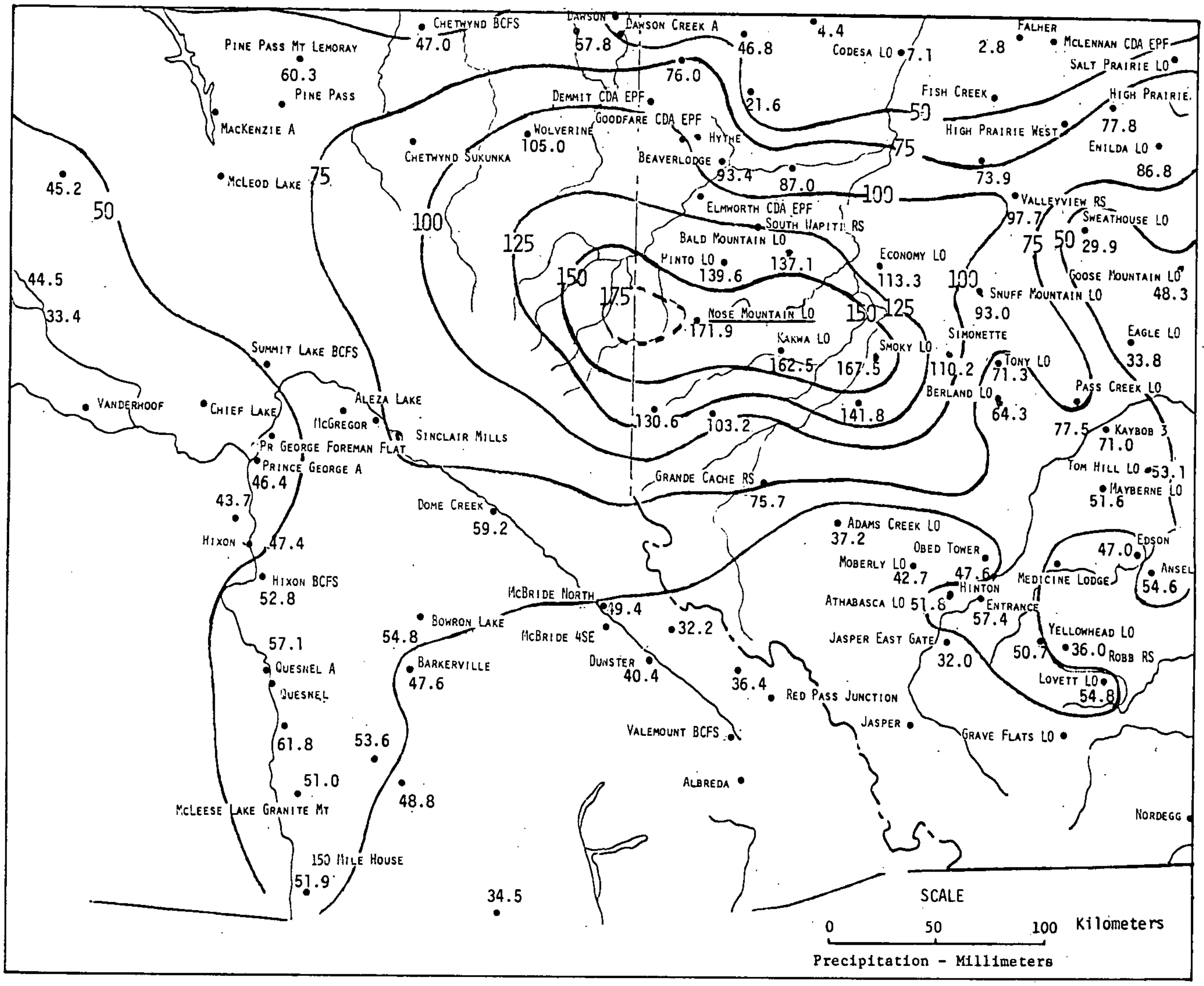



FIGURE 11 ISOHYETAL CHART - SMOKY RIVER BASIN (WAPITI RIVER) - JULY 13-15, 1982 (A.E.S. - EDMONTON)

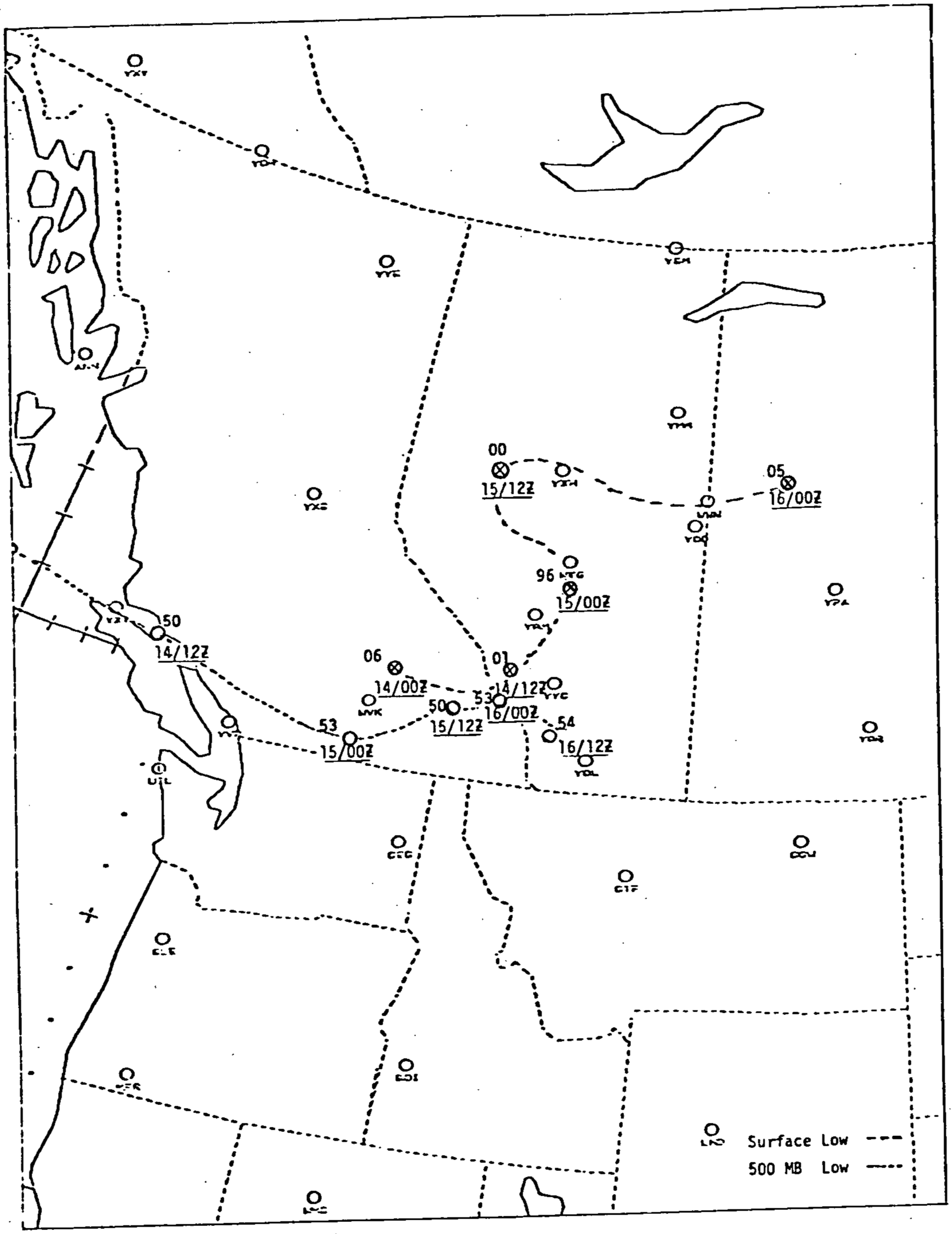
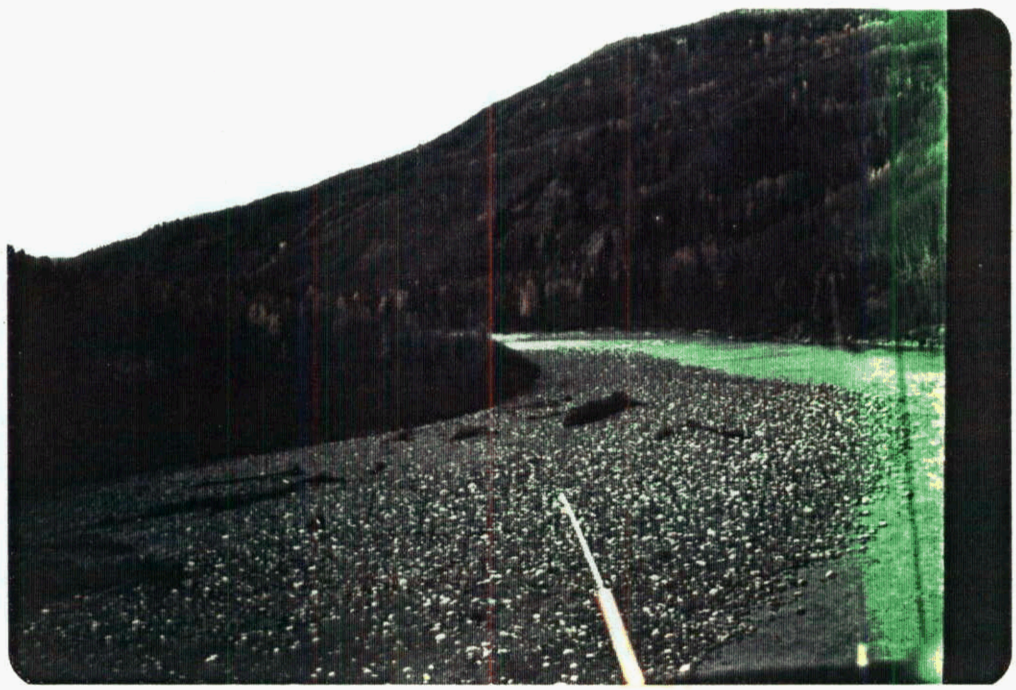



Figure 12 Surface Low and 500-Millibar Low Chart - July 14-15,1982
(A.E.S. Edmonton)

#10 exposure

Crest Stage Gauge Located on Post



Looking Upstream from Station

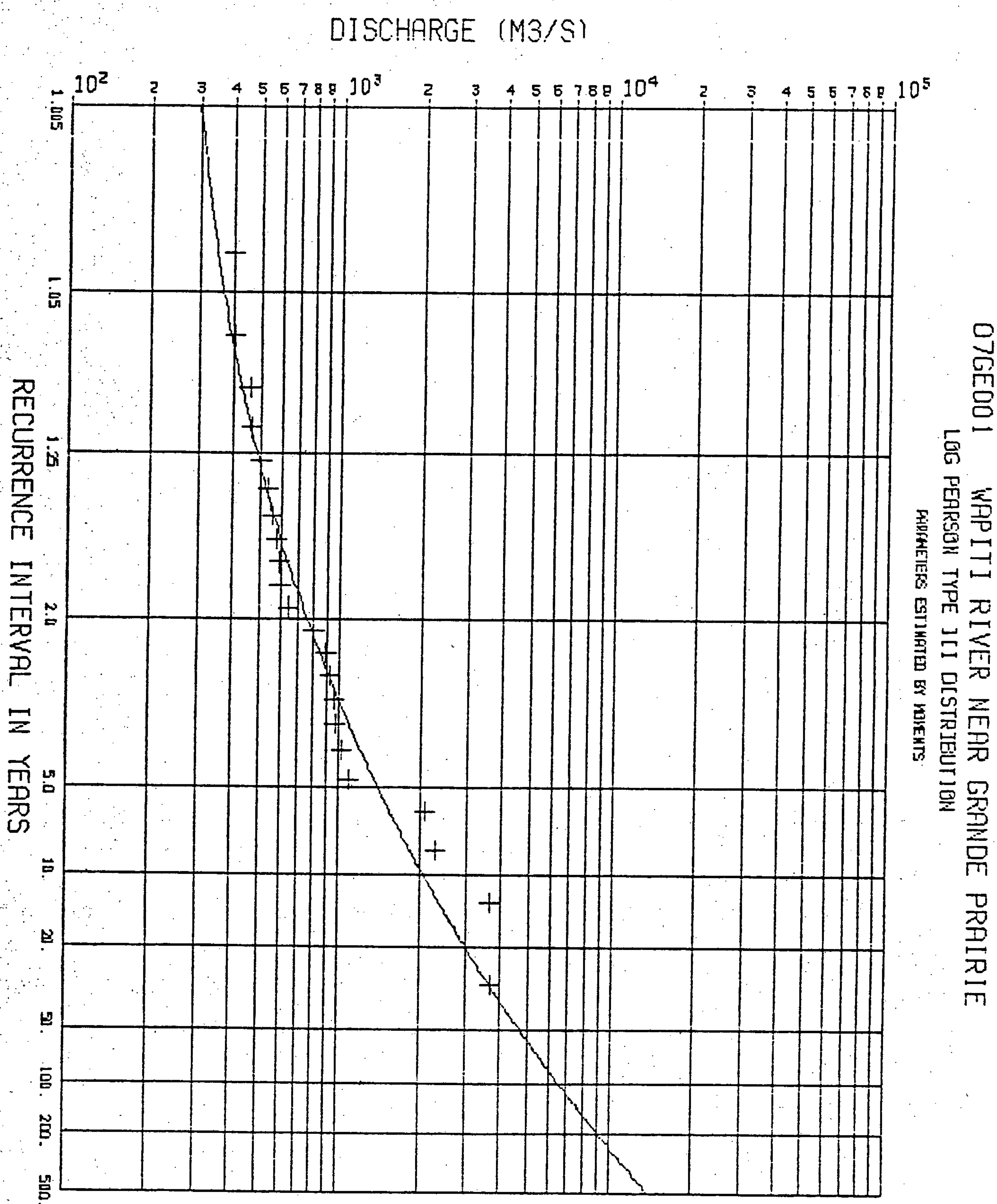
Figure 13. Wapiti River above Mistanusk Creek after Flood of July 14, 1982

#4 Exposure

Highwater Mark on Left Bank and Downstream of Control

Highwater Mark Left Bank

Figure 13a. Wapiti River above Mistanusk Creek after Flood of July 14, 1982



07GE001 WAPITI RIVER NEAR GRANDE PRAIRIE
LOG PEARSON TYPE III DISTRIBUTION
PARAMETERS ESTIMATED BY MOMENTS
DISCHARGE (M3/S)
RECURRENCE INTERVAL IN YEARS

# M A X I M U M   D A I L Y   M E A N   F L O W S

## 07GC001     WAPITI RIVER ABOVE MISTANUSK CREEK

| DATE | MAXIMUM DAILY FLOW IN M3/S |
|---|---|
| JUL 11 1978 | 231.0 |
| JUN 05 1979 | 314.0 |
| JUN 04 1980 | 371.0 |
| MAY 26 1981 | 258.0 |
| JUL 14 1982 | 650.0 |

| RANK | RECURRENCE INTERVAL IN YEARS | MAXIMUM DAILY FLOW IN M3/S | YEAR |
|---|---|---|---|
| 1 | 7.237 | 650.0 | 1982 |
| 2 | 3.125 | 371.0 | 1980 |
| 3 | 1.993 | 314.0 | 1979 |
| 4 | 1.463 | 258.0 | 1981 |
| 5 | 1.155 | 231.0 | 1978 |

MEAN ANNUAL FLOOD: 364.8 M3/S

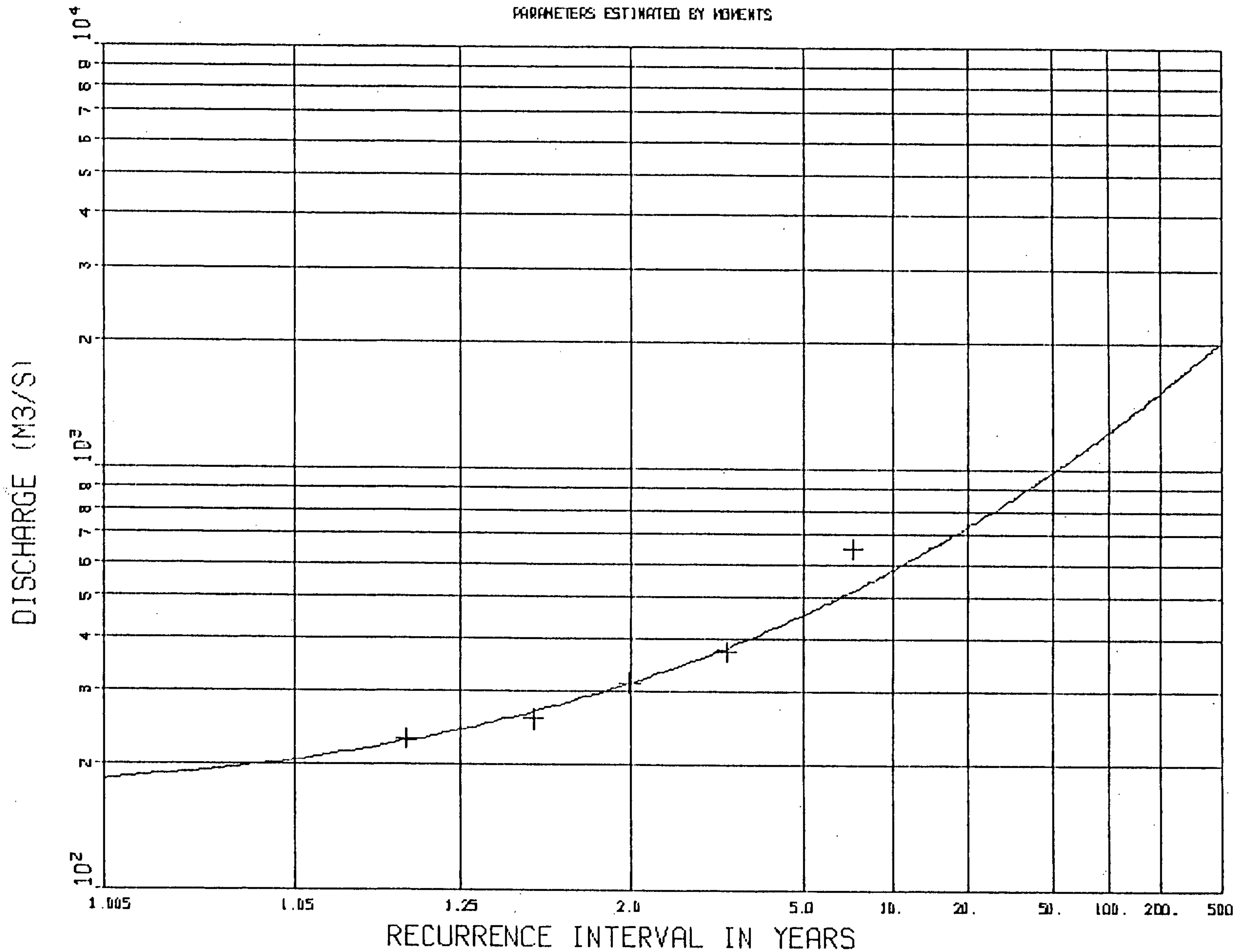
DRAINAGE AREA: 2400 SQ KM

STANDARD DEVIATION: 168.276 M3/S

07GC001 WAPITI RIVER ABOVE MISTANUSK CREEK

LOG PEARSON TYPE III DISTRIBUTION

PARAMETERS ESTIMATED BY MOMENTS



# M A X I M U M   D A I L Y   M E A N   F L O W S

## 07GE001   WAPITI RIVER NEAR GRANDE PRAIRIE

| DATE | MAXIMUM DAILY FLOW IN M3/S |
|---|---|
| MAY 24 1961 | 396.0 |
| JUL 19 1962 | 1020.0 |
| MAY 23 1963 | 535.0 |
| JUN 29 1964 | 2090.0 |
| JUL 9 1965 | 2280.0 |
| MAY 11 1966 | 606.0 |
| JUN 3 1967 | 960.0 |
| JUN 14 1968 | 807.0 |
| MAY 4 1969 | 402.0 |
| JUN 4 1970 | 467.0 |
| JUL 13 1971 | 968.0 |
| JUN 13 1972 | 3680.0 |
| MAY 19 1973 | 459.0 |
| APR 30 1974 | 595.0 |
| JUL 17 1975 | 561.0 |
| AUG 8 1976 | 926.0 |
| MAY 7 1977 | 889.0 |
| JUL 12 1978 | 646.0 |
| JUN 4 1979 | 585.0 |
| JUN 5 1980 | 1100.0 |
| MAY 27 1981 | 505.0 |
| JUL 16 1982 | 3630.0 |

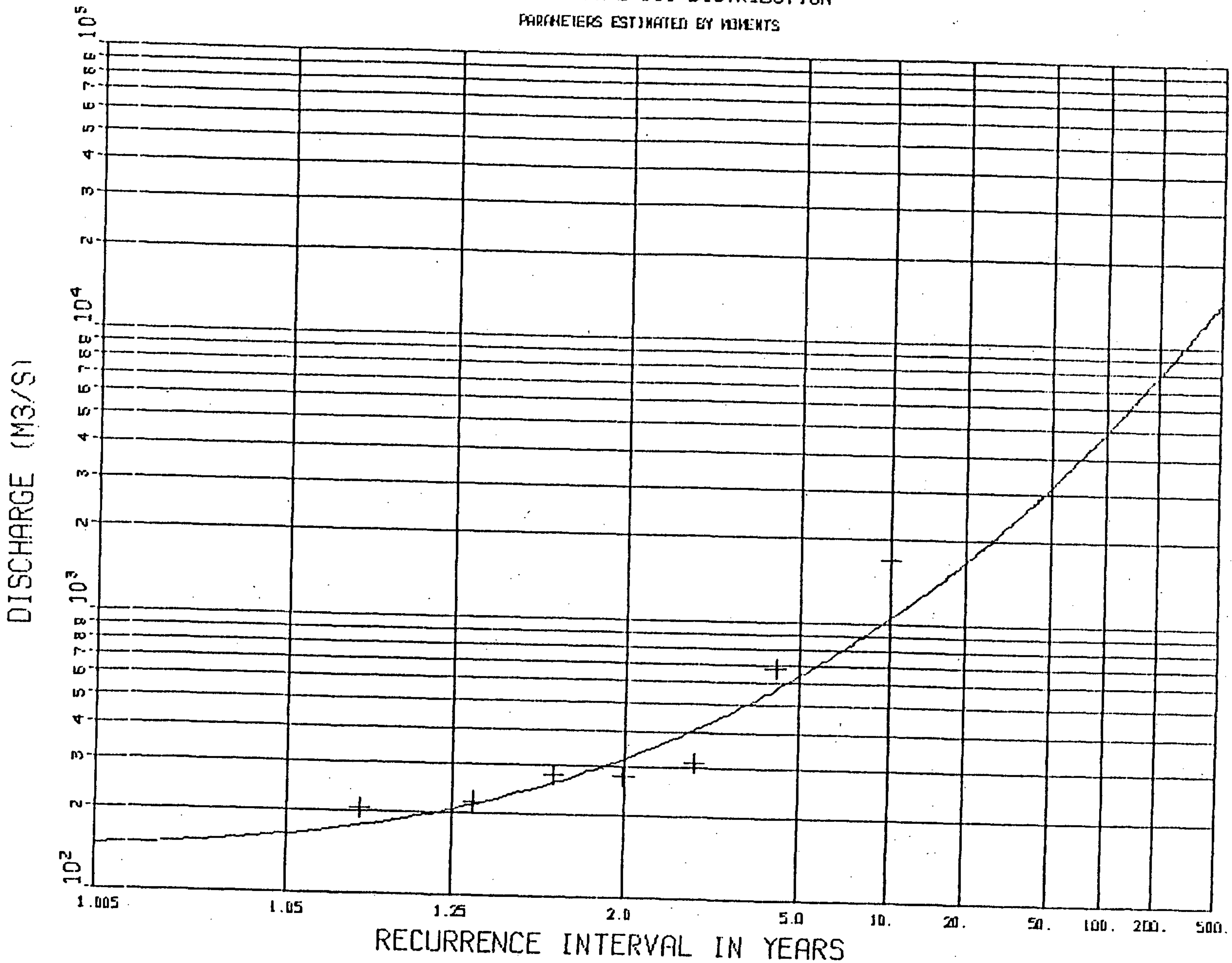
| RANK | RECURRENCE INTERVAL IN YEARS | MAXIMUM DAILY FLOW IN M3/S | YEAR |
|---|---|---|---|
| 1 | 29.605 | 3680.0 | 1972 |
| 2 | 12.784 | 3630.0 | 1982 |
| 3 | 8.152 | 2280.0 | 1965 |
| 4 | 5.984 | 2090.0 | 1964 |
| 5 | 4.727 | 1100.0 | 1980 |
| 6 | 3.906 | 1020.0 | 1962 |
| 7 | 3.328 | 968.0 | 1971 |
| 8 | 2.899 | 960.0 | 1967 |
| 9 | 2.568 | 926.0 | 1976 |
| 10 | 2.305 | 889.0 | 1977 |
| 11 | 2.091 | 807.0 | 1968 |
| 12 | 1.913 | 646.0 | 1978 |
| 13 | 1.763 | 606.0 | 1966 |
| 14 | 1.635 | 595.0 | 1974 |
| 15 | 1.524 | 585.0 | 1979 |
| 16 | 1.428 | 561.0 | 1975 |
| 17 | 1.342 | 535.0 | 1963 |
| 18 | 1.267 | 505.0 | 1981 |
| 19 | 1.199 | 467.0 | 1970 |
| 20 | 1.139 | 459.0 | 1973 |
| 21 | 1.084 | 402.0 | 1969 |
| 22 | 1.034 | 396.0 | 1961 |

MEAN ANNUAL FLOOD:   1095.8 M3/S

DRAINAGE AREA:   11300 SQ KM

STANDARD DEVIATION:   960.209 M3/S

07GB002 KAKWA RIVER NEAR GRANDE PRAIRIE
LOG PEARSON TYPE III DISTRIBUTION
PARAMETERS ESTIMATED BY MOMENTS



## 07GB002 KAKWA RIVER NEAR GRANDE PRAIRIE

| DATE | MAXIMUM DAILY FLOW IN M3/S |
|---|---|
| JUN 27 1976 | 275.0 |
| MAY 06 1977 | 309.0 |
| JUN 23 1978 | 220.0 |
| MAY 27 1979 | 275.0 |
| JUN 04 1980 | 683.0 |
| MAY 27 1981 | 205.0 |
| JUL 15 1982 | 1680.0 |

| RANK | RECURRENCE INTERVAL IN YEARS | MAXIMUM DAILY FLOW IN M3/S | YEAR |
|---|---|---|---|
| 1 | 9.868 | 1680.0 | 1982 |
| 2 | 4.261 | 683.0 | 1980 |
| 3 | 2.717 | 309.0 | 1977 |
| 4 | 1.995 | 275.0 | 1976 |
| 5 | 1.576 | 275.0 | 1979 |
| 6 | 1.302 | 220.0 | 1978 |
| 7 | 1.109 | 205.0 | 1981 |

MEAN ANNUAL FLOOD: 521.0 M3/S

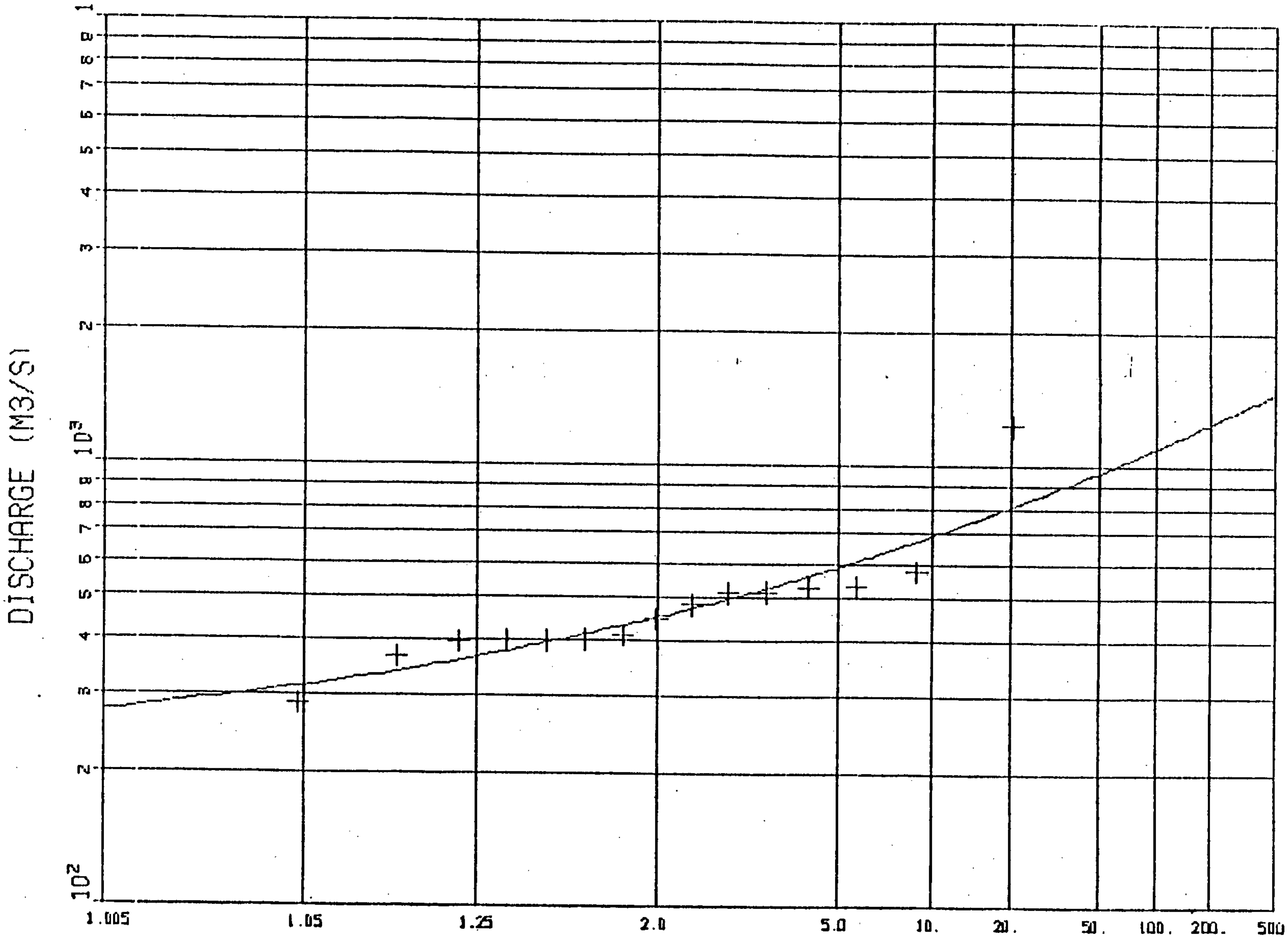
DRAINAGE AREA: 3290 SQ KM

STANDARD DEVIATION: 536.339 M3/S

07GA001 SMOKY RIVER ABOVE HELLS CREEK

LOG PEARSON TYPE III DISTRIBUTION

PARAMETERS ESTIMATED BY MAXIMUM LIKELIHOOD



# M A X I M U M   D A I L Y   M E A N   F L O W S

## 07GA001   SMOKY RIVER ABOVE HELLS CREEK

| DATE | MAXIMUM DAILY FLOW IN M3/S |
|---|---|
| MAY 21 1968 | 286.0 |
| JUN 04 1969 | 399.0 |
| JUN 04 1970 | 527.0 |
| JUN 09 1971 | 515.0 |
| JUN 12 1972 | 1230.0 |
| JUN 24 1973 | 575.0 |
| JUN 16 1974 | 532.0 |
| JUL 06 1975 | 396.0 |
| JUL 01 1976 | 365.0 |
| JUN 08 1977 | 484.0 |
| JUL 11 1978 | 399.0 |
| JUN 05 1979 | 409.0 |
| JUN 04 1980 | 446.0 |
| MAY 26 1981 | 402.0 |
| JUN 15 1982 | 513.0 |

| RANK | RECURRENCE INTERVAL IN YEARS | MAXIMUM DAILY FLOW IN M3/S | YEAR |
|---|---|---|---|
| 1 | 20.395 | 1230.0 | 1972 |
| 2 | 8.807 | 575.0 | 1973 |
| 3 | 5.616 | 532.0 | 1974 |
| 4 | 4.122 | 527.0 | 1970 |
| 5 | 3.256 | 515.0 | 1971 |
| 6 | 2.691 | 513.0 | 1982 |
| 7 | 2.293 | 484.0 | 1977 |
| 8 | 1.997 | 446.0 | 1980 |
| 9 | 1.769 | 409.0 | 1979 |
| 10 | 1.588 | 402.0 | 1981 |
| 11 | 1.441 | 399.0 | 1969 |
| 12 | 1.318 | 399.0 | 1978 |
| 13 | 1.215 | 396.0 | 1975 |
| 14 | 1.126 | 365.0 | 1976 |
| 15 | 1.050 | 286.0 | 1968 |

MEAN ANNUAL FLOOD: 498.5 M3/S

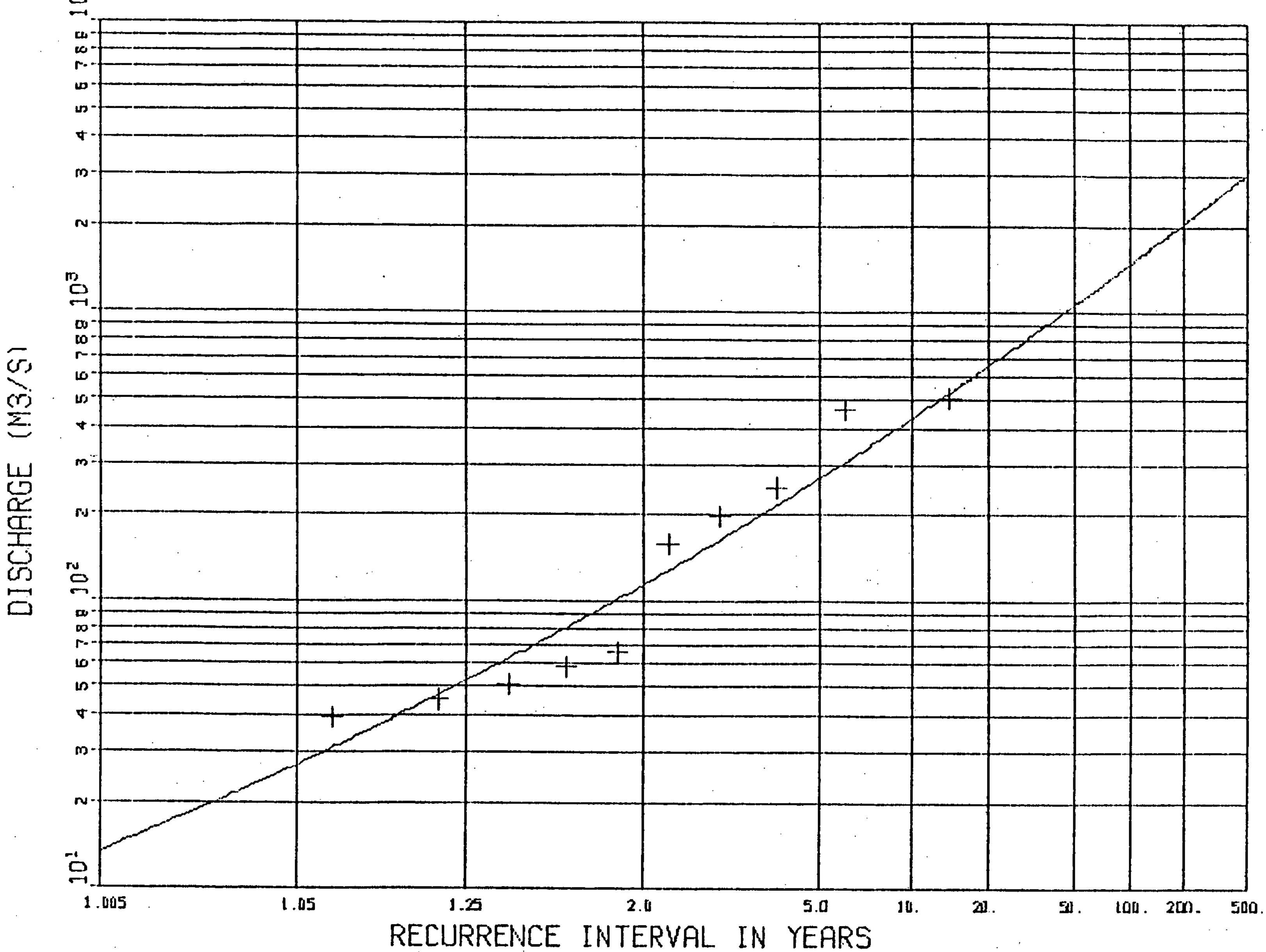
DRAINAGE AREA: 3830 SQ KM

STANDARD DEVIATION: 216.619 M3/S

07GB001 CUTBANK RIVER NEAR GRANDE PRAIRIE

LOG PEARSON TYPE III DISTRIBUTION

PARAMETERS ESTIMATED BY MOMENTS



# MAXIMUM DAILY MEAN FLOWS

## 07GB001 CUTBANK RIVER NEAR GRANDE PRAIRIE

| DATE | MAXIMUM DAILY FLOW IN M3/S |
|---|---|
| JUL 11 1971 | 198.0 |
| JUN 12 1972 | 464.0 |
| MAY 05 1973 | 39.2 |
| MAY 01 1974 | 51.3 |
| MAY 06 1977 | 159.0 |
| SEP 18 1978 | 45.0 |
| MAY 16 1979 | 66.0 |
| JUN 04 1980 | 249.0 |
| JUL 30 1981 | 59.2 |
| JUL 15 1982 | 506.0 |

| RANK | RECURRENCE INTERVAL IN YEARS | MAXIMUM DAILY FLOW IN M3/S | YEAR |
|---|---|---|---|
| 1 | 13.816 | 506.0 | 1982 |
| 2 | 5.966 | 464.0 | 1972 |
| 3 | 3.804 | 249.0 | 1980 |
| 4 | 2.793 | 198.0 | 1971 |
| 5 | 2.206 | 159.0 | 1977 |
| 6 | 1.823 | 66.0 | 1979 |
| 7 | 1.553 | 59.2 | 1981 |
| 8 | 1.353 | 51.3 | 1974 |
| 9 | 1.199 | 45.0 | 1978 |
| 10 | 1.076 | 39.2 | 1973 |

MEAN ANNUAL FLOOD: 183.7 M3/S

DRAINAGE AREA: 842 SQ KM

STANDARD DEVIATION: 174.651 M3/S

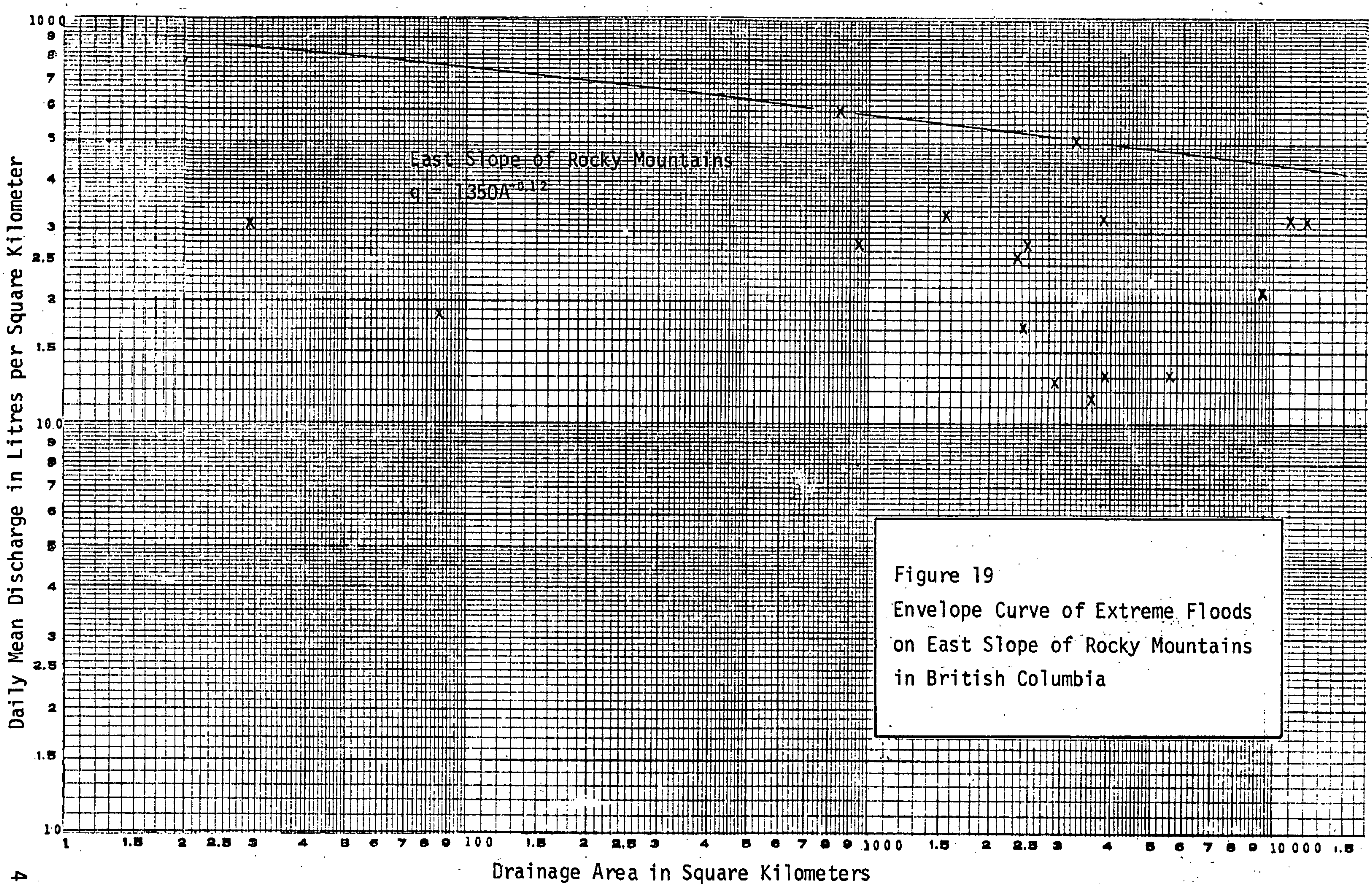



Figure 19
Envelope Curve of Extreme Floods
on East Slope of Rocky Mountains
in British Columbia