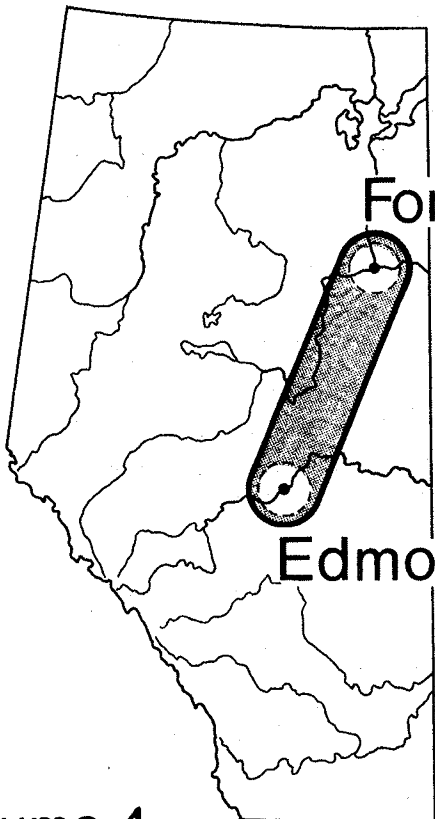
Transportation Corridor Study



Volume 4 Appendix

Environment

general characteristics & conditions - part 1

prepared for

Alberta
ENVIRONMENT

by

bolter parish trimble ltd.
ducks unlimited (canada)
tom peters & associates
siemens realty & appraisal services ltd.
stewart weir stewart watson & heinrichs

october, 1973

edmonton, alberta

TRANSPORTATION CORRIDOR STUDY

FORT McMURRAY to EDMONTON

VOLUME 4 – APPENDIX

ENVIRONMENT

GENERAL CHARACTERISTICS AND CONDITIONS PART I

Chapter I – Environment Characteristics and Conditions
by
Bolter Parish Trimble Ltd.

Chapter II – Soils
by
Tom Peters and Associates

Chapter III – Wildlife
by
Stewart Weir Stewart
Watson & Heinrichs

Ducks Unlimited (Canada)

Chapter IV – Preliminary Review and Land Evaluation
by
Siemens Realty and
Appraisal Services Ltd.

Prepared for:

Alberta
Environment
The Honorable
William Yurko

October, 1973

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

Edmonton, Alberta

TABLE OF CONTENTS

CHAPTER I - ENVIRONMENT CHARACTERISTICS AND CONDITIONS

LIST OF FIGURES

		Page

LIST OF FIGURES - (continued)

LIST OF TABLES

LIST OF PLATES

CHAPTER II - SOILS

CHAPTER III - WILDLIFE

LIST OF TABLES

LIST OF FIGURES

Page

LIST OF FIGURES - (continued)

LIST OF PLATES

CHAPTER IV - PRELIMINARY REVIEW AND LAND EVALUATION

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

TRANSPORTATION CORRIDOR STUDY

FORT McMURRAY to EDMONTON

CHAPTER I

ENVIRONMENT CHARACTERISTICS AND CONDITIONS

Prepared for:

Alberta
Environment
The Honorable
William Yurko

By:

Bolter Parish Trimble Ltd.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

INTRODUCTION

This report has been prepared on behalf of Stewart, Weir, Stewart, Watson and Heinrichs, and forms part of a study for the Alberta Department of Environment. The study consists of an evaluation of the type of transportation corridor(s) to be developed in conjunction with the development of the Athabasca Tar Sands.

The purpose of this report is to document the available information pertaining to the existing conditions and characteristics of:

1. Climate
2. Surface Water
3. Fish Resources
4. Impact of Existing Transportation Facilities on the Stream Crossings, between Edmonton and Fort McMurray
5. An Environment Sensitivity Map

The study area used is bounded by ranges 1 and 23 (west of the 4th meridian), and townships 53 and 90.

This report does not eliminate the need for future preliminary engineering investigations at individual sites.

CLIMATE OF THE EDMONTON - FORT MCMURRAY REGION

A Preliminary Report

INTRODUCTION

In the area north and east of Edmonton as far as Fort McMurray, various meteorological stations have been reporting for many years. The Alberta Forestry Service meteorology branch, as well as operating several summer recording stations, has analyzed summer temperature and precipitation data for the past decade. From the data available, annual climatic factors such as temperature means, maximums and minimums, precipitation, wind speed and direction have been presented as well as a summary of river break-up, freeze-up and ice thickness. The summary is based on D.O.T. and Alberta Forest Service weather record summaries and data.

TEMPERATURE

The area might be considered to be fairly homogeneous as far as mean annual temperatures are concerned.

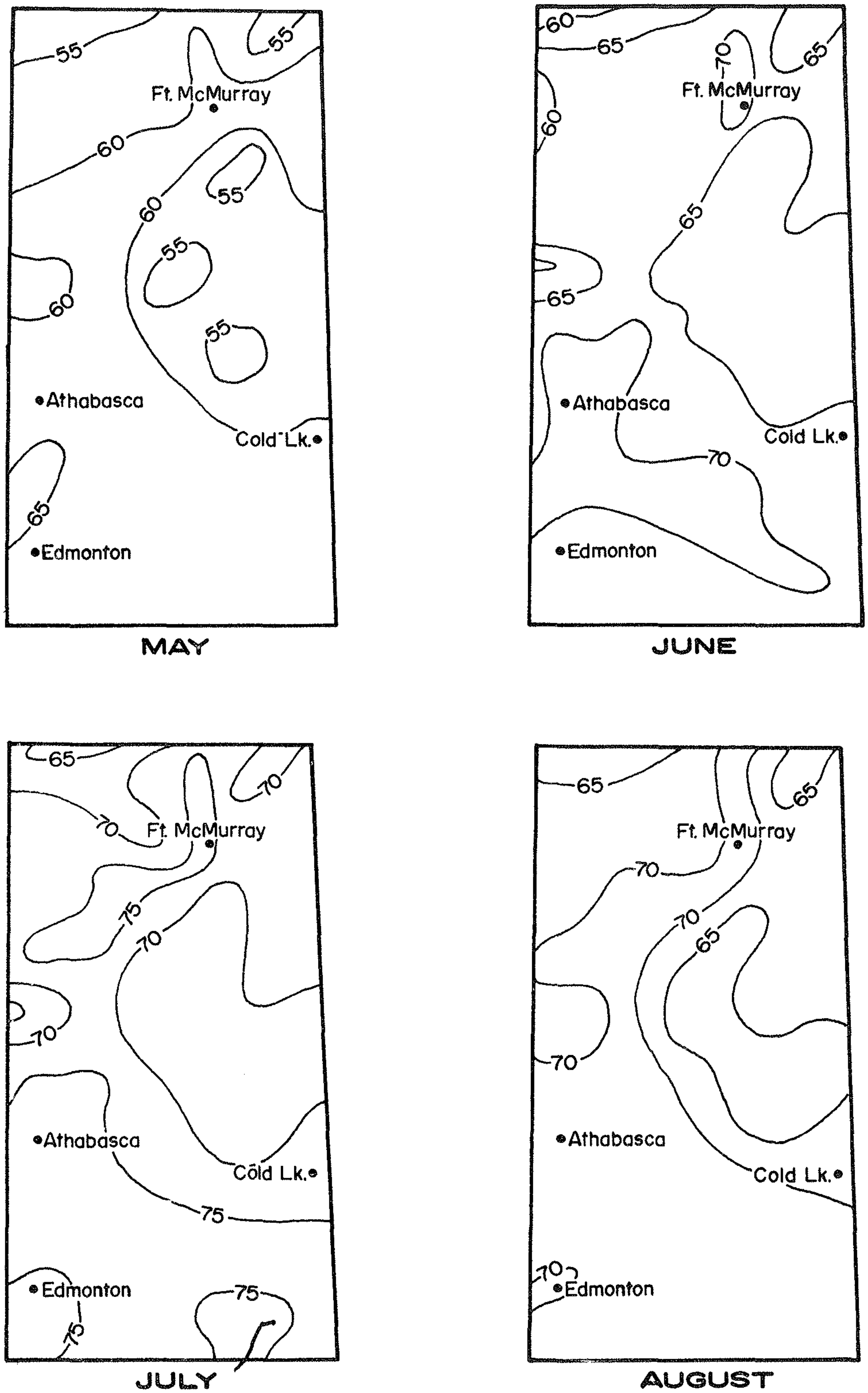
Annual Mean Daily Temperature Range of the Region is $34^{o}F \pm 2^{o}$.

Annual Mean Daily Maximum Temperature Range of the Region is $45^{o}F \pm 2^{o}$.

Annual Mean Daily Minimum Temperature Range of the Region is $25^{o}F \pm 2^{o}$.

Northwards, a slight decrease in temperatures is discernible (Figures 1A and 1B). Distribution of temperatures throughout the year is quite similar over the area with near freezing temperatures beginning in late September - October, and ending in March. See Figures 2 to 9 for temperature data for selected stations.

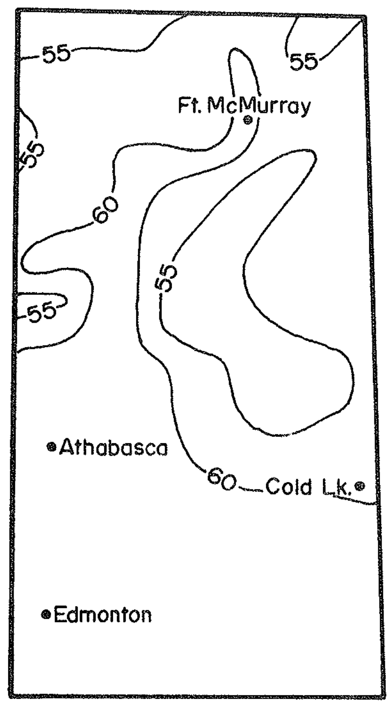
FIG. Ia



Monthly Mean Maximum Temperature

Dates from 1931 to 1960

Source · ALBERTA FOREST SERVICE



SEPTEMBER

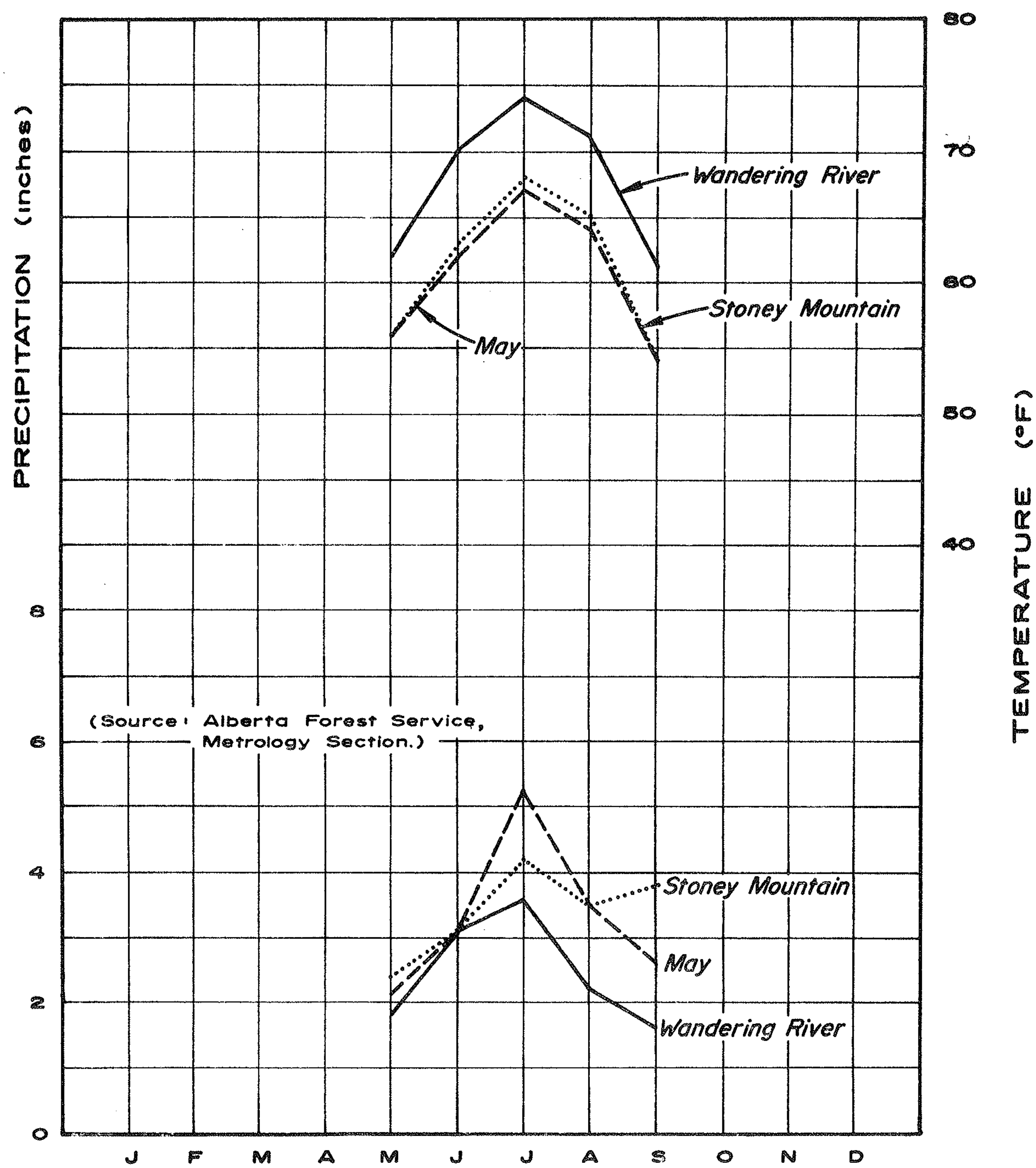
Monthly Mean Maximum Temperature

Dates from 1931 to 1960

Source · ALBERTA FOREST SERVICE

Mean monthly precipitation and probable 30 year normal maximum temperatures for three stations in Stoney Mountain Upland.
(May – September, 1963 – 1970)

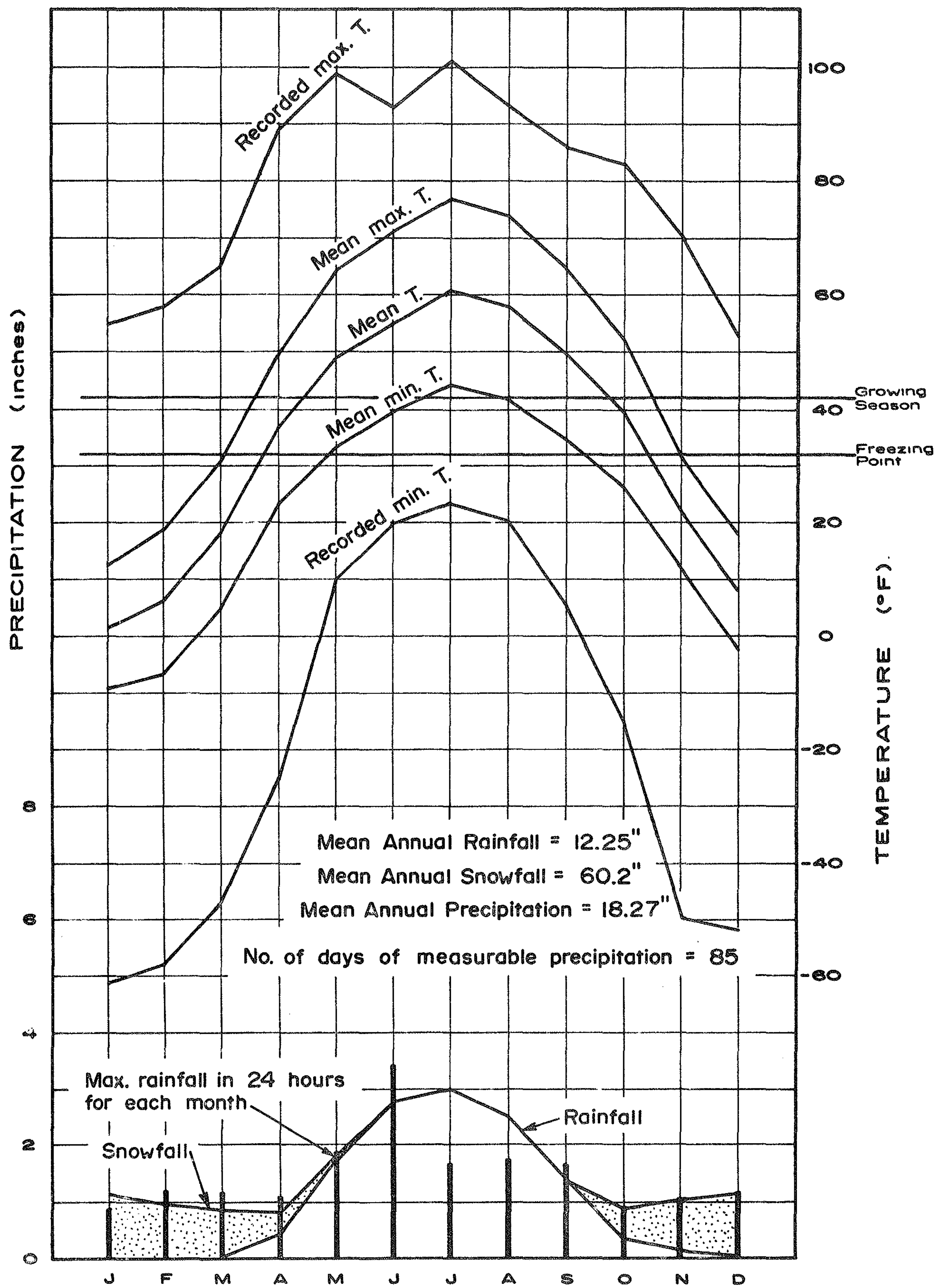
Wandering River – Elevation 1850 ft. A.S.L.
May – Elevation 2940 ft. A.S.L.
Stoney Mountain – Elevation 2500 ft. A.S.L.



ATHABASCA

FIG. 3

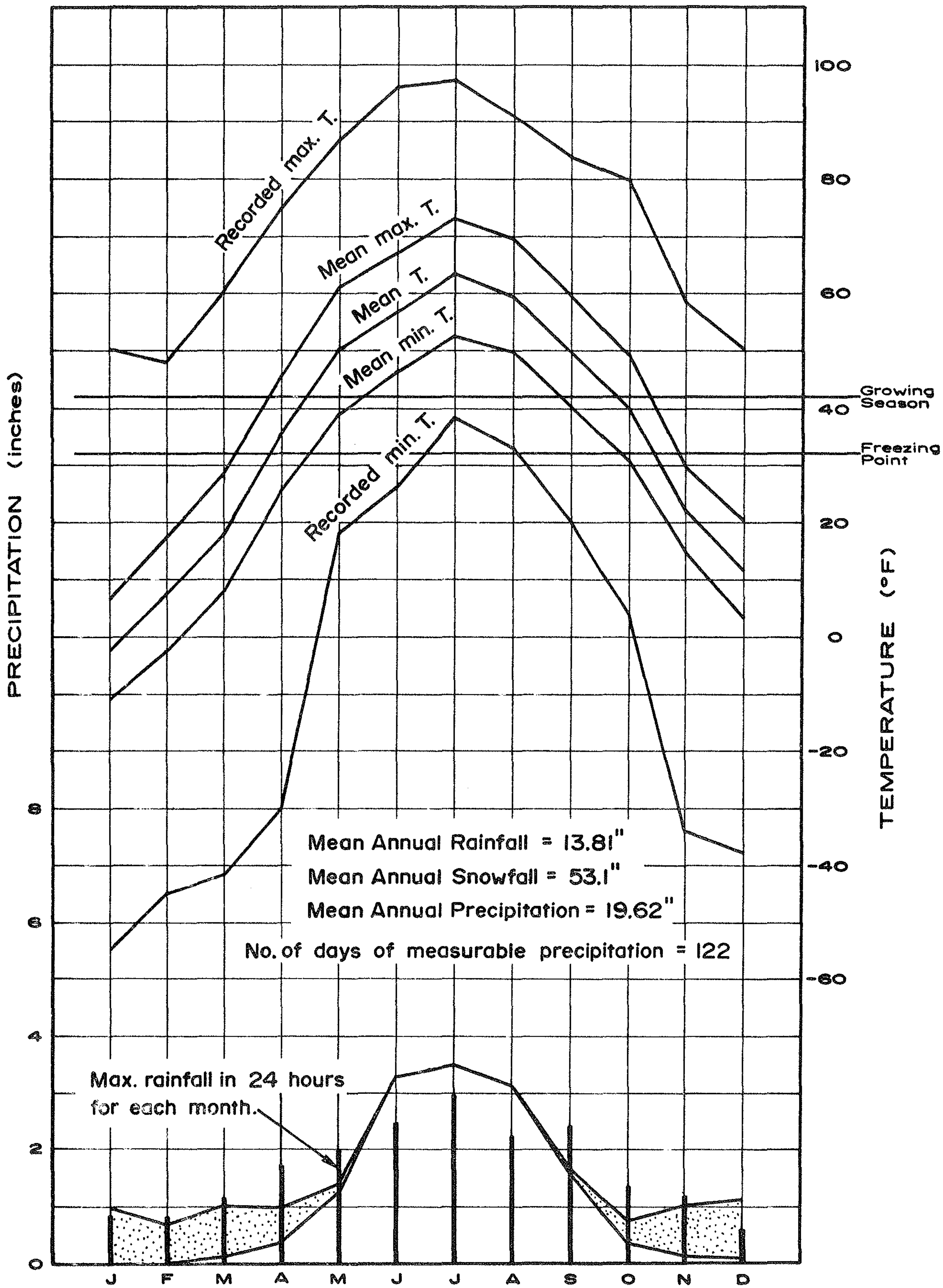
Elevation 1700 ft. A.S.L.



COLD LAKE A

FIG. 4

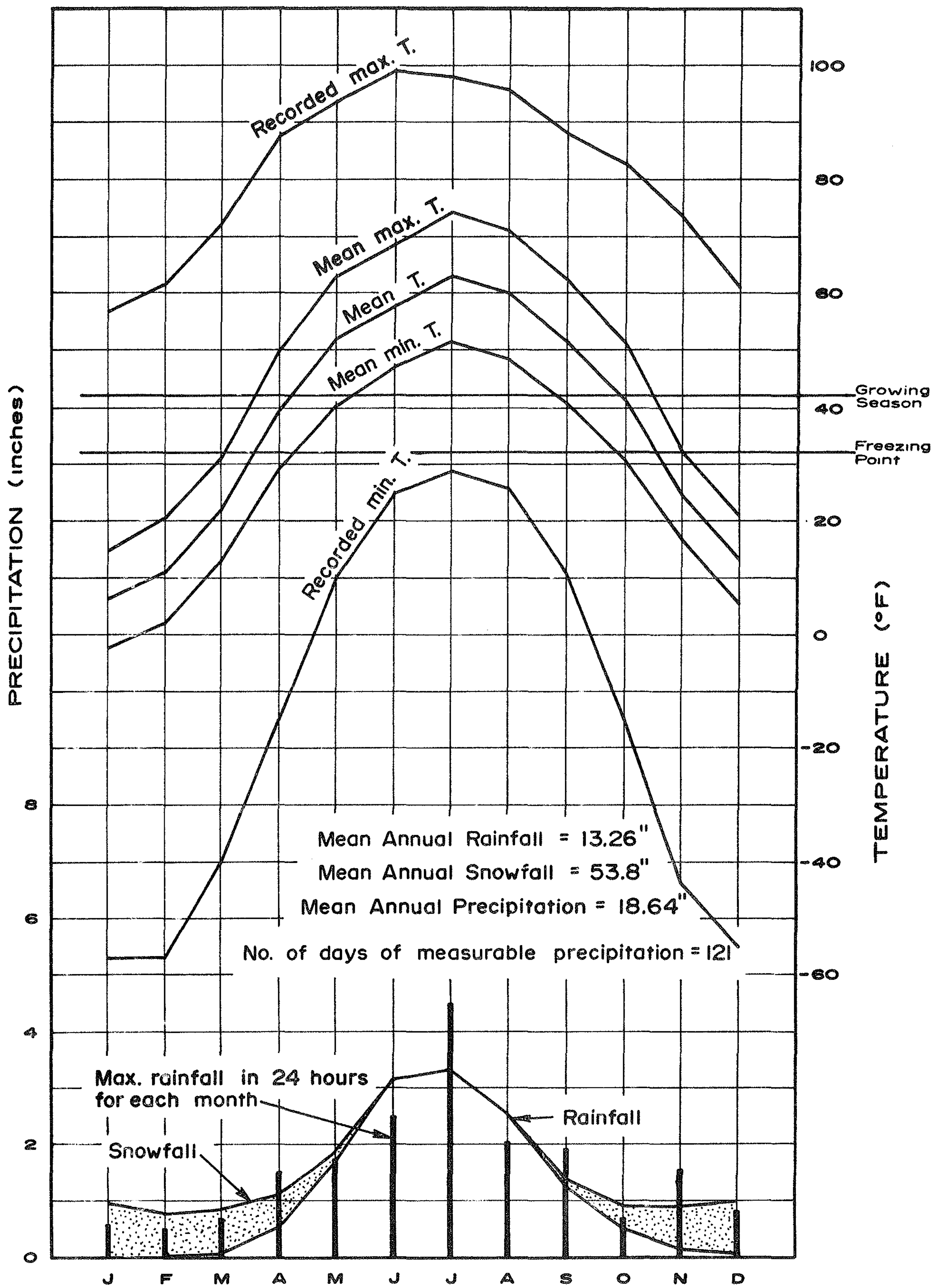
Elevation 1784 ft. A.S.L.



EDMONTON INDUSTRIAL A

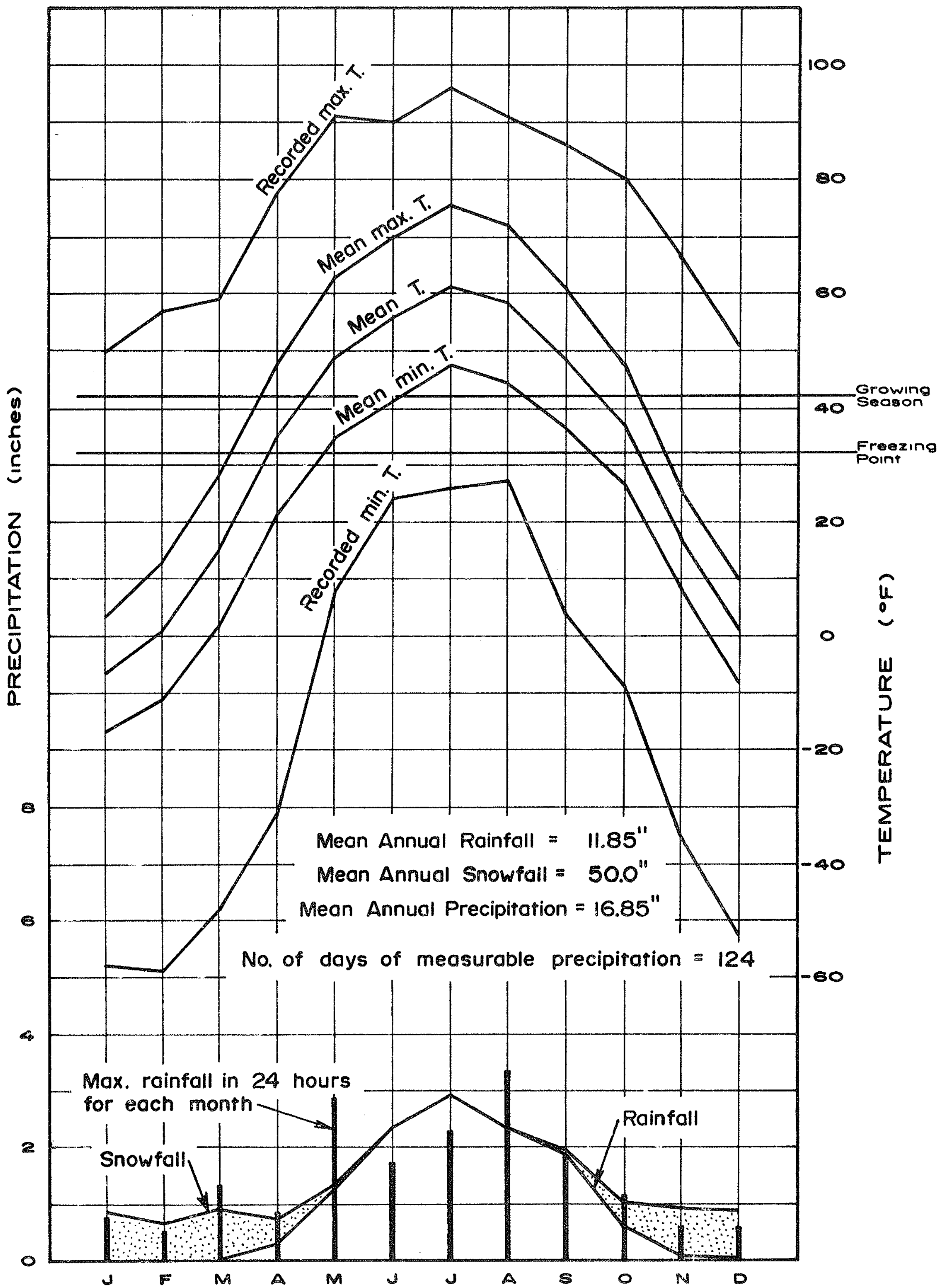
FIG. 5

Elevation 2219 ft. A.S.L.



FORT McMURRAY FIG. 6

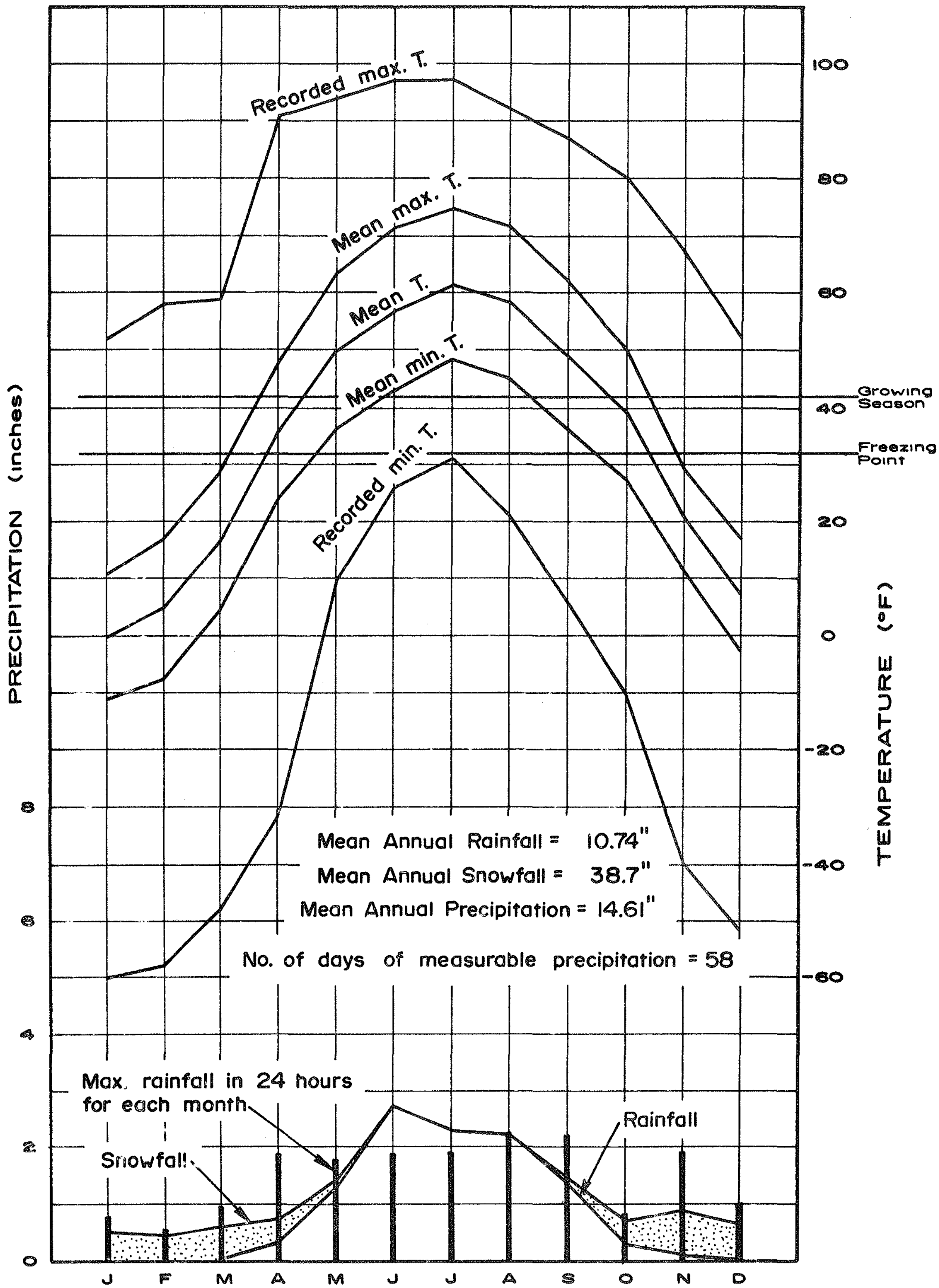
Elevation 1213 ft. A.S.L.



IRON RIVER

FIG. 7

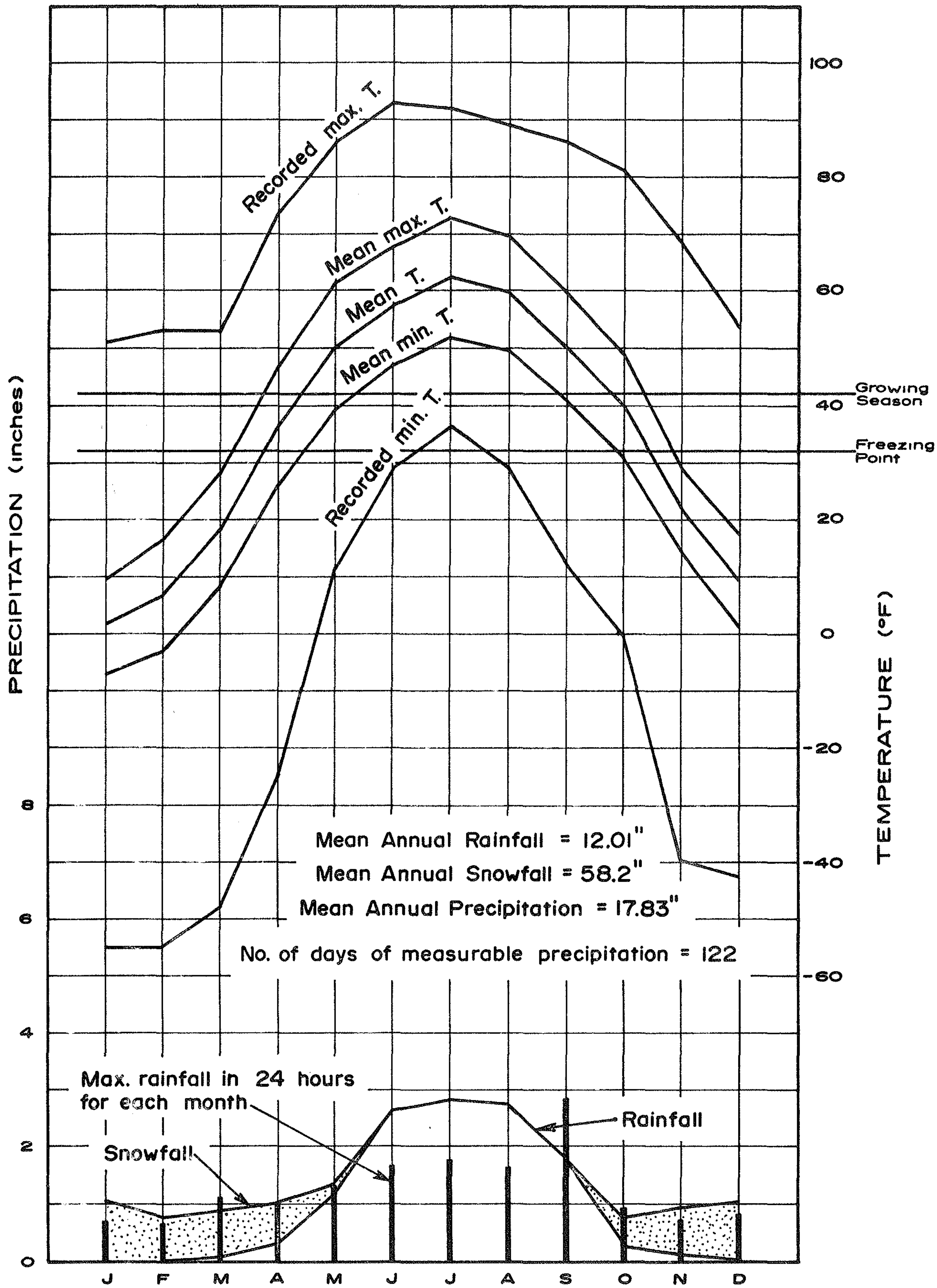
Elevation 1900 ft. A.S.L.



LAC LA BICHE

FIG. 8

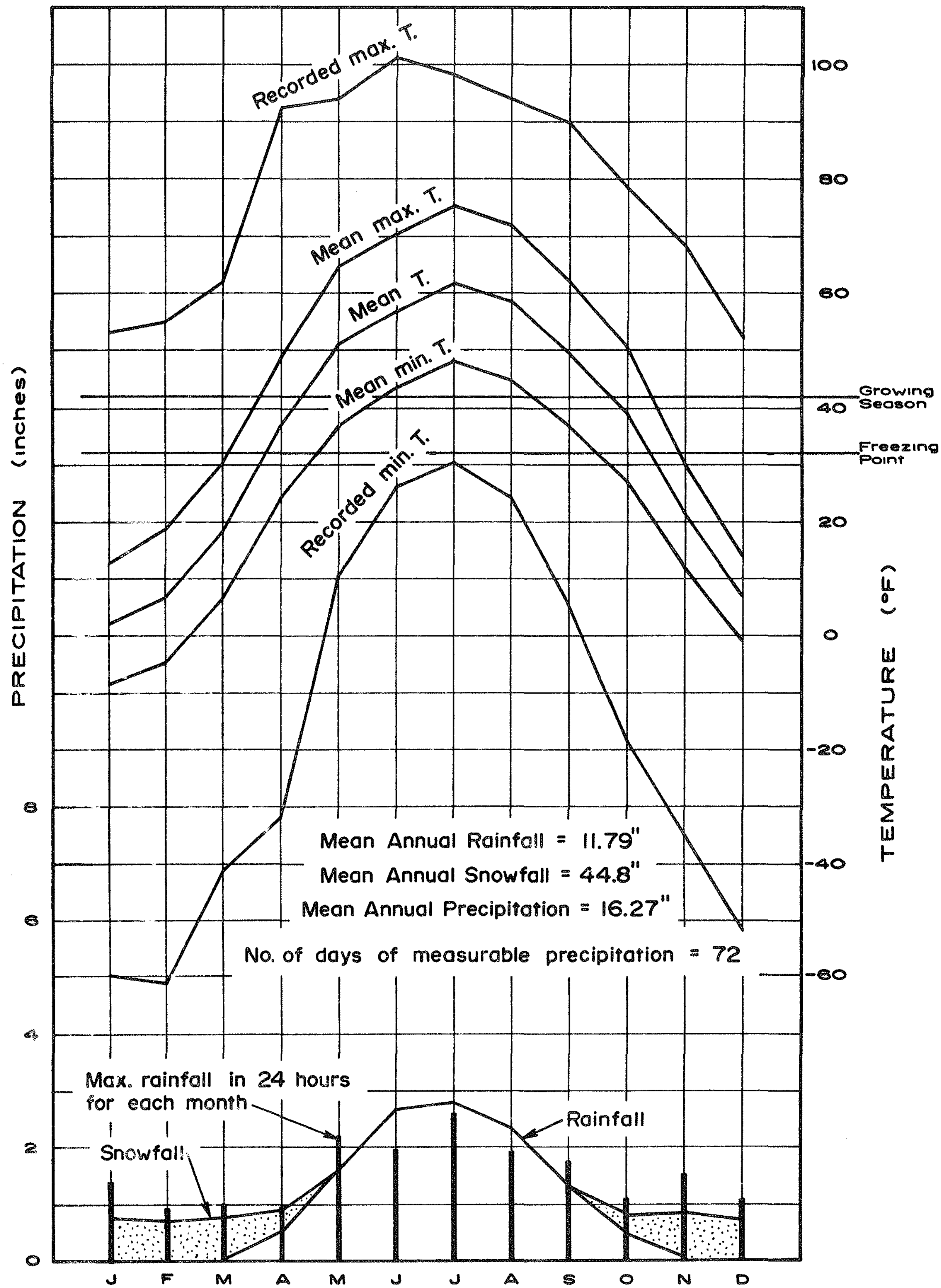
Elevation 1835 ft. A.S.L.



THORHILD

FIG. 9

Elevation 2125 ft. A.S.L.



TEMPERATURE - (Continued)

There are slight latitudinal and relief influences present on the large scale, but the micro-climatic temperatures are subject to stronger variations. The sub forest canopy layer will have less extreme temperatures than open country, such as south of Wandering River, or in wide right-of-ways.

PRECIPITATION

The mean precipitation varies from 14 inches in the S.E. and N.W. to 22 inches in the central part of the area (Figure 10). Comparable summer (May to September) figures are 10 to 17 inches. The distribution of precipitation totals for the annual and summer periods, as shown in Figure 10, are similar, and strongly influenced by relief. Figure 11A and 11B shows the mean monthly isohyets, as prepared by the Alberta Forest Service. Figures 2 to 9 indicate that snowfall generally contributes less than 40% of the total precipitation, and that this figure is often closer to 25% (see Table 1 for snow cover information). The heavy rainfall months are June, July and August with June generally the wettest month. The maximum rainfalls in 24 hours were recorded in June and July in the west, north and central parts of the area, and in August and September in the S.E. part. The probable maximum rainfall in 24 hours may be as high as 4 inches for the higher elevations, and 3 inches over much of the area except the lower elevations in the N.E. part of the area. Compared to the Peace River country, rainfall intensities are lower, but duration longer.

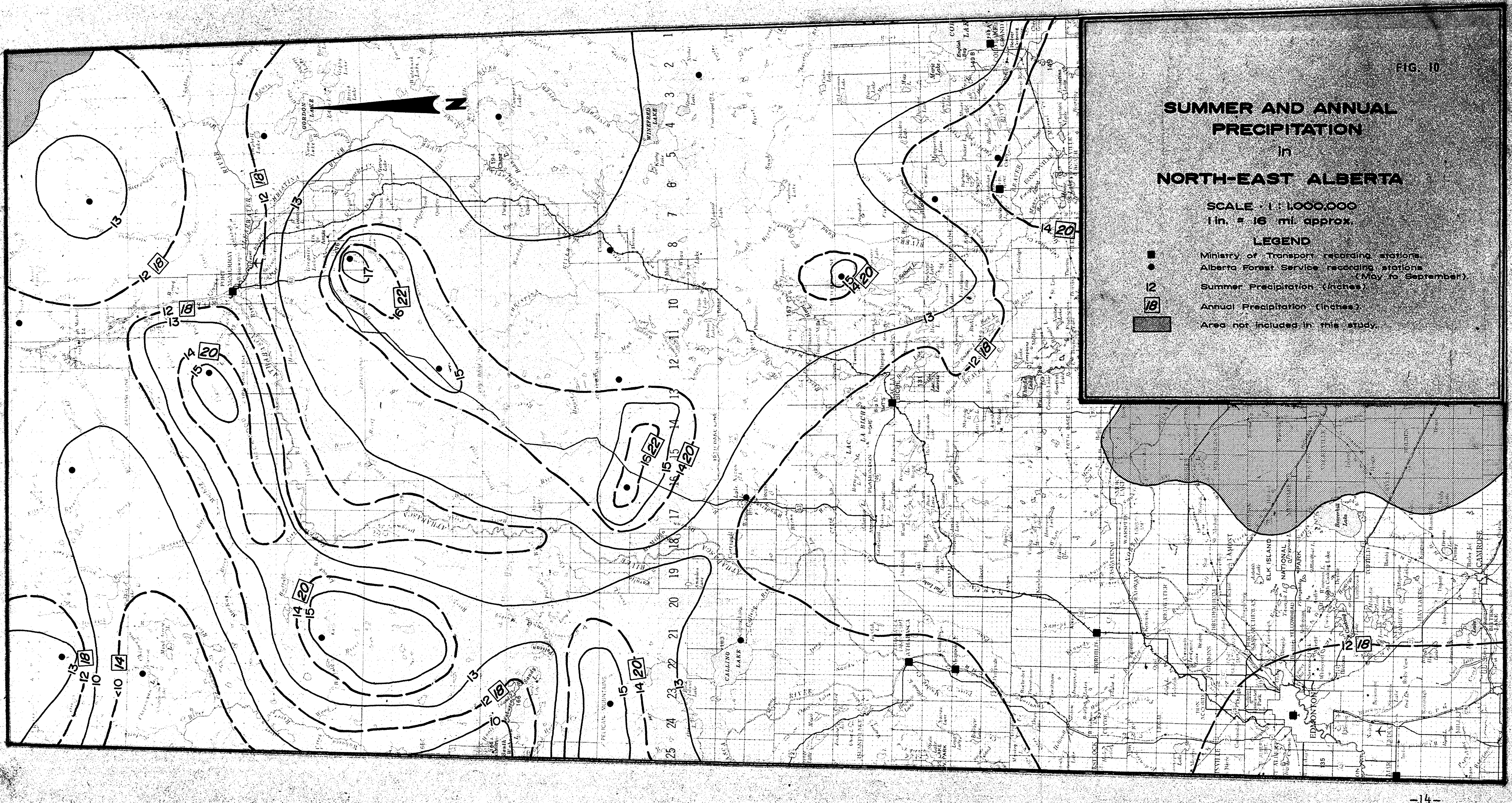
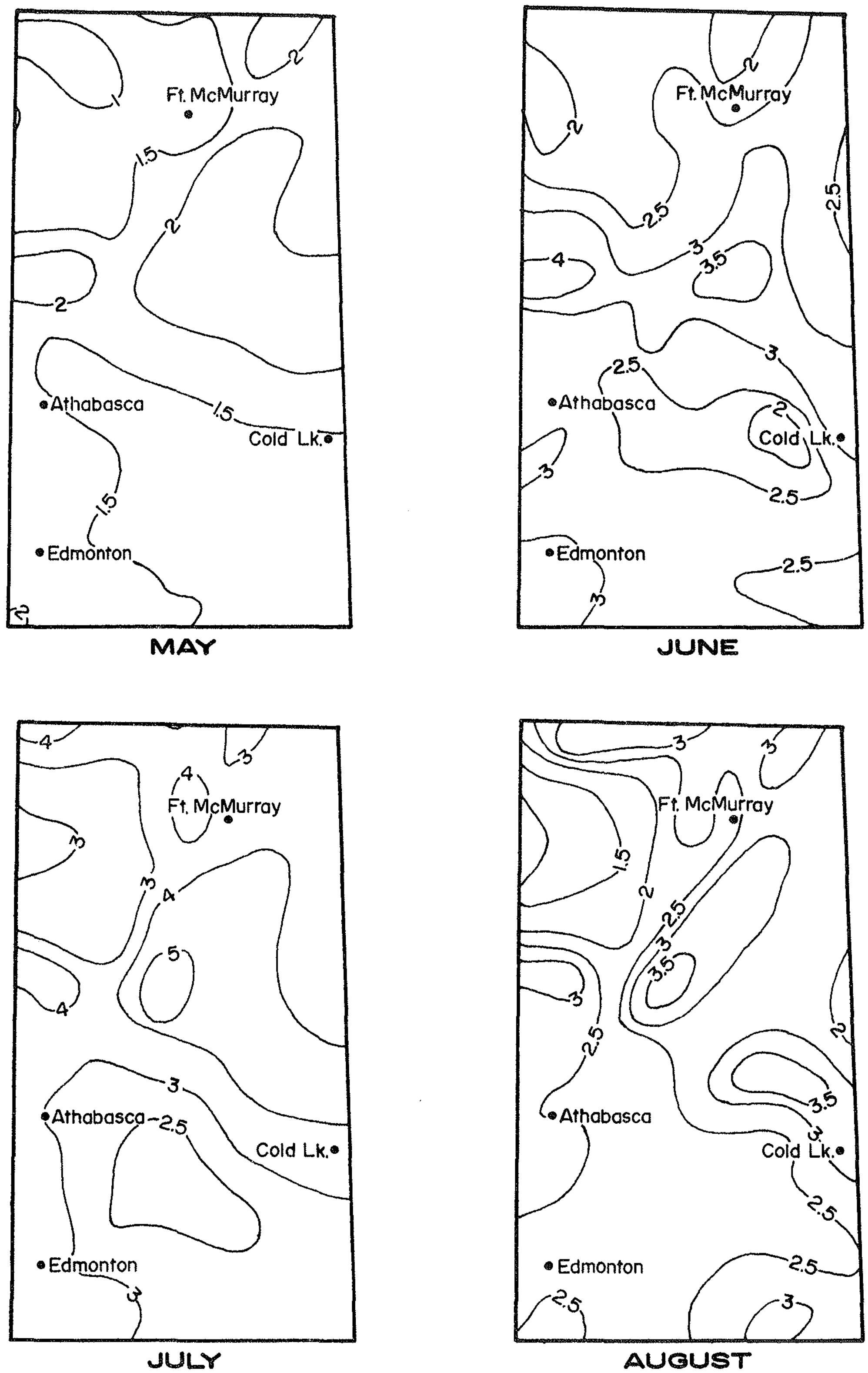


FIG. 10
SUMMER AND ANNUAL PRECIPITATION in NORTH-EAST ALBERTA
SCALE - 1 : 1,000,000
1 in. = 16 mi. approx.
LEGEND
Ministry of Transport recording stations.
Alberta Forest Service recording stations (May to September).
12 Summer Precipitation (inches).
18 Annual Precipitation (inches).
Area not included in this study.
FORT McMURRAY
EDMONTON
CAMROSE
CALLING LAKE
PELICAN MOUNTAINS
LAC LA BICHE
ELK ISLAND NATIONAL PARK
WINEFRED LAKE
GORDON LAKE

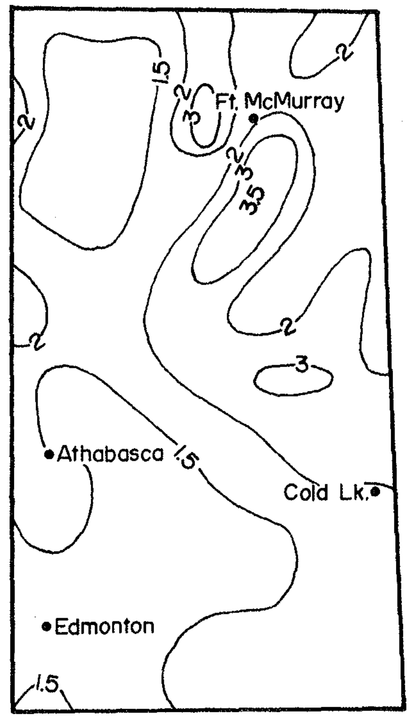


Monthly Mean Precipitation

Dates from 1963 to 1970

Source · ALBERTA FOREST SERVICE

FIG. IIb



SEPTEMBER

Monthly Mean Precipitation

Dates from 1963 to 1970

Source ALBERTA FOREST SERVICE

SNOW COVER

Table 1

STATION	Occurrence of Snow Cover of 1 inch or more: Date of first Snow Cover	Days with Snow Cover	Date of last Snow Cover	Depth of Snow Cover in Inches: Sept. 30	Oct. 31	Nov. 30	Dec. 31	Jan. 31	Feb. 28	Mar. 31	Apr. 30	May 31	Winter Maximum
EDMONTON INDUSTRIAL A (Elev. 2219 Ft.)													
Earliest or Least	Sept. 26	61	Mar. 23	0	0	0	0	0	0	0	0	0	3
Latest or Greatest	Jan. 6	160	May 11	0	4	15	8	14	19	4	0	0	27
Median	Oct. 31	117	Apr. 20	0	0	3	4	6	7	0	0	0	12
Arithmetic Mean	Nov. 5	121	Apr. 16	0							0	0	12
LAC LA BICHE A (Elev. 1835 Ft.).													
Earliest or Least	Sept. 26	111	Mar. 29	0	0	0	0	0	0	0	0	0	8
Latest or Greatest	Nov. 26	173	May 15	1	4	18	27	38	34	19	1	0	39
Median	Oct. 30	142	Apr. 17	0	0	3	9	11	12	4	0	0	19
Arithmetic Mean	Oct. 25	143	Apr. 18					13	13				19
FORT MCMURRAY A (Elev. 1216 Ft.).													
Earliest or Least	Oct. 5	127	Mar. 27	0	0	0	1	0	4	0	0	0	9
Latest or Greatest	Dec. 2	186	May 12	0	5	17	23	26	23	19	3	0	41
Median	Oct. 31	154	Apr. 22	0	0	4	8	11	14	5	0	0	17
Arithmetic Mean	Oct. 31	154	Apr. 17	0			9		14			0	18

(Source: Snow Cover by J.G. Potter, Climatological Studies No. 3, D.O.T.).

BREAK-UP AND FREEZE-UP

The data available is for the large rivers in the study area (Table 2).

WIND

The wind "roses" (Figure 12) indicate that the strongest winds blow from the N.W., while more persistent winds of moderate strength blow from the S.E. In the case of Fort McMurray the funnelling influence of the deep Athabasca and Clearwater valleys is evident.

BREAK-UP AND FREEZE-UP DATES AND ICE THICKNESS

STATION AND WATER BODY	YEARS OF RECORD	THICKNESS	BREAK-UP BEGINS	BREAK-UP ENDS	FREEZE-UP BEGINS	FREEZE-UP ENDS
Athabasca River						
1. @ Athabasca	1920 - 53					
Mean				Apr. 21		Nov. 20
Earliest				Apr. 4/41		Nov. 10/24
Latest				May 9/54		Dec. 1/23
2. @ Fort McMurray	1938 - 63					
Mean			Apr. 22		Nov. 2	Nov. 19
Earliest			Apr. 12/60		Oct. 5/61	Oct. 27/57
Latest			May 9/54		Nov. 28/54	Dec. 31/53
3. Lac La Biche	1945 - 63					
Mean		31" - 48"		May 13		Nov. 17
Earliest				Apr. 30/46		Oct. 28/51
Latest				May 25/54		Nov. 30/49
4. Clearwater River @ Fort McMurray	1938 - 63					
Mean			Apr. 24			
Earliest			Apr. 10/49		Oct. 18/59	Nov. 1/59
Latest			May 8/54,61		Nov. 28/54	Dec. 8/54
5. Cold Lake	1941 - 63					
Mean		18"	May 12	May 17	Dec. 13	Dec. 21
Earliest			Apr. 22/58	May 4/44	Nov. 11/61	Nov. 27/54
Latest			May 24/53	May 26/53	Dec. 24/52,57	Dec. 29/57,62
6. North Saskatchewan River @ Edmonton	1881 - 1963					
Mean			Apr. 14	Apr. 17	Nov. 3	Nov. 14
Earliest			Mar. 28/30	Apr. 4/30,44	Oct. 11/81	Oct. 23/81
Latest			May 2/09	May 6/09	Nov. 24/62	Dec. 15/54
7. Primrose Lake	1956 - 63					
Mean				May 26*	Nov. 14**	Dec. 8**
Earliest					Nov. 1	Nov. 24
Latest					Nov. 27	Dec. 18

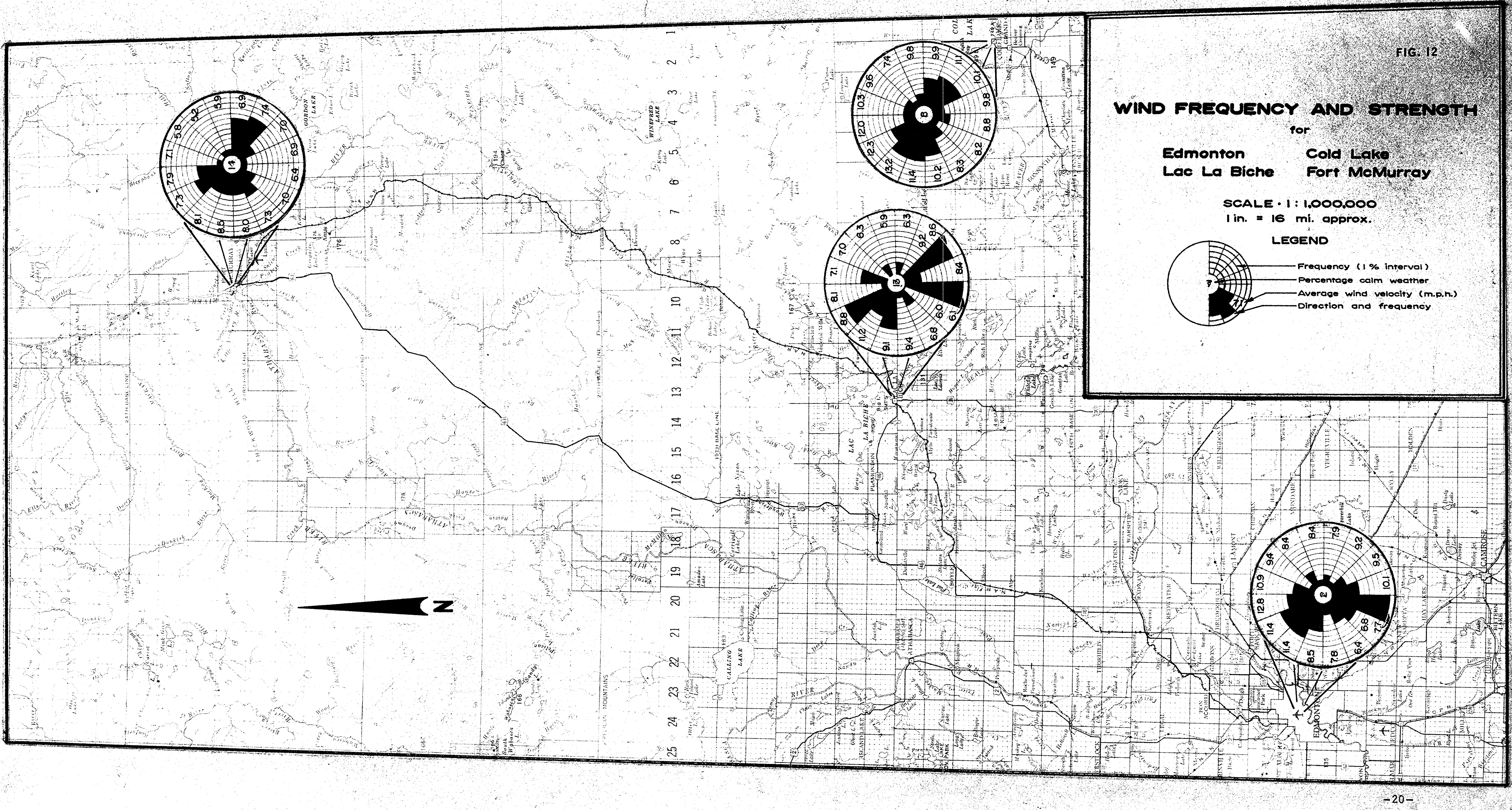


FIG. 12

WIND FREQUENCY AND STRENGTH

for

Edmonton   Cold Lake
Lac La Biche   Fort McMurray

SCALE · 1 : 1,000,000
1 in. = 16 mi. approx.

HYDROLOGY

INTRODUCTION

The Athabasca River drainage system dominates the study area north of Boyle. South of this point North Saskatchewan River drainage is encountered in the more extensively cultivated and settled land. The drainage pattern and lake distribution in these two basins is shown in Figure 13.

The available hydrologic data is predominately from the North Saskatchewan drainage courses, though limited data for Pine Creek, Hangingstone River, Horse River, the Athabasca River at Athabasca and Fort McMurray, and the North Saskatchewan River at Edmonton is available. There are a large number of creeks occupying a large area for which there is little data. The hydrographs for recorded maximum flow years are presented in Figures 14 to 18 for selected streams crossed by the existing transportation facilities to Fort McMurray. In addition, a regional analysis of existing flood flow data is given below. Information concerning sediment transport is almost wholly lacking.

GENERAL HYDROLOGY

The hydrographs presented in Figures 14 to 18 indicate that in the low relief areas (cf. Pine Creek and Waskatenau Creek) the major floods may be associated with the snowmelt period. In the upland (cf. Wandering, Hangingstone and Clearwater Rivers), high runoff areas, floods equal to or greater than those of the snowmelt period may be caused by heavy rainfall events.

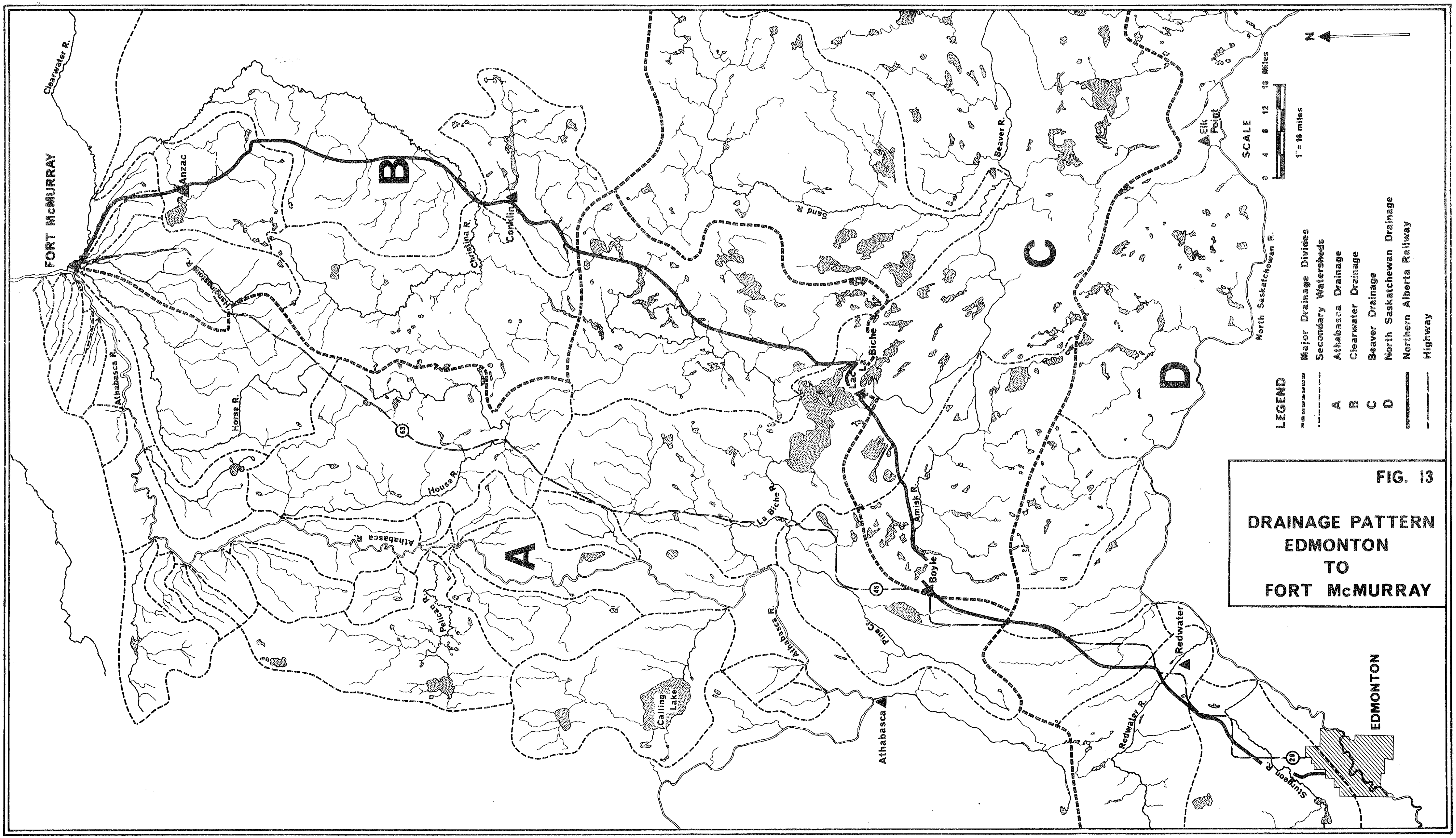
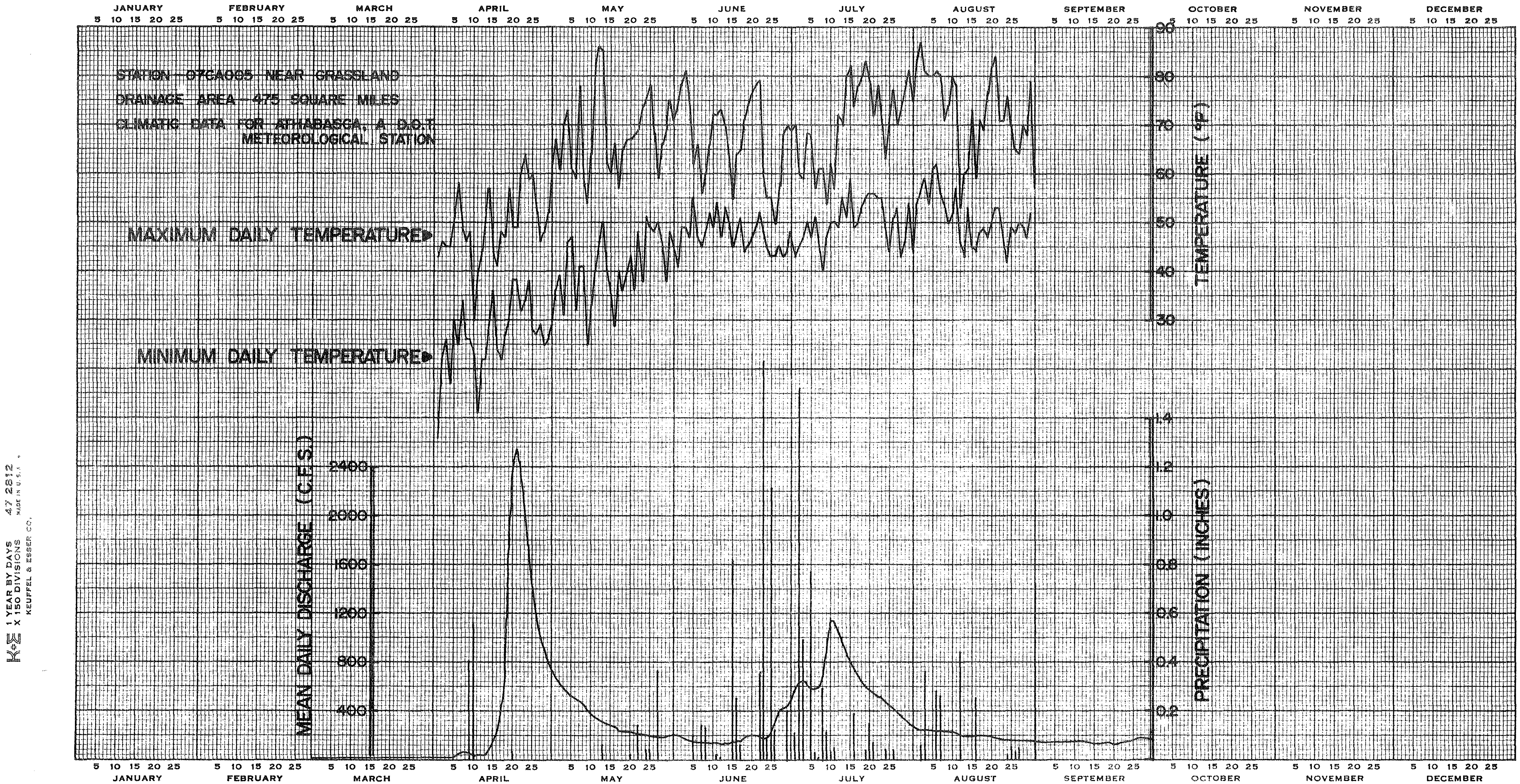


FIG. 13

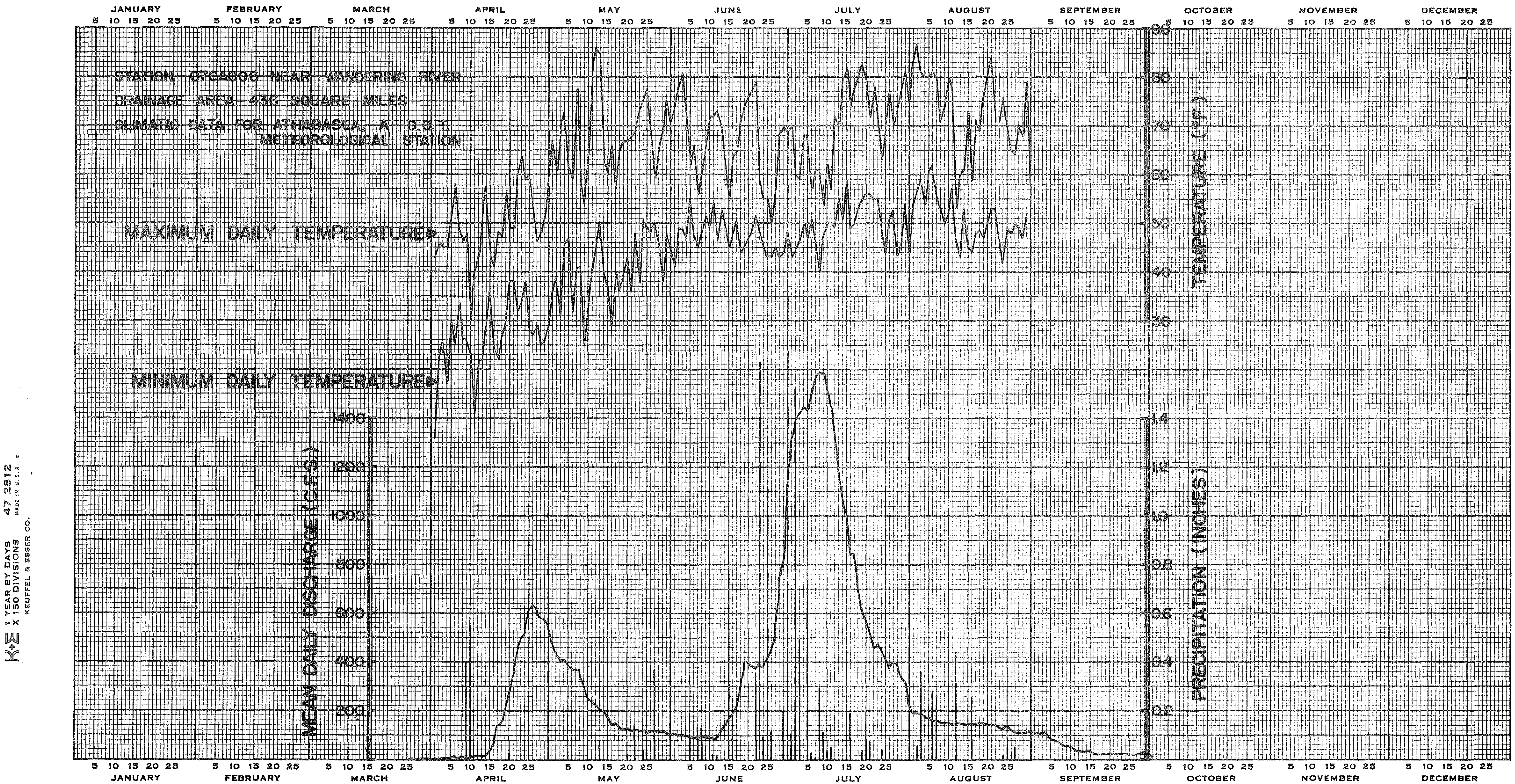
DRAINAGE PATTERN
EDMONTON
TO
FORT McMURRAY



PINE CREEK

1971

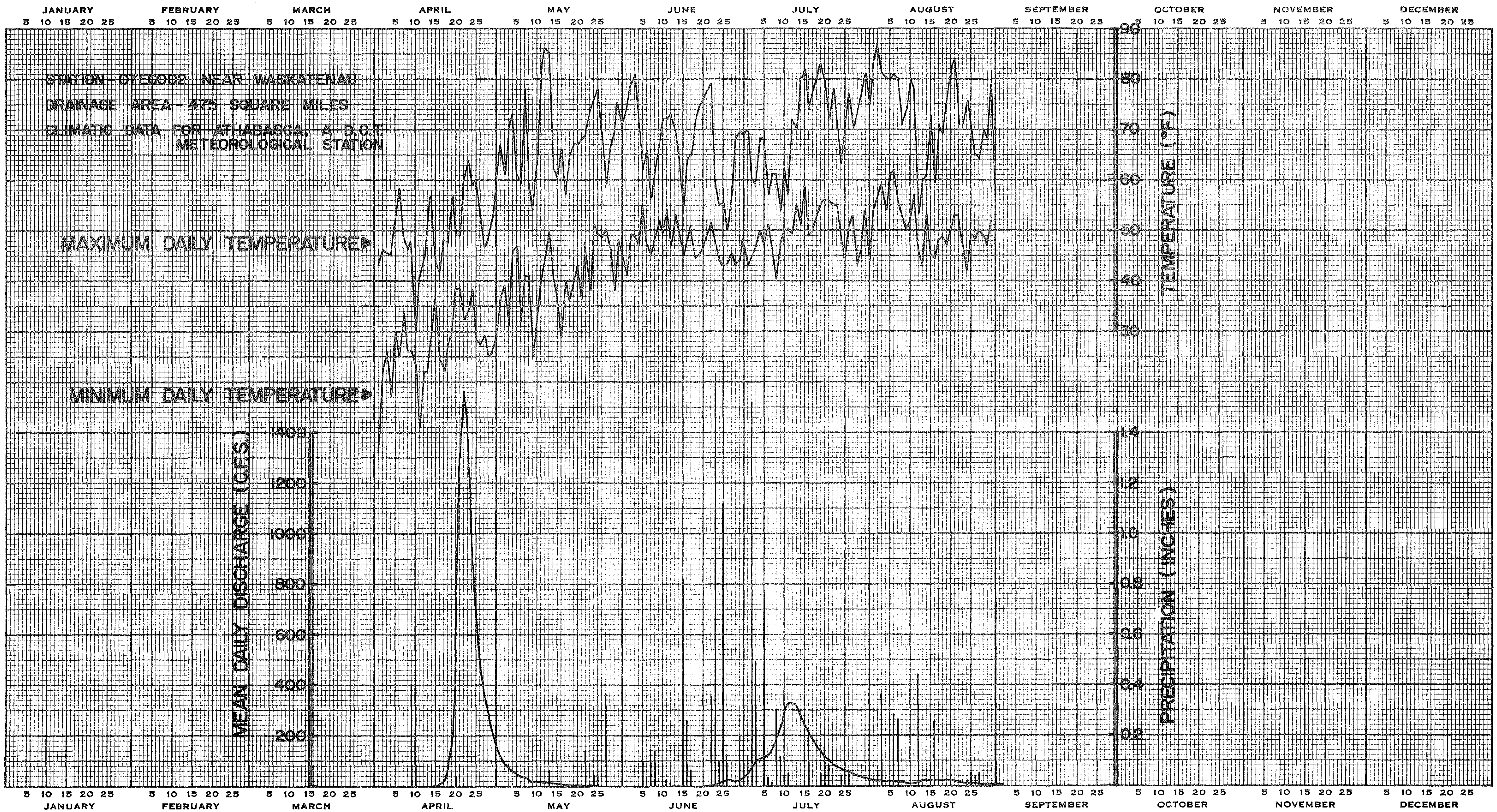
FIG. 15



WANDERING RIVER

1971

FIG. 16

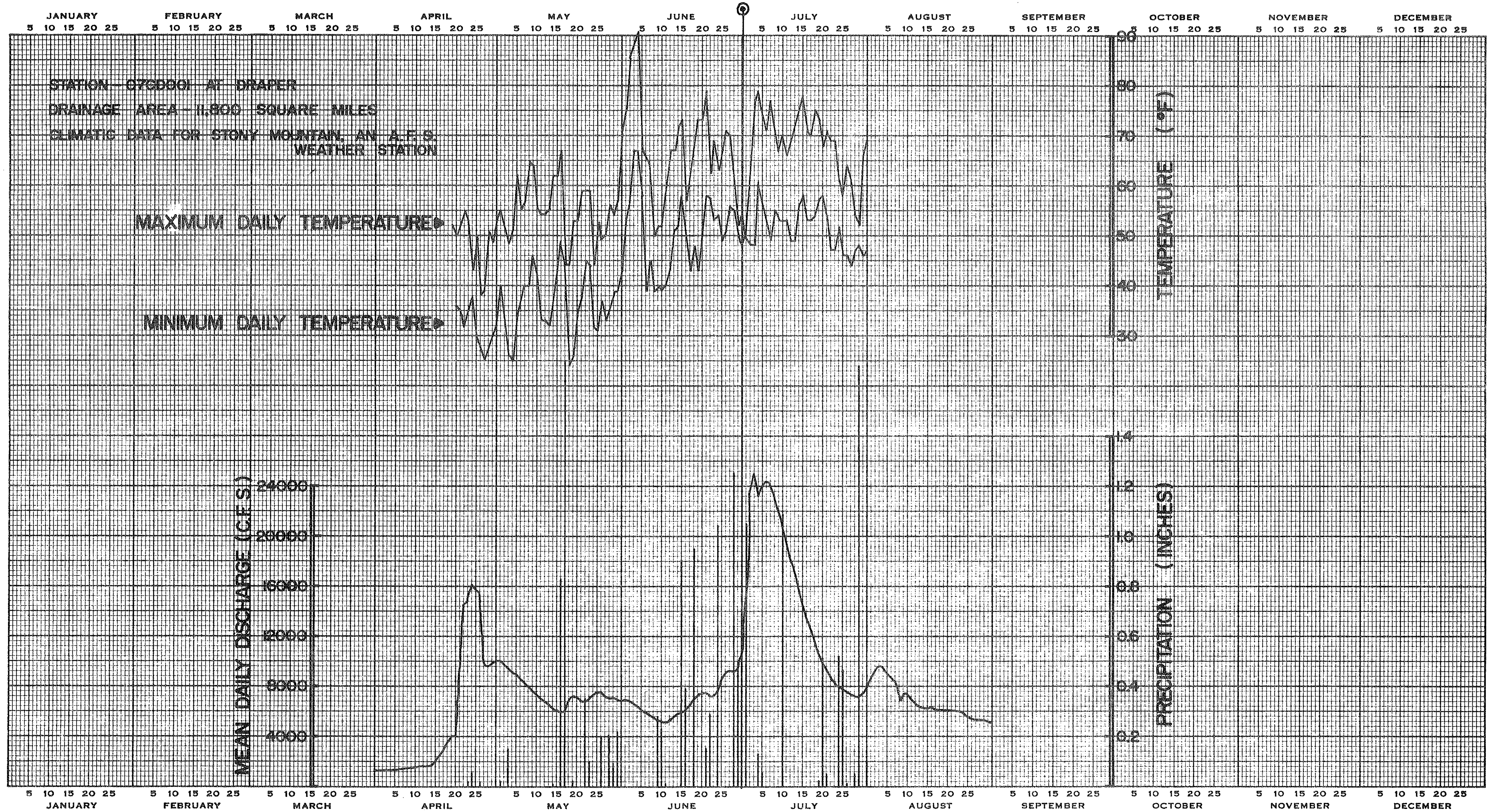


K+E 1 YEAR BY DAYS X 150 DIVISIONS 47 2812 KEUFFEL & ESSER CO. MADE IN U.S.A.

WASKATENAU CREEK

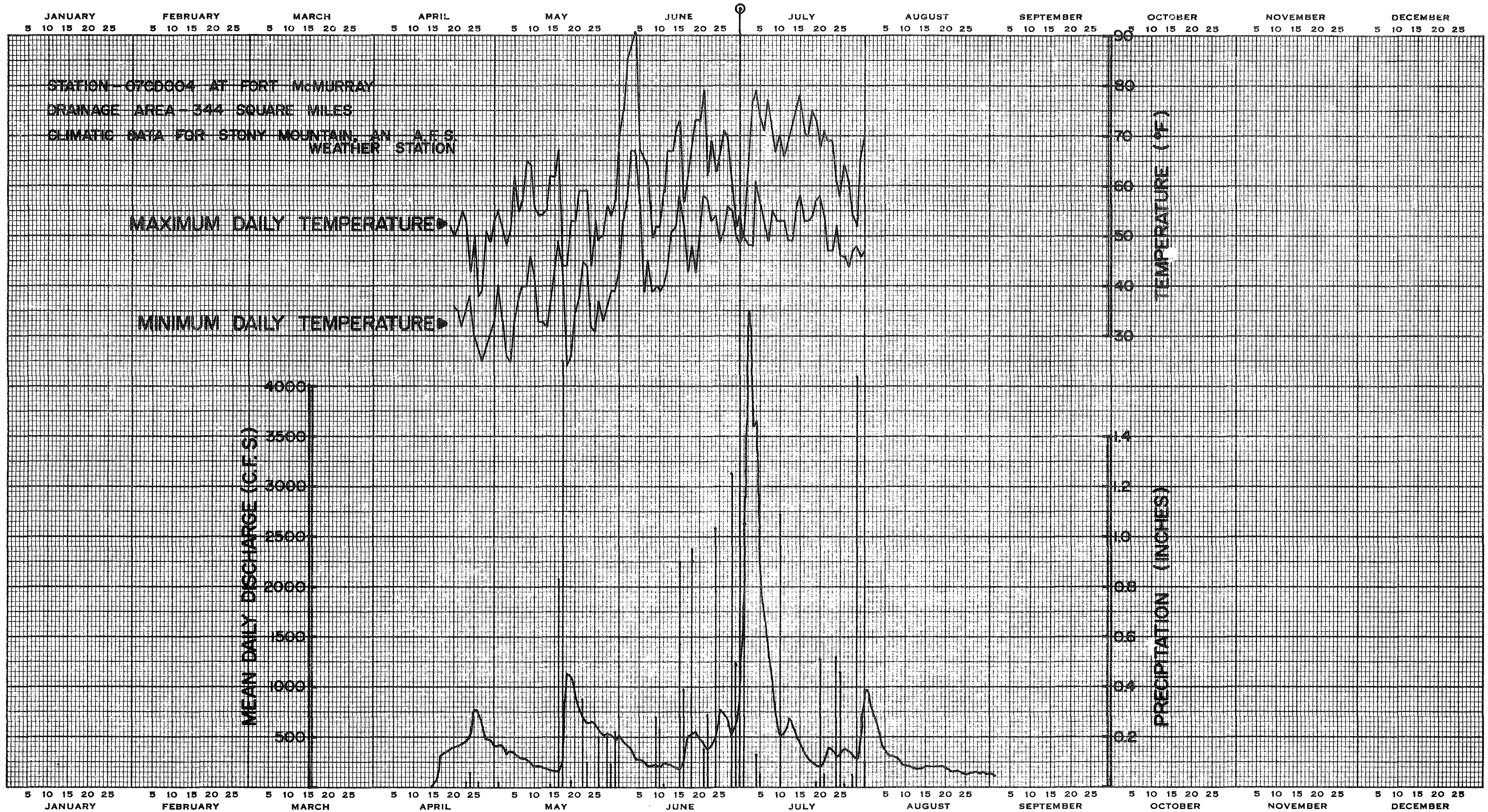
1971

FIG. 17



CLEARWATER RIVER

1970



HANGINGSTONE RIVER

1970

In the south eastern part of the study region, the Beaver River basin occasionally has major floods due to rainfall events in September. North of Atmore the major floods due to rainfall events seem to occur in June and July. The snowmelt peaks tend to occur toward the end of April. The hydrographs for the North Saskatchewan River at Edmonton, and the Athabasca River at Athabasca are presented in Figure 19 for wet, moderate wet and dry years.

These observations are based on a relatively short period of records. A larger period of records, and more flow recording stations, especially north of Atmore would facilitate a more detailed assessment of the varying characteristics of stream flow in the study area.

REGIONAL RUNOFF PATTERN

The sparse data available for the study area precludes a detailed report on river runoff patterns. However, by using the envelope curve method an estimate of the regional runoff pattern has been made. The data consists of recorded maximum flows, determined from gauged rivers in the study area, and design discharge estimates made for various highway river crossings between Edmonton and Fort McMurray. It is clear that no common frequency of events is present, but the figures given are determined as rare events, rather than frequent events. The envelope method generally consists of a curve formula developed to include the historical floods, independent of climate or physiography. Such a curve developed by C.R. Neill (formerly of the R.C.A.) for all Alberta rivers was of the form $Q = fA^{0.8}$.

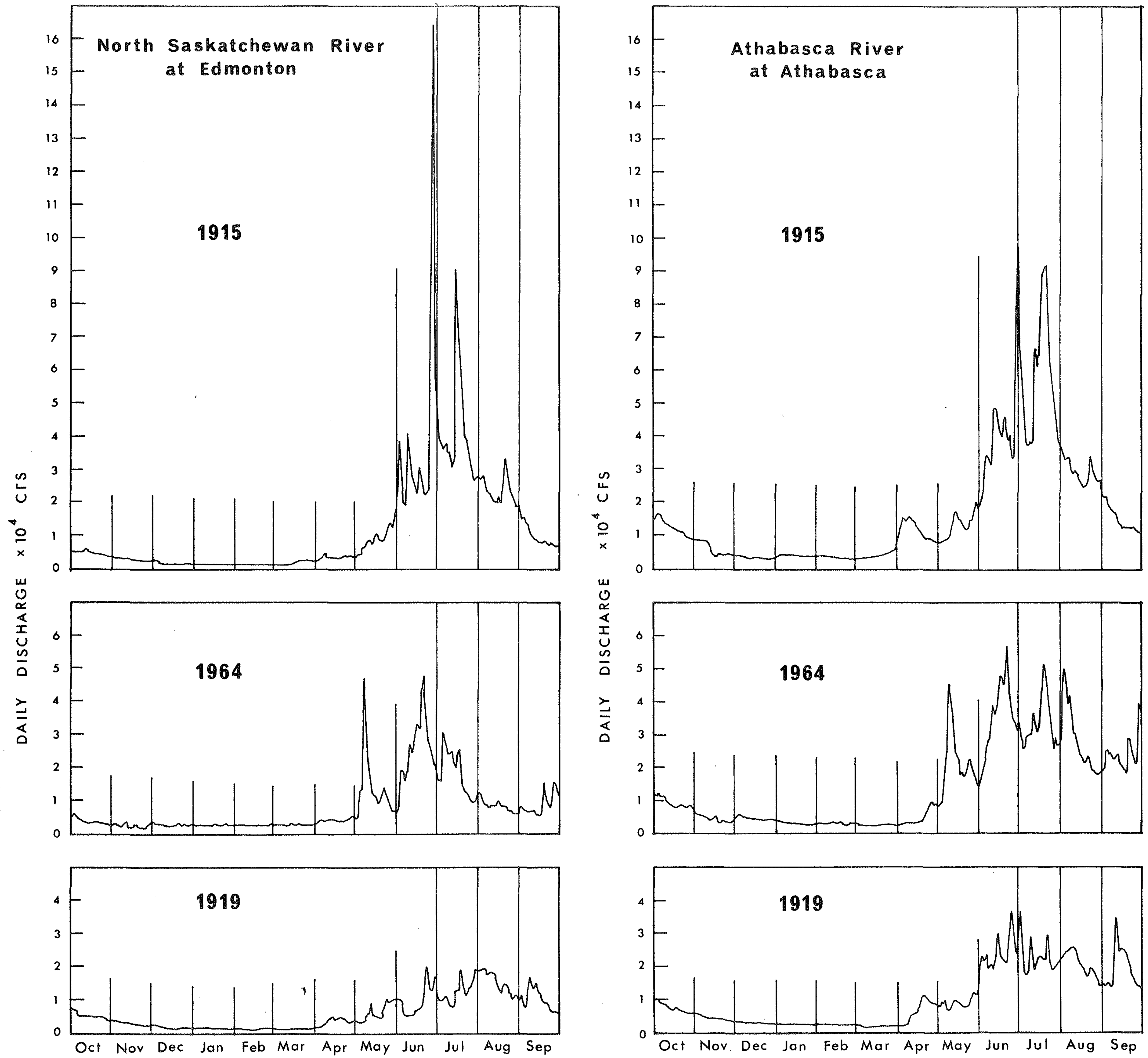


FIG. 19

ANNUAL HYDROGRAPHS IN WET MODERATE AND DRY YEARS FOR THE ATHABASCA AND NORTH SASKATCHEWAN RIVERS

REGIONAL RUNOFF PATTERN - (Continued)

By including data from a known high runoff area such as the Peace River district, a further guide to the regional pattern within the study area is provided.

The data plotted in Figure 20 indicate that by using a curve with a slope of 0.8 (cf. Neill, above), a reasonable upper limit to discharge for a given effective drainage area is provided by the formula $Q = 75A^{0.8}$. A further series of curves parallel to this one but with different "f" values may be reasonably assumed to approximate different rainfall values in the study area. An assessment of the approximate location of the isolines separating areas of different runoff is therefore given by Figure 21 in which the values of "f" are shown. An estimate of possible peak discharge for a given basin may be made using Figure 21.

The runoff pattern shown in Figure 3, indicates that higher runoff occurs over the May Hill and Stony Mountains Upland areas. The lowest runoff occurs in the southern part of the area. Since the higher runoff occurs in the higher relief areas, the most sensitive areas to disruption of stream behaviour are likely to occur on rivers rising in these areas. It is not surprising therefore, that many streams rising in these hills are deeply incised in friable surficial sediments, with gravel beds. Lowland streams are more sluggish, with more silty beds, in wide rolling valleys.

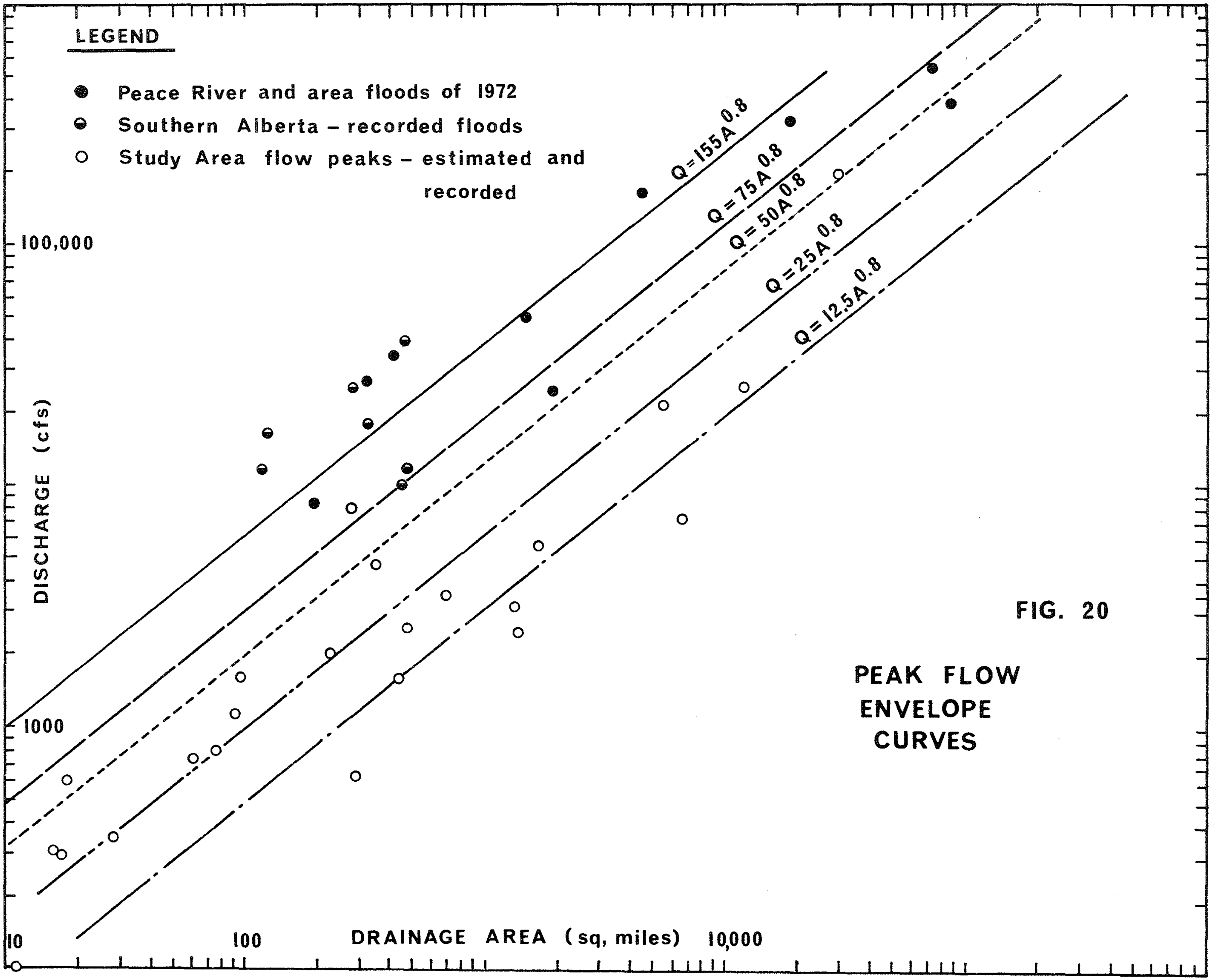


FIG. 20

PEAK FLOW ENVELOPE CURVES

This map is intended to provide a rough guide to the estimation of probable peak discharge and is not for accurate design work.

PROCEDURE :

1. Determine areas of major lake control, (A_L) and muskeg control, (A_M) within the drainage basin under investigation.
2. The value of the factor "f" to be used is in each case the highest value traversed on the map by the drainage basin divide.
3. For the area with no controls $Q_e = fA_e^{0.8}$
   For the area with lake controls $Q_L = fA_L^{0.8}/4$
   For the area with muskeg controls $Q_M = fA_M^{0.8}/2$
4. Total probable peak discharge $= Q_e + Q_L + Q_M$.

Probable peak discharge means a flood recurring once in 50 to 100 years.

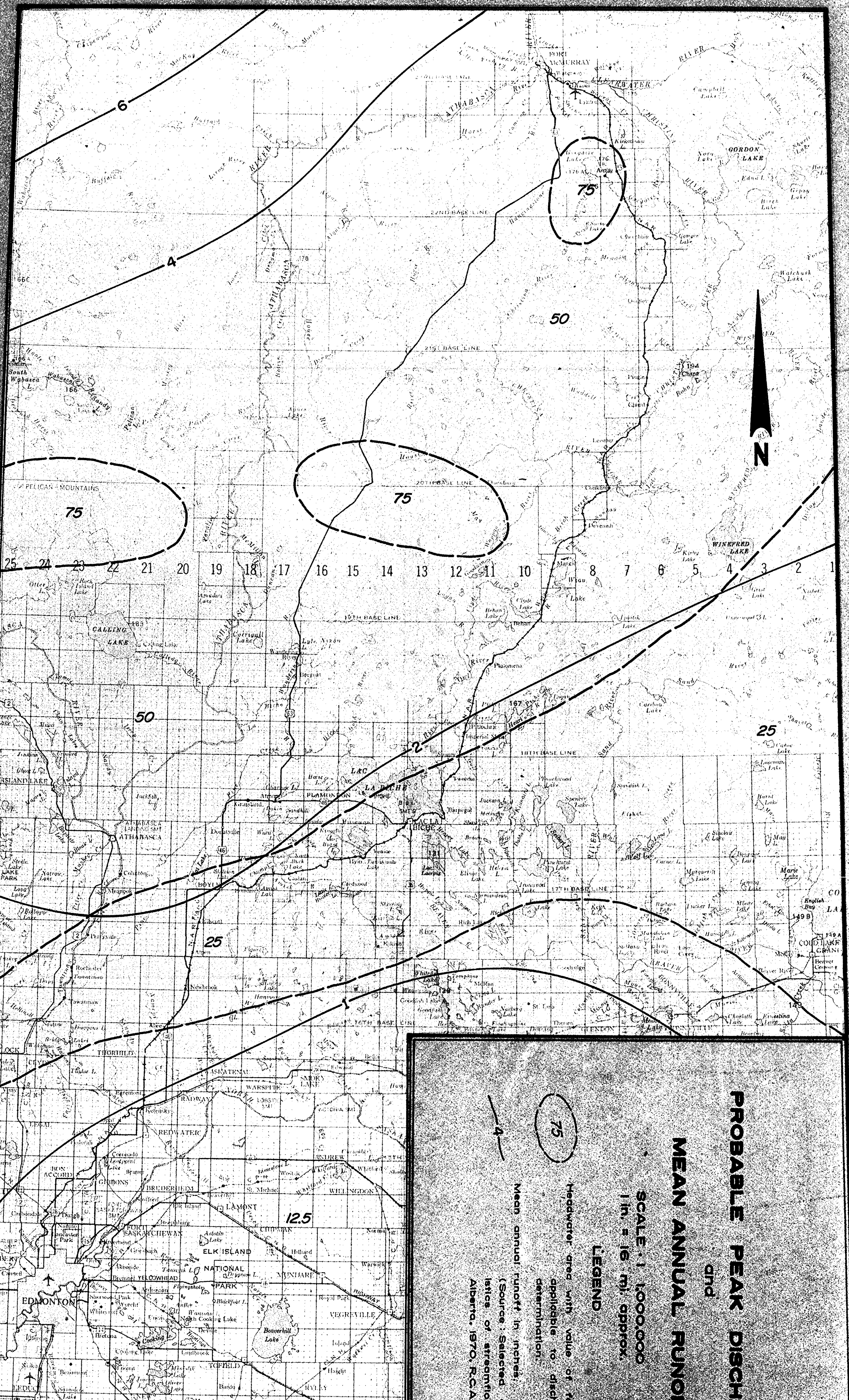


FIG. 21

PROBABLE PEAK DISCHARGE
and
MEAN ANNUAL RUNOFF

SCALE : 1 : 1,000,000
1 in. = 16 mi. approx.

FISH RESOURCES

INTRODUCTION

The Fish and Wildlife Division of the Alberta Department of Lands and Forests is undertaking a survey of fisheries resources in the study area. Field investigations were completed as far south as Township 84 in 1972. The information presented in this paper is from a report by William E. Griffiths, Fishery Biologist with the Department of Lands and Forests: 'Preliminary Fisheries Survey of the Fort McMurray Tar Sands Area.' His report is based primarily on the survey undertaken in 1972.

The survey for the balance of the study area is presently underway and will be made available by permission of Dr. M. Paetz, Chief Fishery Biologist, in the fall of 1973.

METHODS

Streams and rivers were sampled to assess the current utilization by different species of fish. Water samples, fish and bottom fauna were collected and a descriptive evaluation was made of physical parameters pertaining to the suitability of the water body as fish habitat. Additional observations by helicopter of areas where access was difficult supplemented the on-site collection of field data. Similar collections were made from lakes. In addition, plankton samples were collected and bottom contours determined.

A score sheet was used to establish the class rating of the individual streams and rivers. The class rating was determined as follows:

SCORE SHEET FOR STREAM CLASSIFICATION

FACTOR	UNIT	SCORE
Flow (minimum winter)	Good	5
	Shallow riffle	3
	Intermittent	1
Summer temperature	3 months over 15°C	5
	3 months over 12°C	3
	3 months less than 12°C	1
Depths of pools (based on minimum flow)	Greater than 3 ft.	5
	1 ft. - 3 ft.	3
	Less than 1 ft.	1
Frequency of pools (percentage)	40 - 60%	5
	60 - 80% or 30 - 45%	3
	Greater than 80% or less than 40%	1
Refugia (banks, logs, deep still pools)	Good	5
	Fair	3
	Poor	1
Nutrients	Good	5
	Fair	3
	Poor	1
Bank cover (amount of shading and bank stability)	Good	5
	Fair	3
	Poor	1
Substrate type of riffle	Gravel, rubble	5
	Sand	3
	Silt, mud or large boulders	1
Land utilization which will or has affected the stream for 5 to 10 years	Grazing Logging Pollution Mineral Exploration	-1 to -5

CLASSES

Class 1	Score 35-40	Class 3	Score 21-27
Class 2	Score 28-34	Class 4	Score 1-20

RESULTS

The results of this survey are contained in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

The following excerpt from William E. Griffiths' report has been edited to include only those recommendations which pertain to our study area.

> " Preliminary studies of this nature are limited both by a time factor and by the methods available for the collection of the necessary biological data. The collection of data on the rivers and creeks in the Fort McMurray area was restricted to a period of six weeks in the field by the approach of winter and by a completion deadline. The field work for the lake reports was completed in the summers of 1967 and 1969, but scheduling of these surveys was also restrictive.
>
> Because of these limitations, the following recommendations and conclusions are necessarily general and further study on the main water bodies identified in this report would be desirable. A number of important watersheds have been identified in the report. Most of these are already of importance to the Fort McMurray area both to fulfill present recreational needs and in an aesthetic sense. In the near future these areas will acquire even more significance and it would be of value to attempt to place a dollar value on these systems to guarantee their protection in the future.
>
> The following watersheds are considered to be of the greatest importance and are rated either as a class I or a high class 2:

1. Clearwater River Watershed

Although most of the Clearwater drainage is not in Alberta, there are a number of important tributary rivers and a few lakes in its lower reaches that are important to the Fort McMurray area. The Hangingstone River is already providing local sportsmen with a fishery for Arctic grayling. The Christina, the Clearwater, and portions of the Gregoire are also important as grayling fisheries and provide excellent walleye and pike fishing. The High Hill River undoubtedly has the highest future potential of any of the smaller rivers in the study area and will provide an excellent fishery for Arctic grayling and mountain whitefish. The fishery for mountain whitefish is unique for this area. Gregoire Lake already plays an important role in the recreational needs of the residents of Fort McMurray. Provincial Park authorities have built a large campsite on this lake and fishing for walleye and pike is excellent.

2. ....

Although many of the other watersheds in the study area are of lesser importance, they should not be totally disregarded. It may be possible to protect these watersheds during construction .... if care is taken. It should be stressed that the watershed protection concept is extremely important. River systems cannot be subdivided into their component parts. The lower reaches of a watershed are just as important to the total system as the upper reaches. Blockage .... in lower portions of a river could prevent spawning runs or isolate fish from their wintering areas. Increases in siltation or introduction of pollutants into upper portions of a watershed could adversely affect the entire length of the rivers or streams.

Bearing this in mind, a number of guidelines should be established in order to protect the environment. The hazards to be encountered will result directly from the development of the oil industry and indirectly from the increased population in the Fort McMurray area. The growth in population will increase the need for suitable recreational outlets and place increasing demands on the fisheries resource of the area. A number of steps should be taken to alleviate the problems that will arise.

1. .... Re-routing or channelization should not be permitted on any of the higher class rivers or creeks. ....

2. The use of round corrugated culverts on road construction is not acceptable unless the gradient of the tube is near zero percent or the natural gradient of the stream is maintained. The outfall must also be located below the stream bed elevation and erosion must be prevented to maintain this situation. Recent studies show that improperly designed culverts effectively block fish movement.[1] Bridges or open bottom structural steel arch culverts should be used wherever possible, even on small tributary streams.

3. Road and pipeline construction should be conducted in a manner that will minimize erosion and sedimentation.[2] Reclamation of the road or pipeline rights-of-way should be carried out concurrent with construction. ....

4. No waste products should be discharged without treatment of the effluents to acceptable standards (i.e. Not harmful to the aquatic community.).

---

1. Saltzman, W. and R.O. Koski. 1971. Fish passage through culverts. Special Report. Oregon State Game Commission. 6 pp.

2. Lantz, R.L. 1971. Guidelines for stream protection in logging operations. Special Report. Oregon State Game Commission. 29 pp.

5. Automatic shuf-off valves should be required on all oil pipelines where they cross streams or where spills would result in extensive damage to other waterbodies.

6. Damming of streams or raising of lake levels should be critically reviewed and the appropriate studies should be conducted before implementation.

7. Pesticides should not be used, especially chlorinated hydrocarbons, except where necessary for health reasons. (i.e. Control of insect pests would not be considered to be a health reason.)

8. The domestic fishery of the native people should be reviewed and compensation should be paid for losses attributed to the oil industry. "

ENVIRONMENTAL IMPACT ASSESSMENT
OF THE EXISTING TRANSPORTATION FACILITIES

INTRODUCTION

During May and June 1973, field inspections were made with the express purpose of assessing the environmental impact on the stream crossings of the Northern Alberta Railway from Lac La Biche to Fort McMurray, Highway 63 from Atmore to Fort McMurray and the Great Canadian Oil Sands (G.C.O.S.) pipeline from Edmonton to Fort McMurray. A standard inspection form was used to evaluate the conditions and impact at each crossing. The inspection required careful assessment of the bank, streambed, channel pattern, and siltation processes, as well as the aesthetic appearance, amount of deterioration, design and wildlife consideration. Subsequently this data was transcribed into the matrices shown in Tables 3, 4 and 5. The scores shown are relative one to another, and have not been weighted beyond the original field assessment. The impact observations #1 and #14 were rated good, fair or poor, equalling scores of 3, 2 or 1 respectively. For all other impact observations an answer "yes" or "no" gave scores of 0 or 1 respectively. The total scores were expressed as percentages, since streams with culverts could score a maximum of 19, while all other crossing types could score a maximum of only 17. The summary scores are also expressed as percentages for comparative purposes. It is from these matrices and the many photographs taken in the field that the following environmental impact assessment was made.

ENVIRONMENTAL IMPACT MATRIX FOR STREAM CROSSINGS

BASED ON FIELD OBSERVATION OF EXISTING TRANSPORTATION FACILITIES

TABLE 3

NORTHERN ALBERTA RAILWAYS - LAC LA BICHE TO FORT McMURRAY

IMPACT OBSERVATION / CROSSING (Mile)	120.2	133.2	137.2	145.5	152.2	156.8	163.4	164.3	165.3	166.0	168.2	172.3	180.4	180.5	180.9	181.5	185.4	190.5	198.3	199.0	206.7	209.5	215.1	215.7	216.4	216.8	221.6	222.7	223.5	229.2	234.8	235.4	246.6	253.0	255.9	272.0	275.0	276.8	279.4	281.0	SUMMARY % IMPACT SCORE
1. Environmental Deterioration	3	3	3	3	3	2	2	3	3	3	3	2	2	2	2	2	2	2	1	3	1	2	2	2	2	3	3	2	2	1	3	3	2	2	2	3	3	3	3	2	80
2. Stream Behaviour	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	85
3. Bank Erosion or Migration	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	41
4. Increased Siltation	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	1	0	0	0	1	1	1	0	1	59
5. Erosion in Ditches or R/W	0	1	1	1	0	1	0	1	1	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	1	0	0	1	1	0	1	1	0	1	1	1	1	0	59
6. Stream Bed Erosion	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	92
7. Flood Flow Constriction	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	85
8. Presence of Construction Debris	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	95
9. Hindrance to Fish Migration (Due to #8)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
10. Culvert - Invert Above Stream-Bed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. Culvert - Degradation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Culvert - Excessive Velocities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Presence of Oil in Water	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
14. Aesthetic Appearance	3	3	3	3	3	2	3	3	3	3	3	3	3	2	2	2	2	2	1	2	1	2	3	2	2	3	3	2	2	1	3	3	2	2	3	3	3	3	3	3	85
15. Affects Wildlife	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
TOTAL SCORE % (S)	94	100	100	100	94	75	81	100	100	100	94	94	81	69	69	63	63	69	38	88	37	69	81	69	75	94	94	69	75	50	88	88	75	75	75	94	94	94	94	75	Mean S=84
TYPE OF STRUCTURE - BRIDGE - CULVERT	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B C	B	 C*	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	Including Culverts S̄ = 81

* Wooden 4' x 4' Culvert

Scoring: 0 - lowest
1 & 3 - highest

NORTHERN ALBERTA RAILWAY (N.A.R.)

The use of a N.A.R. track speeder facilitated a visit to all stream crossings from Lac La Biche to Fort McMurray. The results of this investigation are shown in Table 3, with each crossing identified by the N.A.R. mileage, and the items investigated scored as shown.

The railway, from south to north leaves the lowland around Lac La Biche, crosses the Moostoos Upland, the Christina Basin, skirts the east flank of the Stony Mountain Uplands, and thence into Fort McMurray via the deep valley of the Clearwater River. The surficial deposits consist largely of glacial outwash sands and gravels, lacustrine silts and clays, and aeolian sands, with hummocky morainic till around the Stony Mountain Uplands. The underlying bedrock consists largely of shale and minor sandstones of the Upper Cretaceous La Biche Group with outcrops of the Joli Fou, Pelican and Grand Rapids, Clearwater and McMurray (oilsands) formations north of Anzac. Vegetation is largely aspen poplar, with some areas of sphagnum moss and Black Spruce treed muskeg, and stands of Jackpine and White Spruce. The principal areas draining to the N.A.R. are shown in Figures 22A and 22B.

The environmental impact matrix (Table 3) indicates that:

1. The N.A.R. stream crossings were generally good. (Mean score = 84%).

2. Timber trestles were the dominant structure, and undoubtedly this enhanced the aesthetic appeal of each crossing.

3. The major criticisms concerned bank erosion, increased siltation, and ditch erosion. The bank erosion and siltation occurred mostly as the result of the clearing of vegetation around the bridges and on the fills.

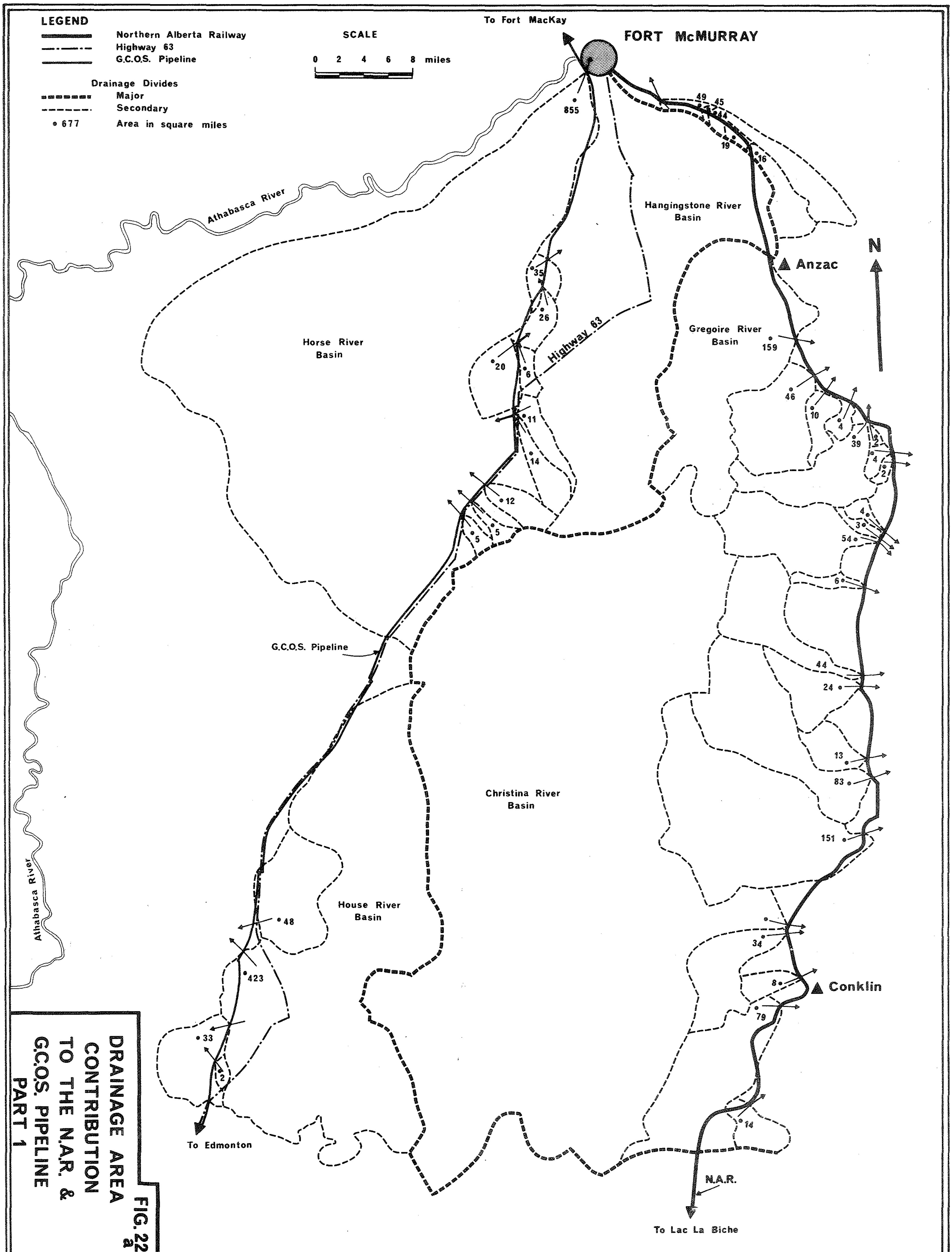


FIG. 22 a

DRAINAGE AREA CONTRIBUTION TO THE N.A.R. & G.C.O.S. PIPELINE PART 1

FIG. 22b

DRAINAGE AREA CONTRIBUTION TO THE N.A.R. & G.C.O.S. PIPELINE PART 2

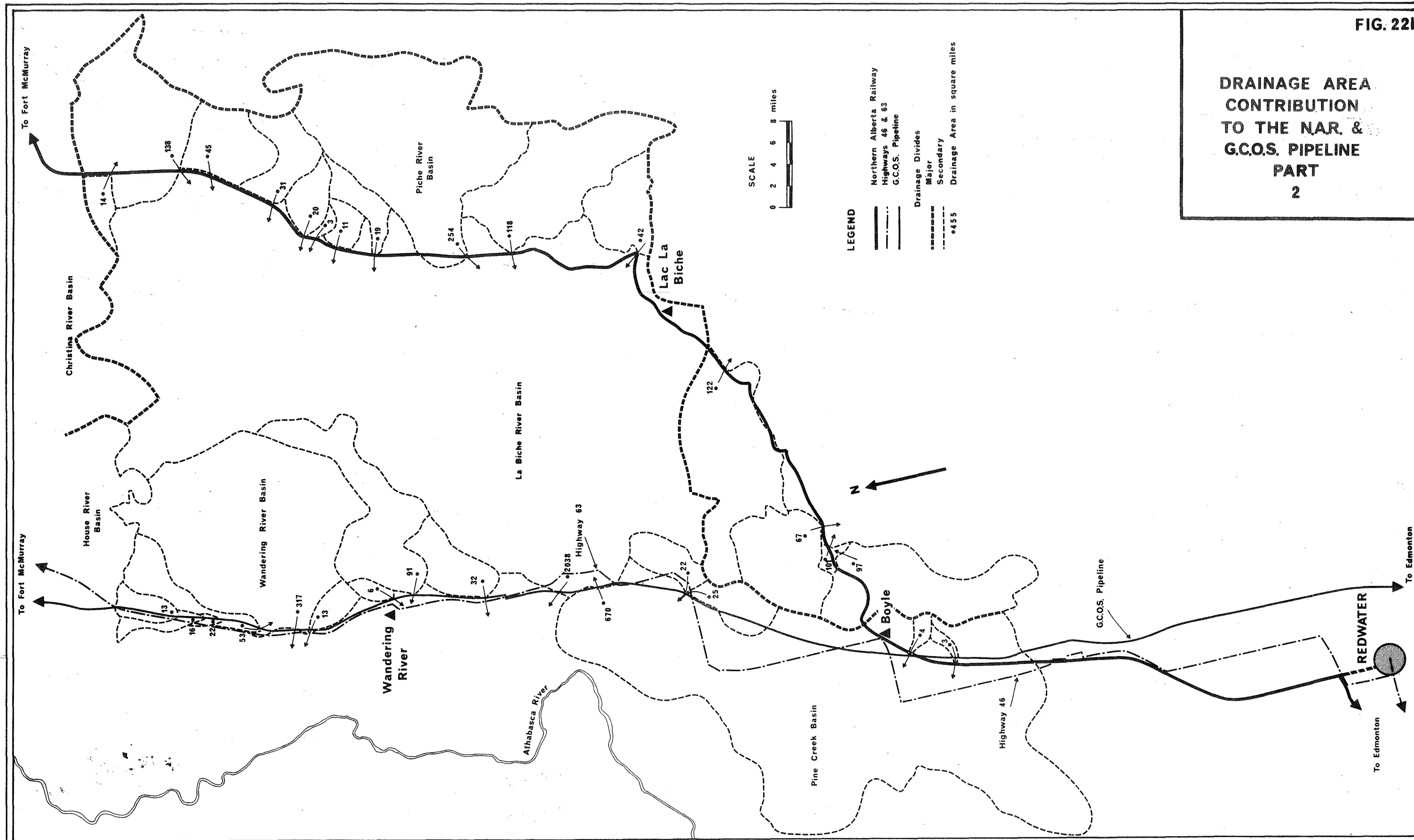


PLATE 1

CROSSING OF WIAU RIVER - MILE 166.0
S= 100 %

PLATE 2

CROSSING OF JACKFISH CREEK - MILE 198.3
S= 38 %

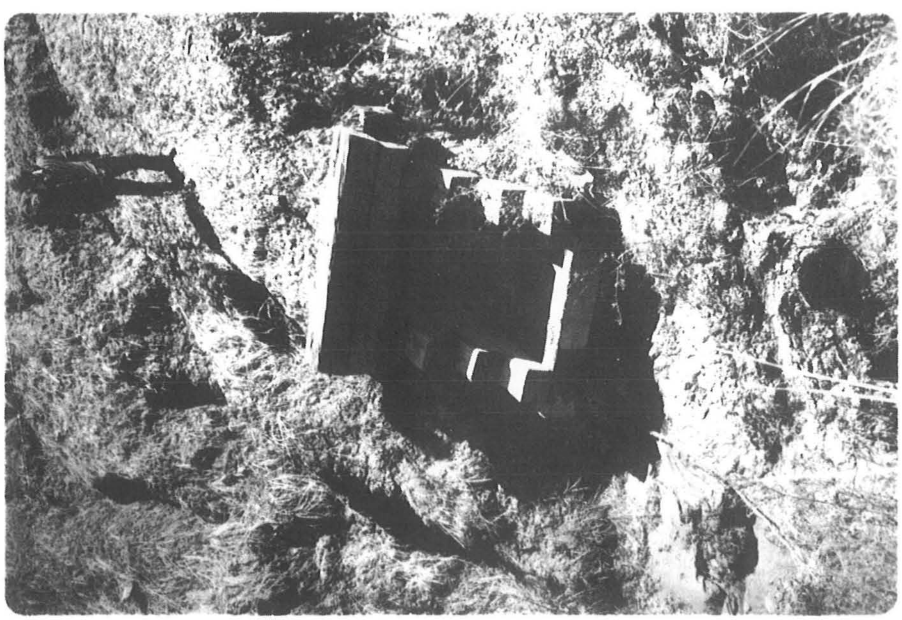


PLATE 3

CROSSING OF SMALL CREEK - MILE 206.7
S= 37 %

NORTHERN ALBERTA RAILWAY (N.A.R.) - (Continued)

4. Examples of poor crossings were noted, one due to poor construction of a channel diversion with old culvert installations (Mile 198.3), one where a wooden box culvert was poorly installed (Mile 206.7), and one where the channel processes had been disrupted (Mile 229.2).

5. Crossings in muskeg areas seemed quite good. Problems arose largely in areas of friable or unstable surficial deposits.

6. Photographs 1, 2 and 3 illustrate selected good and poor crossings noted.

ALBERTA HIGHWAY (#63)

On two separate trips all the creeks crossed by bridges, or culverts greater than 24 inches diameter were inspected utilizing the standard inspection forms mentioned above. The results of this investigation and the matrix scores are shown in Table 4, with each crossing identified by an approximate mileage beginning with 0 at Atmore and 154 at Fort McMurray.

Highway 63 northwards from Atmore traverses the northern edge of the Eastern Alberta Plains before rising gradually into the Stony Mountain Upland where it follows closely the major N.E. - S.W. drainage divide, all the way into the deep valley confluence of the Athabasca and Clearwater Rivers. The surficial geology consists largely of glacial outwash sands and gravels, interbedded lacustrine silts and clays; and glacio-fluvial sands, and sands and gravels. There are occasional ridges of glacial till in the uplands. The bedrock geology is similar to that of the N.A.R. route, with the addition of sandstones, shales, coal and minor bentonite of the Upper Cretaceous Wapiti Formation in the May Hill area. Vegetation consists largely of aspen poplar forest with less than 50% cultivation near Atmore, then intermittent Black Spruce

ENVIRONMENTAL IMPACT MATRIX FOR STREAM CROSSINGS

BASED ON FIELD OBSERVATION OF EXISTING TRANSPORTATION FACILITIES

TABLE 4

HIGHWAY 63 - ATMORE TO FORT MCMURRAY

IMPACT OBSERVATION / CROSSING (Mile)	9	13	14	20.2	26	29	37	63	65	73	97.5	101.5	103	105.9	111	113.5	119.4	120.6	125	126	131.7	133.3	140.9	142	144	144.5	145	146	150.6	154	SUMMARY % IMPACT SCORE	BRIDGES % IMPACT SCORE	CULVERTS % IMPACT SCORE
1. Environmental Deterioration	2	3	3	1	3	2	3	1	3	3	2	1	1	2	1	2	1	1	2	2	2	2	2	2	3	3	1	1	1	2	62	86	55
2. Stream Behaviour	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	60	100	48
3. Bank Erosion or Migration	1	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	1	47	100	30
4. Increased Siltation	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	83	86	83
5. Erosion in Ditches or R/W	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	23	29	22
6. Stream Bed Erosion	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	0	0	1	1	80	100	74
7. Flood Flow Constriction	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	13	43	4
8. Presence of Construction Debris	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	90	100	87
9. Hindrance to Fish Migration (Due to #8)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100	100	100
10. Culvert - Invert Above Stream-Bed	-	0	0	0	-	-	-	0	-	-	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	-	-	-	9
11. Culvert - Degradation	-	1	1	0	-	-	-	0	-	-	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	1	0	-	-	-	52
12. Culvert - Excessive Velocities	-	1	1	0	-	-	-	0	-	-	1	0	0	1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	0	-	-	-	52
13. Presence of Oil in Water	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	93	86	96
14. Aesthetic Appearance	2	3	3	2	2	2	3	1	2	3	2	2	2	2	2	3	1	1	1	2	1	2	2	2	3	2	2	2	1	2	67	76	64
15. Affects Wildlife	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	1	0	1	53	100	48
TOTAL SCORE % (S)	87	90	90	47	81	69	94	26	87	87	58	47	47	58	47	58	32	37	63	68	37	63	63	58	90	79	53	42	32	75	Mean S=62	Mean S=83	Mean S = 56
TYPE OF STRUCTURE - BRIDGE - CULVERT	B	C	C	C	B	B	B	C	B	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	B			

Scoring: 0 - lowest
1 & 3 - highest

treed muskeg, to Jackpine and White Spruce stands in muskeg on the Stony Mountain Uplands, and finally aspen poplar and muskeg around Fort McMurray.

The environmental impact matrix (Table 4) indicates that:

1. The bridge crossings on the highway had a very low impact. (Mean S = 83%)

2. The culvert crossings on the highway caused the most serious environmental impact. (Mean S = 56%)

3. The bridge crossings were faulty mostly because of ditch erosion and flood flow constriction.

4. The culvert crossings generally rated poorly for visual deterioration, changing stream patterns, bank erosion, ditch erosion, flood flow constriction, culvert setting, aesthetics and adverse effects on fish resources. In most cases the poor scores were attributable to lack of consideration of all the environmental factors in the vicinity of the downstream end.

5. Overall the highway rated fairly low as far as the environmental impact was concerned. (Mean S = 62%)

6. The bridges were aesthetically better than the majority of the culverts.

7. Photographs 4, 5 and 6 illustrate selected good and poor crossings noted.

THE GREAT CANADIAN OIL SANDS PIPELINE

All of the reasonably accessible larger stream crossings along the 260 mile length of the pipeline were inspected, from Edmonton to Fort McMurray. The results of the investigation and matrix scores are shown in Table 5, with each crossing identified either by the name of the creeks, or a Highway 63 mileage.

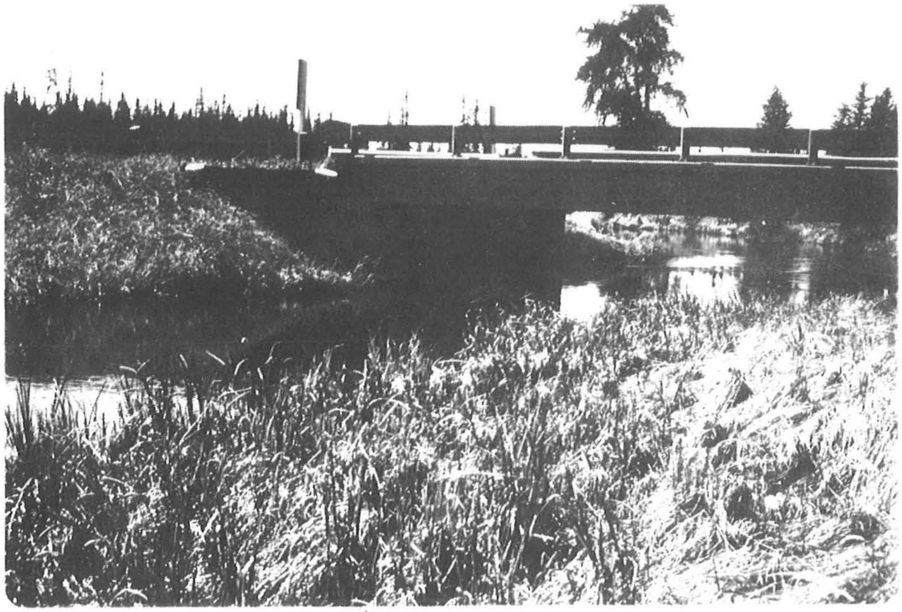


PLATE 4

CROSSING OF SMALL CREEK - MILE 73
S= 87 %

PLATE 5

CROSSING OF SMALL CREEK - MILE 20
S= 90 %

PLATE 6

CROSSING OF HANGINGSTONE RIVER - MILE 131.7
S= 37 %

ENVIRONMENTAL IMPACT MATRIX FOR STREAM CROSSINGS

BASED ON FIELD OBSERVATION OF EXISTING TRANSPORTATION FACILITIES

TABLE 5

SUN OIL PIPELINE - EDMONTON TO FORT MCMURRAY

IMPACT OBSERVATION / CROSSING	Pointe Aux Pins	Ross	Redwater	Namepi	Beaver Dam Cr.	Ellscott Cr.	Antler Cr.	Pine Cr.	La Biche	Mi. 20.2	Mi. 24	Mi. 37	Mi. 65	Mi. 73	Mi. 97.5	Mi. 101.5	Mi. 103	Mi. 105.9	Mi. 111	Mi. 113.5	Mi. 119.4	Mi. 120.6	Athabasca River	SUMMARY % IMPACT SCORE
1. Environmental Deterioration	3	3	3	2	3	2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	1	2	1	72
2. Stream Behaviour	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	78
3. Bank Erosion or Migration	1	1	1	1	1	1	0	0	1	0	0	0	0	1	1	0	1	0	1	0	0	1	0	52
4. Increased Siltation	1	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	83
5. Erosion in Ditches or R/W	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	1	0	0	0	0	1	1	65
6. Stream Bed Erosion	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	87
7. Flood Flow Constriction	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	83
8. Presence of Construction Debris	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	0	1	74
9. Hindrance to Fish Migration (Due to #8)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	91
10. Culvert - Invert Above Stream-Bed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. Culvert - Degradation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Culvert - Excessive Velocities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Presence of Oil in Water	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	87
14. Aesthetic Appearance	3	2	3	2	3	2	2	2	2	2	2	2	2	3	3	3	3	2	2	3	1	2	3	78
15. Affects Wildlife	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
TOTAL SCORE % (S)	100	81	100	69	100	75	69	75	69	75	75	81	69	100	87	81	100	62	69	81	37	62	81	Mean S=78
TYPE OF STRUCTURE - ALL PIPE																								

Scoring: 0 - lowest
1 & 3 - highest

THE GREAT CANADIAN OIL SANDS PIPELINE - (Continued)

The pipeline traverses much the same physiography, surficial geology, bedrock geology and vegetation as the highway. Within the Eastern Alberta Plains, south of Atmore, the surficial geology is dominated by ground moraine and hummocky moraine, with isolated areas of lacutrine silts and clays, aeolian sands, and outwash sands and gravels. South of Boyle the bedrock geology consists of the shale, coal and sandstones of the Upper Cretaceous Edmonton Formation. Vegetation is largely aspen-poplar forest, with increasingly more extensive agricultural activity southwards. The principal areas draining to the G.C.O.S. pipeline are shown in Figures 22A and 22B.

The environmental impact matrix (Table 5) indicates that:

1. The pipeline crossings were relatively good and caused minor impact upon the environment. (Mean S = 78%)

2. The pipeline had no major faults, although some bank erosion, ditch erosion and presence of construction debris were evident. A minor disturbance in the bank configuration where high bank-fill occurred was also found, but of minor consequence.

3. Those crossings in deep valleys most consistently created greater environmental deterioration.

4. Pipeline crossings in muskegs were generally very good.

5. There was only one recorded case of a poor crossing of concern equivalent to that of the poor culverts. In this case (Mile 119.4) the pipe and river weight had been exposed within the creek, and construction debris was present.

6. No evidence of oil leaks was found. In two cases oil found near the crossings was thought to originate from the Tar Sands.

7. Photographs 7, 8 and 9 illustrate selected good and poor crossings noted.

PLATE 7

CROSSING OF SMALL CREEK NEAR ELLSCOTT
S= 100 %

PLATE 8

CROSSING OF HOUSE RIVER - MILE 73
S= 100 %

PLATE 9

CROSSING OF SMALL CREEK 35 MILES SOUTH OF FORT McMURRAY - MILE 119.4
S= 37 %

SUMMARY

The major conclusion to be drawn from an inspection of the existing transportation facilities is that bridge and pipeline crossings created the least impact upon the equatic environment. In contrast, culvert installations were generally far from satisfactory; the major faults being downstream bank erosion, and blockage of fish migration routes. The use in bridge construction of alien materials, such as metal and concrete, was generally found less aesthetically pleasing than natural (timber) materials. No attempt was made to assess the visual impact of the actual right-of-way, although the pipeline with its absence of surface structures is both aesthetically better, and less potentially disturbing to terrestial and aquatic wildlife. The lack of a more balanced (though none the less arbitrary) scoring system, and the small numbers of crossings of different types introduces a certain error in the overall scores which may be as much as 10%. This should be born in mind, as the scores given are not absolute. Nonetheless it is apparent that with due care a pipeline right-of-way may have only minimal impact upon the environment at or near stream crossings.

ENVIRONMENT SENSITIVITY MAP

This map (Figure 23) delimits those areas potentially most sensitive to disturbance of the aquatic environment. The main areas of disturbance include deep valleys, areas with high drainage course densities, lakes and areas subject to high runoff peaks. Where two or more of these types of disturbances occur in a given area the sensitivity increases. The general order of magnitude of sensitivity of each area is then described as high, moderate or low.

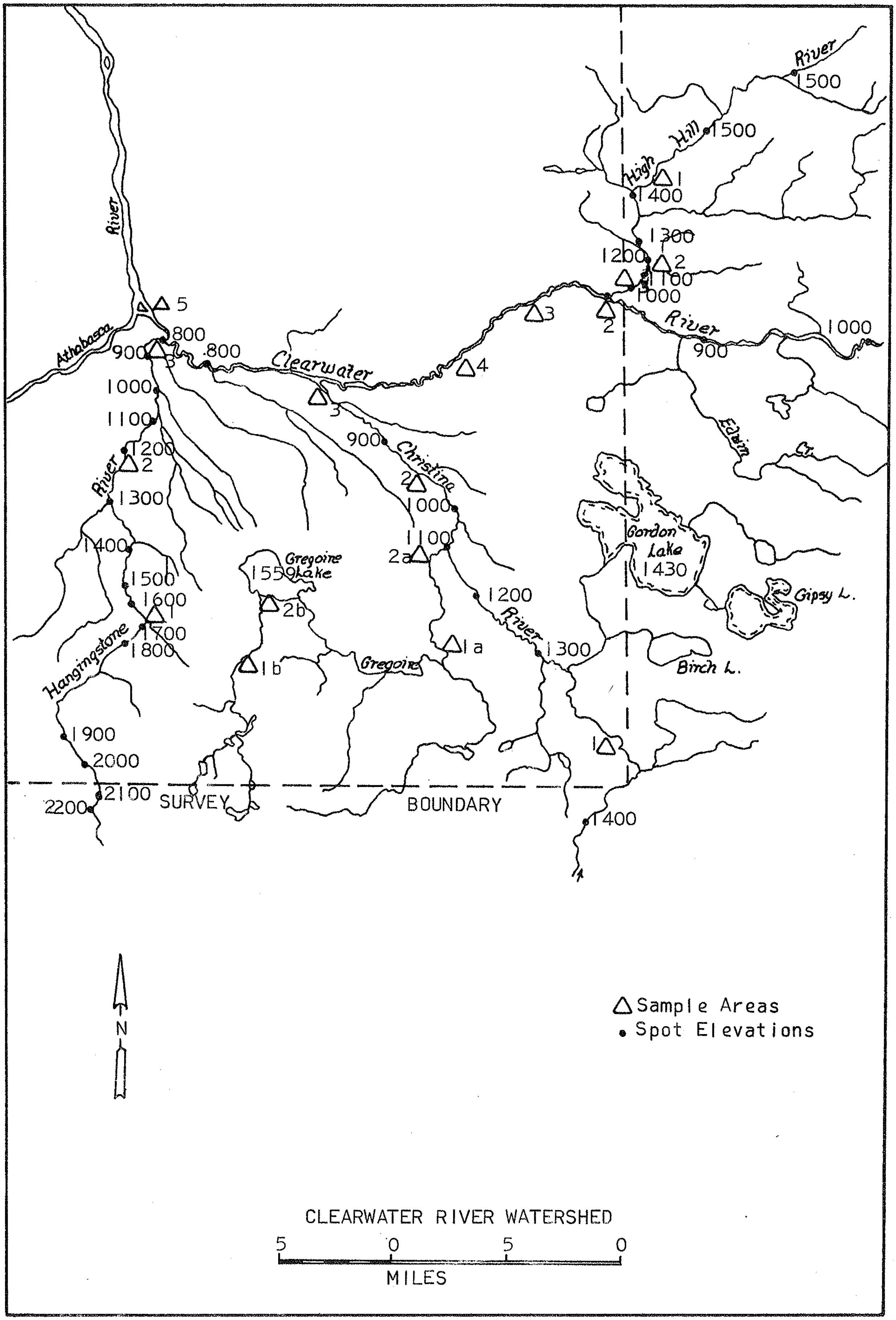
Areas not shaded need not be insensitive to disturbance, but the potential sensitivity due to a disturbance is expected to be low.

FIG. 23 ENVIRONMENT SENSITIVITY MAP

APPENDIX

Data presently available from the Alberta Fish and Wildlife Division, Department of Lands and Forests, concerning the fish resources in the study area north of township 84.

Figure 6


Athabasca
River
Clearwater
River
Christina
River
Hangingstone
River
High Hill
River
Edwin
Cr.
Gregoire
Lake
Gregoire
Gordon
Lake
Gipsy L.
Birch L.
SURVEY
BOUNDARY
N
Sample Areas
Spot Elevations
CLEARWATER RIVER WATERSHED
5
0
5
0
MILES

I. CLEARWATER RIVER WATERSHED

The Clearwater River watershed has its confluence with the Athabasca River at the town of Fort McMurray (Figure 6). This is an extremely large watershed but only a small portion of its total area is in Alberta. It lies to the southeast of Fort McMurray and approximately 71 miles of the Clearwater River is within the province. Other important rivers such as the Hangingstone River, Christina River, and High Hill River plus a few minor streams like the Gregoire River, Gordon River, Georges Creek and Surmont Creek make up this watershed. There are a large number of lakes in this watershed but only Gordon Lake, Gregoire and Georges Lake were looked at. The remaining lakes were outside the survey boundary of the present study.

A. Clearwater River

Total Length: not calculated

Length Surveyed: 71 miles

Watershed Area: 11,800 square miles

In the length surveyed, the Clearwater River is very uniform with only minor changes in flow rate, pool depths and bottom type from its mouth to survey boundary. This is a meandering river with many islands dotting the main channel. Sand bars and stretches of tar sands are often exposed during low water periods which adds to the sinuosity of the main channel. The river bottom is comprised of sand, tar sand and rubble. There are many long deep pools that provide excellent habitat for walleye and northern pike. The river does not appear to be subject to drastic fluctuations in water level. (Figure 7)

LONGITUDINAL PROFILE OF CLEARWATER RIVER

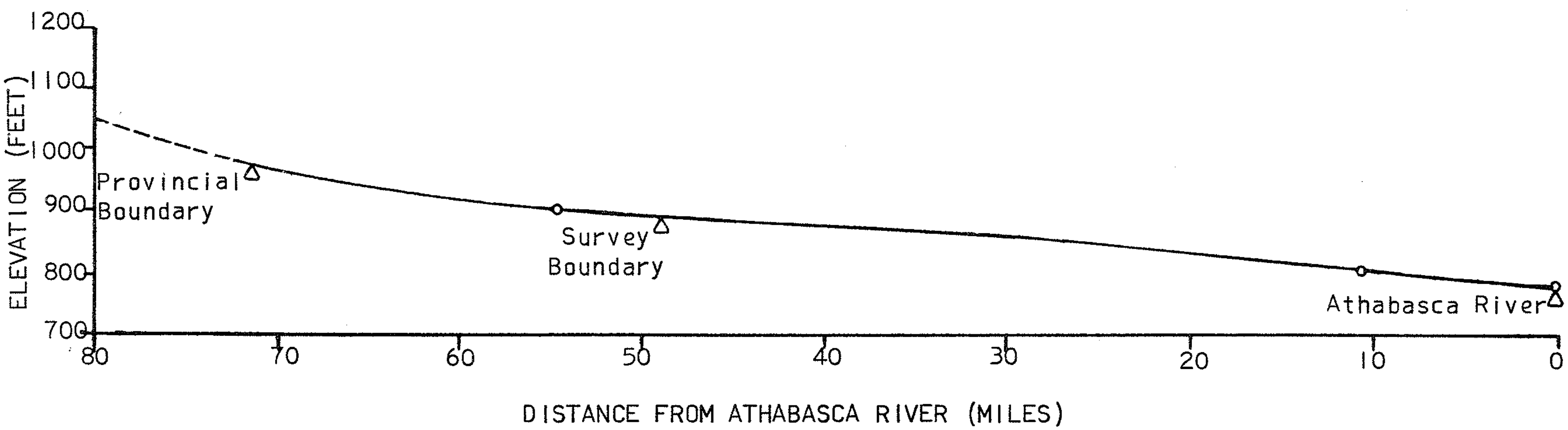


Figure 7. Longitudinal Profile of Clearwater River

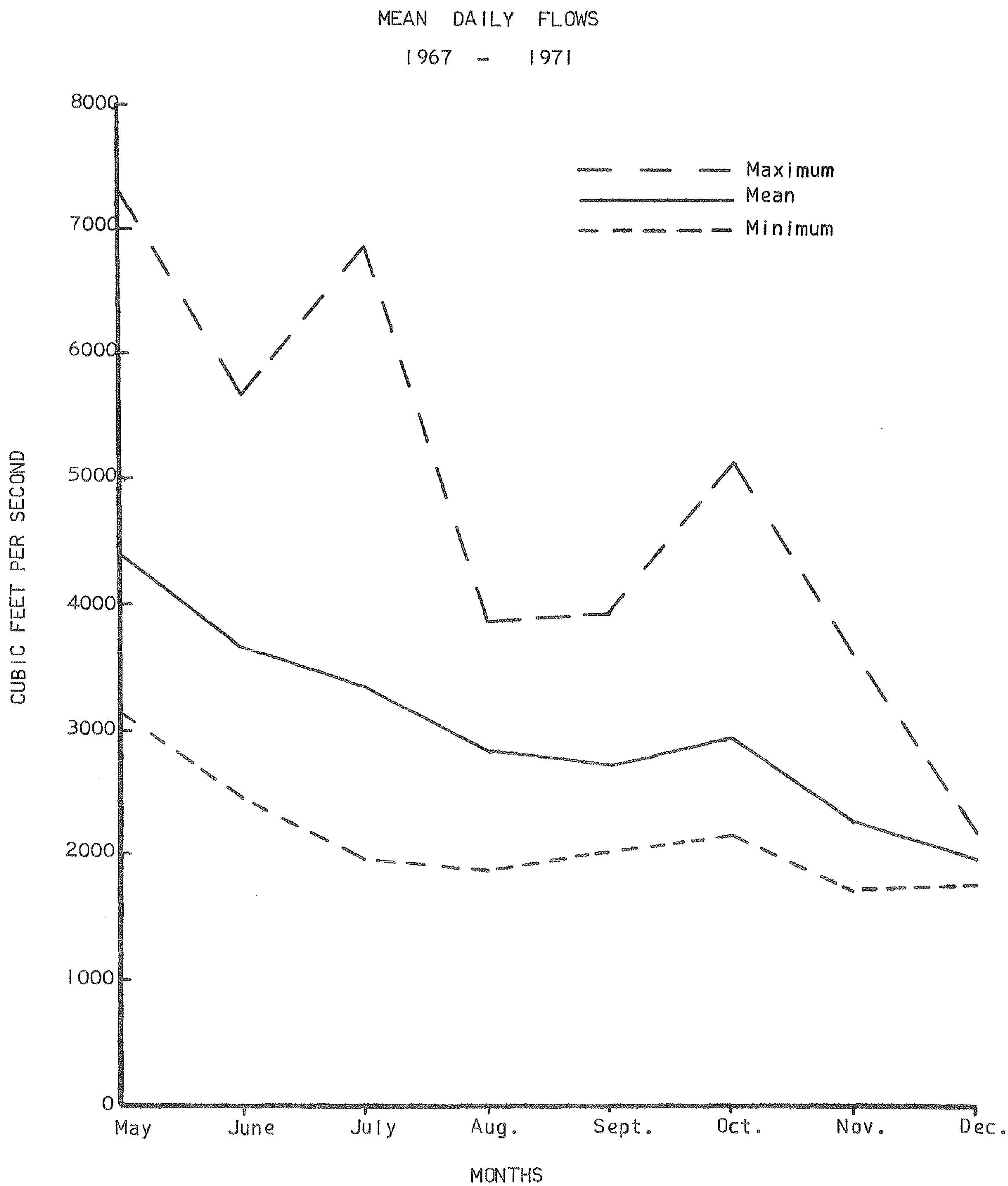


Figure 8. Maximum, minimum and mean flows in the Clearwater River above the Christina River.

Water Chemistry

TABLE I. Water chemistry of the Clearwater River - Station # I

LAB SAMPLE NO. 7510

GRAB SAMPLE

DATE SAMPLED 26/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	-
DISSOVLED OXYGEN		-	-
pH		7.40	-
SPECIFIC CONDUCTANCE		75 umho/cm	-
HARDNESS, TOTAL		34	-
ALKALINITY, TOTAL		30	-
SULFATE		7	-
CHLORIDE		4	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.1	-
CALCIUM		7	-
MAGNESIUM		3	-
SODIUM		3	-
POTASSIUM		0.5	-
PHOSPHATE		0.1	-
AMMONIA - N		0.7	-
TURBIDITY	LESS THAN	1 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Station # 2 - Clearwater River

Survey date: August 27, 1972

Location: Sec. 25 Twp. 89 Rge. 4

The Clearwater River is an excellent looking river. The water is clear with a very good flow rate. The average depth is over 2 feet with some pools ranging in depth from 8 to 10 feet. The pool to riffle ratio is approximately 1:1. The bottom substrate of the pools is a combination of sand and silt while the riffles substrate is sand, gravel, rubble and tar sand. Refugia for fish is excellent in the form of overhanging brush, logs and deep pools. The banks appear stable with high water marks only 2 to 3 feet above the present water level. The banks are covered with grass, willow, alder and a forest of poplar and spruce. Nutrients appear to be high.

Score Sheet Rating

Flow	5
Temperature	3
Pool Depth	5
Frequency of Pools	5
Refugia	5
Nutrients	5
Bank Cover	5
Substrate	3

Total - 36

Class I

Water Chemistry

TABLE 2. Water chemistry of the Clearwater River

LAB SAMPLE NO. 6492

GRAB SAMPLE

DATE SAMPLED 27/8/72 DATE COMPLETED 19/9/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	17° C
DISSOLVED OXYGEN	-	9.4 p.p.m.
pH	8.20	8.0
SPECIFIC CONDUCTANCE	235 umho/cm	-
HARDNESS, TOTAL	44	-
ALKALINITY, TOTAL	40	-
SULFATE	16	-
CHLORIDE	50	-
NITRATE & NITRITE	LESS THAN 0.1	-
IRON, TOTAL	0.2	-
CALCIUM	11	-
MAGNESIUM	3	-
SODIUM	28	-
POTASSIUM	1.2	-
PHOSPHATE	0.4	-
AMMONIA - N	0.3	-
TURBIDITY	3 JTU	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE AND NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Fish Fauna

A number of fish were taken at this location using spinning rods. Fishing success was excellent and a few of the fish were extremely large. All of the fish taken were mature. The largest walleye had a fork length of 71.5 cm., and weighed 3,620 gms. (approximately 8 pounds) .

List of species collected:

Stizostedion vitreum vitreum	Walleye
Esox lucius	Northern Pike

Station # 3 – Clearwater River

Fish Fauna

Rotenone, prima cord and a seine were used at this location to collect fish. Because of the large size of the river only a small side channel could be effectively worked. The Arctic grayling and northern pike captured were all immature fish.

List of species collected:

Esox lucius	Northern Pike
Thymallus arcticus	Arctic Grayling
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Cottus ricei	Spoonhead Sculpin
Couesius plumbeus	Lake Chub
Notropis hudsonius	Spottail Shiner

Station # 4 - Clearwater River

Survey date: August 27, 1972

Location: Sec. 6 Twp. 89 Rge. 5

The Clearwater River appears to be fairly uniform and this location is very similar to the other survey location (Sec. 25 Twp. 89 Rge. 4). A small side channel was tested with prima cord and with a seine and a few mountain whitefish fry were taken. This is a range extension for this species and is very indicative of the quality of this river system.

Fish Fauna

Rotenone, prima cord and a seine were used on a side channel of the Clearwater River to obtain a representative sample of smaller sized fish. A few Mountain whitefish fry were found and it is unknown if there is a resident population of larger whitefish.

List of species collected:

Prosopium williamsoni	Mountain Whitefish
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch

Water Chemistry

TABLE 3. Water chemistry of the Clearwater River - Station # 5

LAB SAMPLE NO. 6494

GRAB SAMPLE

DATE SAMPLED 24/8/72 DATE COMPLETED 19/9/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	-
DISSOLVED OXYGEN	-	-
pH	8.30	-
SPECIFIC CONDUCTANCE	335 umho/cm	-
HARDNESS, TOTAL	68	-
ALKALINITY, TOTAL	69	-
SULFATE	22	-
CHLORIDE	50	-
NITRATE & NITRITE	0.1	-
IRON, TOTAL	0.2	-
CALCIUM	20	-
MAGNESIUM	4	-
SODIUM	39	-
POTASSIUM	1.3	-
PHOSPHATE	0.4	-
AMMONIA - N	0.2	-
TURBIDITY	5 JTU	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

B. Hangingstone River

Total Length: 77 miles

Length Surveyed: 65 miles

Watershed Area: 423 square miles

The Hangingstone River originates in a series of low hills and breaks. In this region many of the small tributaries have steep gradients and are shallow with intermittent rapids. Further downstream where the flow becomes moderate the river increases in fisheries potential and is important as a hatchery area for Arctic grayling. From this region to the mouth there is an increase in pool depth and fish refugia is excellent. The river has excellent spawning potential for most of its length and a number of Arctic grayling were taken at each survey location. The entire river is rated Class 2.

Two named tributary creeks enter the Hangingstone River. The first is Saline Creek and the second is Prairie Creek. Both of these creeks drain muskeg areas and have only short stretches of water that may be significant as Arctic grayling hatchery areas.

LONGITUDINAL PROFILE OF HANGINGSTONE RIVER

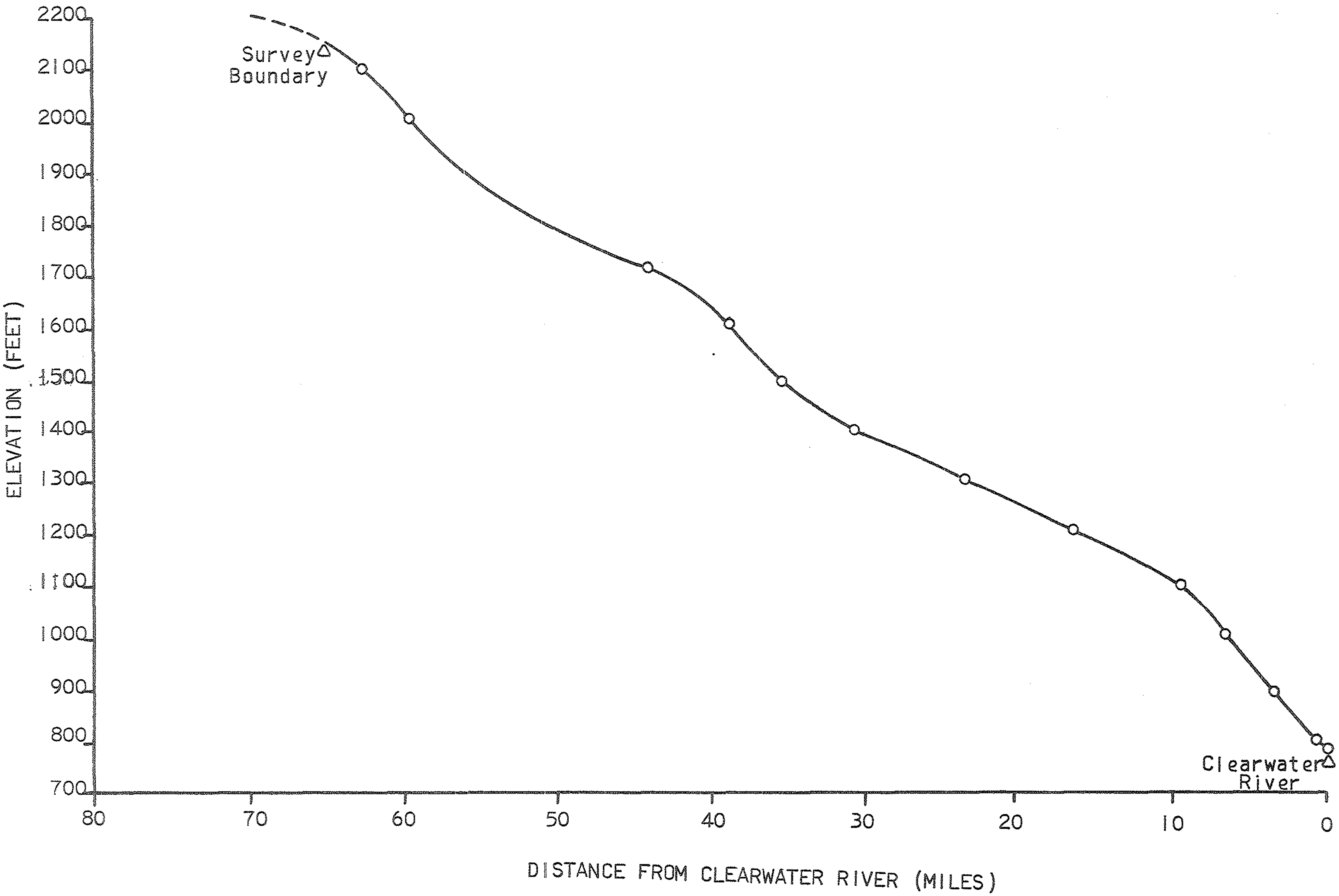


Figure 11. Longitudinal Profile of Hangingstone River

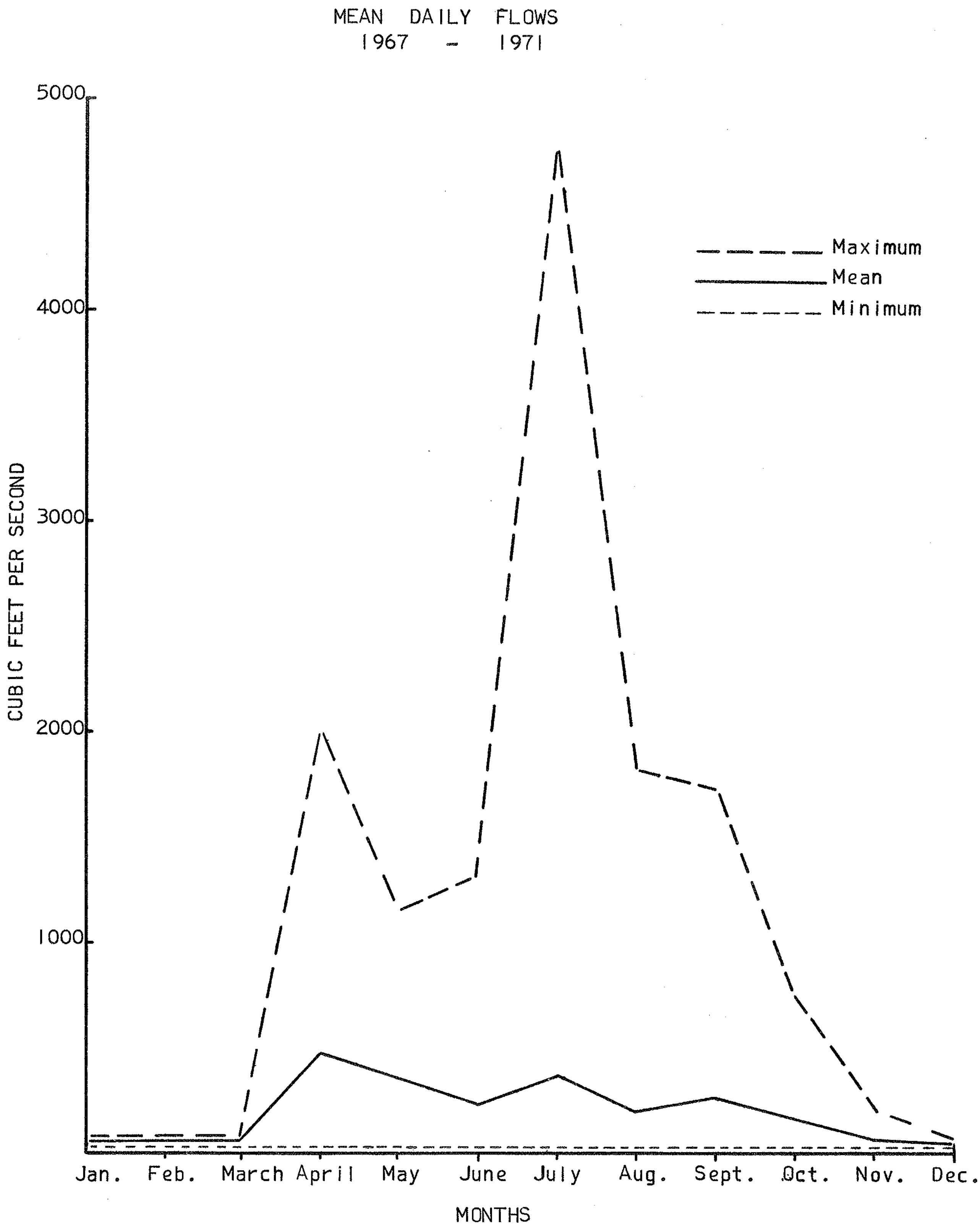


Figure 12. Maximum, minimum and mean flows of the Hangingstone River

Station # 1 - Hangingstone River

Survey date: September 16, 1972

Location: Sec. 33 Twp. 85 Rge. 9

At this location the Hangingstone River has an average width of 25 feet and an average depth of 1 to 2 feet. There are occasional pools with depths up to 4 feet. The flow is good and the summer temperature is favorable for grayling. The pool to riffle ratio is approximately 1:1 and there is an excellent supply of fish refugia in the form of overhanging banks, logs and deep pools. The bottom substrate is gravel and rubble in the riffles with some silt and boulders in the pools. The banks appear stable. They are covered with willow, alder and a forest of poplar and spruce. Nutrients in this river are high.

Score Sheet Rating

Flow	5	
Temperature	3	
Pool Depth	3	
Frequency of Pools	5	
Refugia	3	
Nutrients	3	
Bank Cover	5	Total - 32
Substrate	5	Class 2

Water Chemistry

TABLE 4. Water chemistry of the Hangingstone River

LAB SAMPLE NO. 7519

GRAB SAMPLE

DATE SAMPLED 16/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	6°C
DISSOLVED OXYGEN		-	9.2 p.p.m.
pH		8.20	8.4
SPECIFIC CONDUCTANCE		362 umho/cm	-
HARDNESS, TOTAL		172	-
ALKALINITY, TOTAL		192	-
SULFATE	LESS THAN	5	-
CHLORIDE	LESS THAN	1	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.3	-
CALCIUM		67	-
MAGNESIUM	LESS THAN	1	-
SODIUM		6	-
POTASSIUM		2.0	-
PHOSPHATE		0.3	-
AMMONIA - N		0.4	-
TURBIDITY		13 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGRN.

Bottom Fauna

TABLE 5. Bottom Fauna from the Hangingstone River

Order	Family	Genus
Plecoptera	Periodidae	*Isogenus* sp.
Ephemeroptera	Baetidae	*Ameletus* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.
Trichoptera	Phryganeidae	*Brachycentrus* sp.
Diptera	Rhagionidae	-

Fish Fauna

A large number of fish were taken at this station using rotenone and prima cord. All species except pearl dace were found in such large numbers that only a small subsample was preserved for future lab study. All of the Arctic grayling taken were immature (1 + years old) and ranged from 12 to 18 cm. fork length.

List of species collected:

Thymallus arcticus	Arctic Grayling
Catostomus commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Couesius plumbeus	Lake Chub
Semotilus margarita	Pearl Dace

Station # 2 - Hangingstone River

Survey date: September 18, 1972

Location: Sec. 30 Twp. 87 Rge. 9

The Hangingstone River is similar at this location to the station at Sec. 33 Twp. 85 Rge. 9. Some sampling was done and a few Arctic grayline were taken. Pools in this area are 2 to 3 feet deep with an overall average stream depth of 2 feet. The width is 25 to 30 feet. Pool frequency is 1:1.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	3		
Frequency of Pools	5		
Refugia	5		
Nutrients	3		
Bank Cover	5	Total -	34
Substrate	5	Class	2

Fish Fauna

Fish were collected at this station using both rotenone and prima cord. The Arctic grayling taken were all large mature fish.

List of species collected:

Thymallus arcticus	Arctic Grayling
Percopsis omiscomaycus	Trout Perch

Section # 3 - Hangingstone River

Survey date: September 17, 1972

Location: Sec. 9 Twp. 89 Rge. 9

The Hangingstone River has an average width of 40 feet and an average depth of 1 to 2 feet in this area. The water is clear and the flow is good. The bottom substrate is composed of boulders, rubble and gravel in the riffles with boulders, and silt in the pools. The pool to riffle ratio is 1:1 and there is fairly good fish refugia. The banks show some signs of high water erosion but are generally fairly stable. Present low water conditions leave a number of rock and gravel bars exposed and there is a reduction in the percentage of shaded water. Above these bars the banks are covered with willow and alder. The surrounding forest is mainly poplar and spruce. Nutrients in the river are high. Many of the rocks are covered with moss and algae.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	3		
Frequency of Pools	5		
Refugia	3		
Nutrients	3		
Bank Cover	3	Total	- 30
Substrate	5	Class	2

Water Chemistry

TABLE 6. Water chemistry of the Hangingstone River

LAB SAMPLE NO. 7527

GRAB SAMPLE

DATE SAMPLED 17/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	6°C
DISSOLVED OXYGEN		-	9.6 p.p.m.
pH		8.30	8.8
SPECIFIC CONDUCTANCE		475 umho/cm	-
HARDNESS, TOTAL		190	-
ALKALINITY, TOTAL		210	-
SULFATE		39	-
CHLORIDE		17	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.1	-
CALCIUM		64	-
MAGNESIUM		7	-
SODIUM		35	-
POTASSIUM		2.6	-
PHOSPHATE		0.1	-
AMMONIA - N		0.6	-
TURBIDITY	LESS THAN	1 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 7. Bottom fauna from the Hangingstone River

Order	Family	Genus
Plecoptera	Pteronacidae	*Peteronarcys* sp.
Plecoptera	Nemouridae	*Nemoura* sp.
Ephemeroptera	Baetidae	*Ameletus* sp.
Ephemeroptera	Heptagenidae	*Heptagenia* sp.
Diptera	Rhagionidae	-

Fish Fauna

Rotenone and prima cord were used at this station to collect fish. Both mature and immature Arctic grayling were taken.

List of species collected:

Thymallus arcticus	Arctic Grayling
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

C. Christina River

Total Length: 202 miles

Length Surveyed: 49 miles

Watershed Area: 5,300 square miles

The Christina River is the main tributary of the Clearwater River in Alberta. Only a small portion of the Christina was surveyed but its high sports fisheries potential is evident and the importance of the entire Christina watershed must be stressed. (Ratings at specific locations on this river are a high Class 2 and a Class I.)

Because of its large size adequate fish samples were hard to obtain in the upper portion of the survey region and classification was based mainly on physical parameters and synoptic data. The river has a fast flowing current with many deep pools and excellent spawning potential. Boulders and gravel are common in most of the rapids and fish refugia is excellent. Where the river could be tested good populations of walleye and suckers were found and northern pike are common.

The tributaries of the Christina River were also surveyed and varied considerably in fisheries potential along their length. All of the tributaries drain large stretches of muskeg and a number of large lakes. These streams may be of importance both as spawning routes for fish from the lakes and as as hatchery and rearing area for a number of fish.

The Gregoire River, Georges Creek and Gordon River have only limited sports fisheries potential. Small populations of Arctic grayling were located where a steeper gradient provided favorable flow rates and pool to riffle ratios. Intensive beaver activity and the impoundment of 80 to 90% of the remainder of the stream is the main limiting factor. These areas are generally weed choked, are expected to have high summer temperatures and are only suitable for northern pike.

In contrast, Surmont Creek (which flows into Gregoire Lake) has a much higher fisheries potential. This creek has its headwaters in a group of small hills and has a favorable combination of pool, riffle (spawning gravel) and surrounding cover to be a significant grayling hatchery and provided a number of small catchable size fish.

Gordon Lake was looked at from the air and appeared to be extremely shallow and prolific weed growth was noted. Because of this, further survey was not initiated.

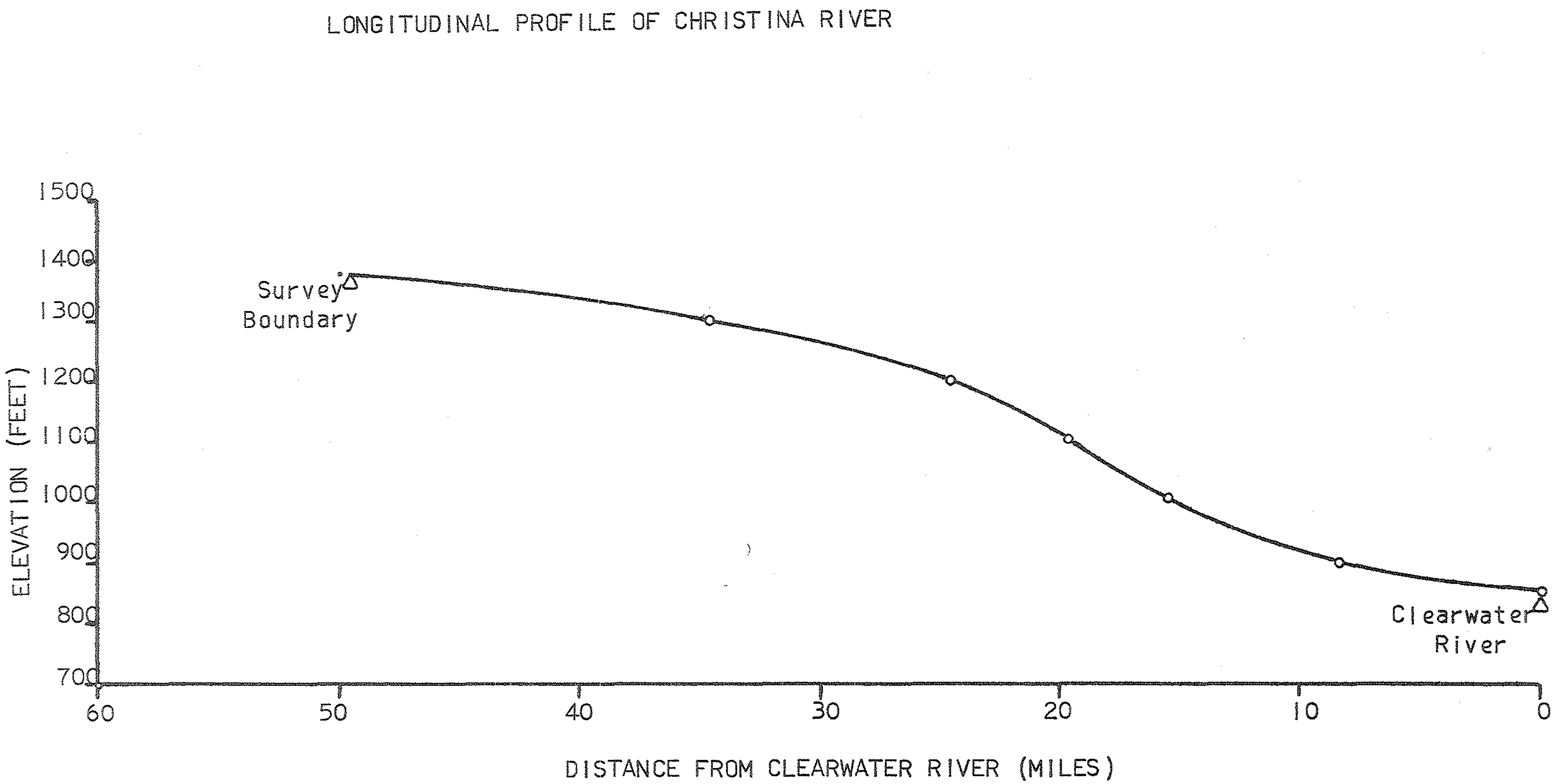


Figure 19. Longitudinal Profile of Christina River

Station # 1 - Christina River

Survey date: September 26, 1972

Location: Sec. 23 Twp. 84 Rge. 4

The Christina River is approximately 200 feet wide at this location and has an average depth of 2 to 4 feet. Many of the pools have depths ranging up to 5 feet. The water is murky and the flow is excellent. The pool to riffle ratio is approximately 1:1 and fish refugia is excellent. Nutrients are high in the river. Most of the rocks are covered with weeds or algae and there is an abundance of bottom fauna. The bottom substrate is mainly gravel with a scattering of boulders. The bank cover is mainly poplar, spruce and willow. There are some signs of erosion from high water (1 to 3 feet) but it has no effect on the river at lower water levels. The bank cover provides very little effective shading because of the size of the river.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	5		
Frequency of Pools	5		
Refugia	5		
Nutrients	5		
Bank Cover	3	Total	- 36
Substrate	5	Class	1

Water Chemistry

TABLE 8. Water chemistry of the Christina River

LAB SAMPLE NO. 7518

GRAB SAMPLE

DATE SAMPLED 26/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	2°C
DISSOLVED OXYGEN		-	-
pH		8.00	-
SPECIFIC CONDUCTANCE		335 umho/cm	-
HARDNESS		128	-
ALKALINITY, TOTAL		159	-
SULFATE		28	-
CHLORIDE		8	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.4	-
CALCIUM		46	-
MAGNESIUM		2	-
SODIUM		18	-
POTASSIUM		1.6	-
PHOSPHATE		0.2	-
AMMONIA - N		0.5	-
TURBIDITY		4 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 9. Bottom fauna from the Christina River

Order	Family	Genus
Plecoptera	Perlodidae	*Isogenus* sp.
Odonata	Gomphidae	*Hagenius* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.

Station # 2 - Christina River

Survey date: Setpember 18, 1972

Location: Sec. 26 Twp. 87 Rge. 6

The Christina River is approximately 100 feet wide at this point. It has a mean depth of 2 to 3 feet with some pools as deep as 5 feet. The pool to riffle ratio is approximately 1:1 and fish refugia is fair (deep pools). The banks provide little or no cover because of the size of the river and the large gravel bars. High water marks are 3 to 4 feet up the bank. The banks show signs of erosion at some points. The cover along the banks is mainly alder, poplar and spruce. The bottom substrate of the river is boulders, rubble and gravel. Most of the boulders are covered with moss or algae. Nutrients are high.

Score Sheet Rating

Flow	5	
Temperature	3	
Pool Depth	5	
Frequency of Pools	5	
Refugia	3	
Nutrients	5	
Bank Cover	1	Total - 30
Substrate	3	Class 2

Water Chemistry

TABLE 10. Water chemistry of the Christina River

LAB SAMPLE NO. 7528

GRAB SAMPLE

DATE SAMPLED 18/9/72 DATE COMPLETED 20/10/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	6°C
DISSOLVED OXYGEN	-	8.6 p.p.m.
pH	8.00	8.8
SPECIFIC CONDUCTANCE	1050 umho/cm	820
HARDNESS, TOTAL	164	-
ALKALINITY, TOTAL	180	-
SULFATE	39	-
CHLORIDE	241	-
NITRATE & NITRITE	0.1	-
IRON, TOTAL	0.3	-
CALCIUM	55	-
MAGNESIUM	6	-
SODIUM	166	-
POTASSIUM	43.0	-
PHOSPHATE	0.2	-
AMMONIA - N	0.5	-
TURBIDITY	7 JTU	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE II. Bottom fauna from the Christina River

Order	Family	Genus
Plecoptera	Perlodidae	*Isogenus* sp.
Hemiptera	Corixidae	-
Diptera	Rhagionidae	-

Fish Fauna

The Christina River was sampled using rotenone and prima cord. Because of its large size both of these methods were ineffective (i.e. only backwaters and side channels could be worked and the fish recovered). A few large size northern pike were taken plus a large number of sucker fry.

List of species collected:

Esox lucius	Northern Pike
Catostomus catostomus	Longnose Sucker
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

Station # 3 - Christina River

Survey date: August 28, 1972

Location: Sec. 33 Twp. 88 Rge. 7

The Christina River appears to be an excellent river at this location. There is a good flow rate with an average stream depth of 1 to 2 feet. Some pools with 4 to 5 foot depths can also be found. The pool to riffle ratio is approximately 1:1 and the riffle substrate is mainly rubble and gravel. The deep pools have a bottom substrate of gravel, sand and silt. The banks show some signs of high water erosion and many gravel bars are evident at low water. The high water level is 4 to 5 feet above the present water level. The banks are covered with willow, alder and a forest of poplar and spruce. Fish refugia appears to be excellent. Nutrients appear to be high.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	5		
Frequency of Pools	5		
Refugia	5		
Nutrients	3		
Bank Cover	3	Total -	34
Substrate	5	Class	2

Water Chemistry

TABLE 12. Water chemistry of the Christina River

LAB SAMPLE NO. 6490

GRAB SAMPLE

DATE SAMPLED 28/8/72 DATE COMPLETED 26/9/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	19°C
DISSOLVED OXYGEN	-	10.8 p.p.m.
pH	8.00	8.8
SPECIFIC CONDUCTANCE	870 umho/cm	-
HARDNESS, TOTAL	154	-
ALKALINITY, TOTAL	163	-
SULFATE	31	-
CHLORIDE	100	-
NITRATE & NITRITE	LESS THAN 0.1	-
IRON, TOTAL	0.2	-
CALCIUM	40	-
MAGNESIUM	12	-
SODIUM	131	-
POTASSIUM	2.5	-
PHOSPHATE	0.4	-
AMMONIA - N	0.5	-
TURBIDITY	7 JTU	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Fish Fauna

This location was reached by boat so a number of collecting techniques could be utilized. Gill nets, prima cord and rotenone were all found to be effective. Rotenone was used in side channels for the smaller fish while prima cord and gill nets were used to collect larger fish in the main channel. A number of large mature walleye and suckers were taken.

List of species collected:

Stizostedion vitreum vitreum	Walleye
Lota lota	Burbot
Catostomus commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Cottus ricei	Spoonhead Sculpin
Cottus cognatus	Slimy Sculpin
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace
Percopsis omiscomaycus	Trout Perch

Station # 1a - Gregoire River

Survey date: September 18, 1972

Location: Sec. 24 Twp. 85 Rge. 6

This is an atypical portion of the Gregoire River. At this location there is a pool to riffle ration of 2:1, an average depth of 2 to 3 feet and a mean width of 25 feet. Fish refugia is excellent and there is a good supply of rubble and gravel in the riffles. The pools are deep and have a bottom substrate of gravel and silt.

A small population of Arctic grayling were found in this portion of the river but the extent of the suitable habitat was limited. Much of the remaining river is blocked by successive beaver dams and lack sufficient spawning gravel and water flow. Summer water temperatures are high and weed growth is prolific.

Score Sheet Rating

Flow	3		
Temperature	3		
Pool Depth	5		
Frequency of Pools	3		
Refugia	5		
Nutrients	5		
Bank Cover	5	Total - 34	
Substrate	5	Class	2

Water Chemistry

TABLE 13. Water chemistry of the Gregoire River

LAB SAMPLE NO. 7520

GRAB SAMPLE

DATE SAMPLED 18/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	6°C
DISSOLVED OXYGEN		-	9.2 p.p.m.
pH		8.20	8.2
SPECIFIC CONDUCTANCE		480 umho/cm	-
HARDNESS, TOTAL		152	-
ALKALINITY, TOTAL		194	-
SULFATE		33	-
CHLORIDE		42	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL	LESS THAN	0.1	-
CALCIUM		49	-
MAGNESIUM		6	-
SODIUM		62	-
POTASSIUM		2.1	-
PHOSPHATE		0.3	-
AMMONIA - N		0.5	-
TURBIDITY		2 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 14. Bottom fauna from the Gregoire River

Order	Family	Genus
Plecoptera	Pteronacidae	*Pteronarcys* sp.
Plecoptera	Nemouridae	*Nemoura* sp.
Ephemeroptera	Baetidae	*Ephemeralla* sp.
Odonata	Gomphidae	*Hagenius* sp.
Hemiptera	Corixidae	-
Trichoptera	Phryganeidae	*Brachycentrus* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.
Diptera	Rhagionidae	-
Diptera	Tendipedidae	-
Diptera	Tabanidae	-
Coleoptera	Elmidae	*Narpus* sp.

Fish Fauna

Rotenone and prima cord were used at this station which resulted in a greater diversity of fish species being collected. In stations where only prima cord was used fish such as the slimy scuplin were not collected.

Both immature and mature Arctic grayling were collected which would indicate that there is a reproductive population in this river.

List of species collected:

Thymallus arcticus	Arctic Grayling
Catostomus commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Cottus cognatus	Slimy Sculpin
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

Station # 2a - Gregoire River

Survey date: September 18, 1972

Location: Sec. 26 Twp. 86 Rge. 6

The mouth of the Gregoire River is low in fisheries potential. There is a fairly good flow rate but there are virtually no pools or other forms of fish refugia. The river channel is 72 feet wide and shows signs of extreme flood conditions. The river itself is only 10 feet wide at time of survey. The bottom substrate is almost entirely large boulders with small amounts of gravel. The banks are heavily eroded and the bank cover is far from the main channel. The average depth of the river is approximately 1 foot. The water is murky.

Score Sheet Rating

Flow	3		
Temperature	3		
Pool Depth	1		
Frequency of Pools	1		
Refugia	1		
Nutrients	5		
Bank Cover	1	Total -	16
Substrate	1	Class	4

Fish Fauna

Because of the torrential nature of the stream bed at this location and the lack of any definitive pools only rotenone was used to collect fish. Only a few small Arctic grayling were taken along with large numbers of the other species.

List of species collected:

Thymallus arcticus	Grayling
Percopsis omiscomaycus	Trout Perch
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

Station # Ib - Surmont Creek

Survey date: September 18, 1972

Location: Sec. 22 Twp. 85 Rge. 8

Surmont Creek has an average width of approximately 10 feet with an average depth of 1 foot. The pool to riffle ratio is approximately 1:2 with few large pools. Fish refugia is excellent with many overhanging banks, brush and logs. The water is clear and cold. The banks are covered with alder, spruce and poplar. The bottom substrate is gravel, rubble and some boulders. The high water mark is 1 to $1\frac{1}{2}$ feet above the present level but only small amounts of erosion are evident. Nutrients are good.

Score Sheet Rating

Flow	3
Temperature	3
Pool Depth	3
Frequency of Pools	3
Refugia	5
Nutrients	3
Bank Cover	5
Substrate	5

Total - 30

Class 2

Water Chemistry

TABLE 15. Water chemistry of the Surmont Creek

LAB SAMPLE NO. 7529

GRAB SAMPLE

DATE SAMPLED 18/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	5°C
DISSOLVED OXYGEN		-	10.8 p.p.m.
pH		8.10	8.4
SPECIFIC CONDUCTANCE		325 umho/cm	360
HARDNESS, TOTAL		162	-
ALKALINITY, TOTAL		161	-
SULFATE		33	-
CHLORIDE		1	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.6	-
CALCIUM		15	-
MAGNESIUM		29	-
SODIUM		6	-
POTASSIUM		2.0	-
PHOSPATE		0.3	-
AMMONIA - N		0.4	-
TURBIDITY		5 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 16. Bottom fauna from Surmont Creek

Order	Family	Genus
Plecoptera	Perlodidae	*Isogenus* sp.
Plecoptera	Perlidae	*Neophasganophora* sp.
Ephemeroptera	Baetidae	*Ephemerella* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.
Trichoptera	Rhyacophilidae	*Rhyacophila* sp.
Trichoptera	Phryganeidae	*Brachycentrus* sp.

Fish Fauna

Both prima cord and rotenone were used to collect fish in Surmont Creek. A few larger mature Arctic grayling and over forty young of the year were taken from one pool. All of the suckers were young of the year.

List of species collected:

Thymallus arcticus	Arctic Grayling
Catostomus catostomus	Longnose Sucker

* The rotenone appear to be ineffective at this station because of low water temperature.

Station # 2b - Surmont Creek

The only stream with sports fisheries potential entering Gregoire Lake is Surmont Creek. The stream has a good gravel bottom and a favorable pool to riffle ratio. In several places roads have been bulldozed across the stream causing some downstream siltation. The stream varies in width from 6 to 12 feet and appears to have stable banks. Tremendous numbers of fish eggs were observed floating downstream and several schools of white suckers were observed. Personal communications with Al Needham, a local forest ranger, indicate that the stream supports a population of Arctic grayling although none were collected in the survey. Water chemistry is shown in Table 17.

Water Chemistry

TABLE 17. Water Chemistry from Surmont Creek

Date	20-V-69
Depth (feet)	1
Temperature (°C)	8
Dissolved oxygen (ppm)	10
Phenolophthalein alkalinity	nil
Total alkalinity	40
Calcium hardness	30
Total hardness	40
pH	7.2
Total dissolved solids (ppm)	29

ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE.

D. High Hill River

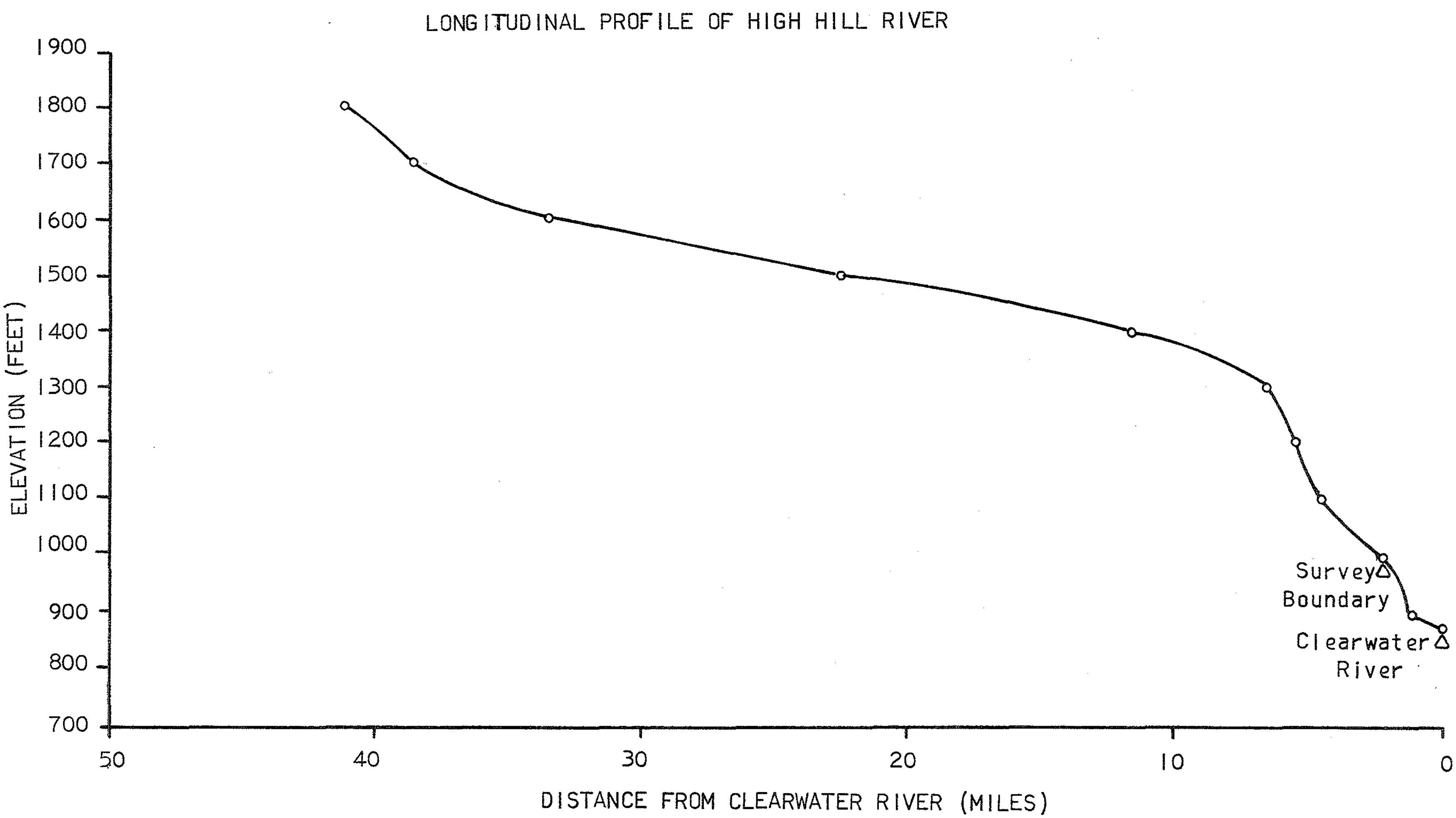
Total Length: 41 miles

Length Surveyed: 41 miles

Watershed Area: 550 square miles

The High Hill River begins in an area of muskeg bogs. For the first few miles there is very little change in gradient and the river is 90 to 95% pool water. Gradually the gradient becomes steeper and the river increases in fisheries potential. In the remaining number of miles the fisheries potential is even higher. Fish refugia is ideal with a 1:1 pool to riffle ratio, extensive spawning gravel and excellent bank cover. A large number of mature Arctic grayling and mountain whitefish were collected along with countless fray and minnows. The rating of this stream is a high Class I and it is undoubtedly the best small stream in the Fort McMurray area.

Figure 33. Longitudinal Profile of the High Hill River



Station # 1 - High Hill River

Survey date: September 26, 1972

Location: Sec. 31 Twp. 90 Rge. 3

This is an excellent river. The average width is 25 feet with a mean depth of 2 to 3 feet. The pool to riffle ratio is approximately 1:1 in this area. The stream has tea-brown colored water. Fish refugia is excellent (overhanging brush, deep pools). The bottom substrate is rock and gravel and the bottom fauna is abundant. Nutrients are high. The banks are stable and are covered with poplar, willow, alder and some spruce. The bank vegetation provides good shade and cover.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	5		
Frequency of Pools	5		
Refugia	5		
Nutrients	5		
Bank Cover	5	Total - 38	
Substrate	5	Class	1

Bottom Fauna

TABLE 18. Bottom fauna from the High Hill River

Order	Family	Genus
Plecoptera	Nemouridae	*Nemoura* sp.
Ephemeroptera	Baetidae	*Ephymerella* sp.
Ephemeroptera	Baetidae	*Ameletus* sp.
Trichoptera	Leptoceridae	*Leptocella* sp.
Diptera	Rhagionidae	-
Diptera	Tipulidae	-

Fish Fauna

Prima cord was used at this sation to collect fish. Both mature and immature Arctic grayling and mountain whitefish were taken. A large number of the immature fish were young of the year which would indicate that reproductive success in this stream is high.

List of species collected:

Prosopium williamsoni	Mountain Whitefish
Thymallus arcticus	Arctic Grayling
Couesius plumbeus	Lake Chub

Station # 2 - High Hill River

High Hill River was also sampled at Sec. 31 Twp. 89 Rge. 3 and a number of large Arctic grayling and mountain whitefish were taken. The sampling was done with prima cord and only 75 feet of a 300 foot long pool was tested. Between 200 to 300 fish were taken with one blast and 75 of these fish were sampled for length, weight and sexual maturity. (Table 20, Figure 39)

Water Chemistry

TABLE 19. Water chemistry of the High Hill River

LAB SAMPLE NO. 7516

GRAB SAMPLE

DATE SAMPLED 26/9/72 DATE COMPLETED 20/10/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	1°C
DISSOLVED OXYGEN		-	-
pH		8.10	-
SPECIFIC CONDUCTANCE		230 umho/cm	-
HARDNESS, TOTAL		110	-
ALKALINITY, TOTAL		118	-
SULFATE		14	-
CHLORIDE		1	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.5	-
CALCIUM		39	-
MAGNESIUM		2	-
SODIUM		8	-
POTASSIUM		0.5	-
PHOSPHATE		0.2	-
AMMONIA - N		0.4	-
TURBIDITY		5 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Fish Fauna

Prima cord was used to sample the fish at this station. The Arctic grayling taken were generally large mature fish. Mountain whitefish were also found which is a new distribution record for this species in Alberta (Paetz and Nelson 1970). A good collection of both mature and immature whitefish were obtained which would indicate the presence of a resident population of these fish and precludes the possibility that these fish are accidental strays from the Athabasca River.

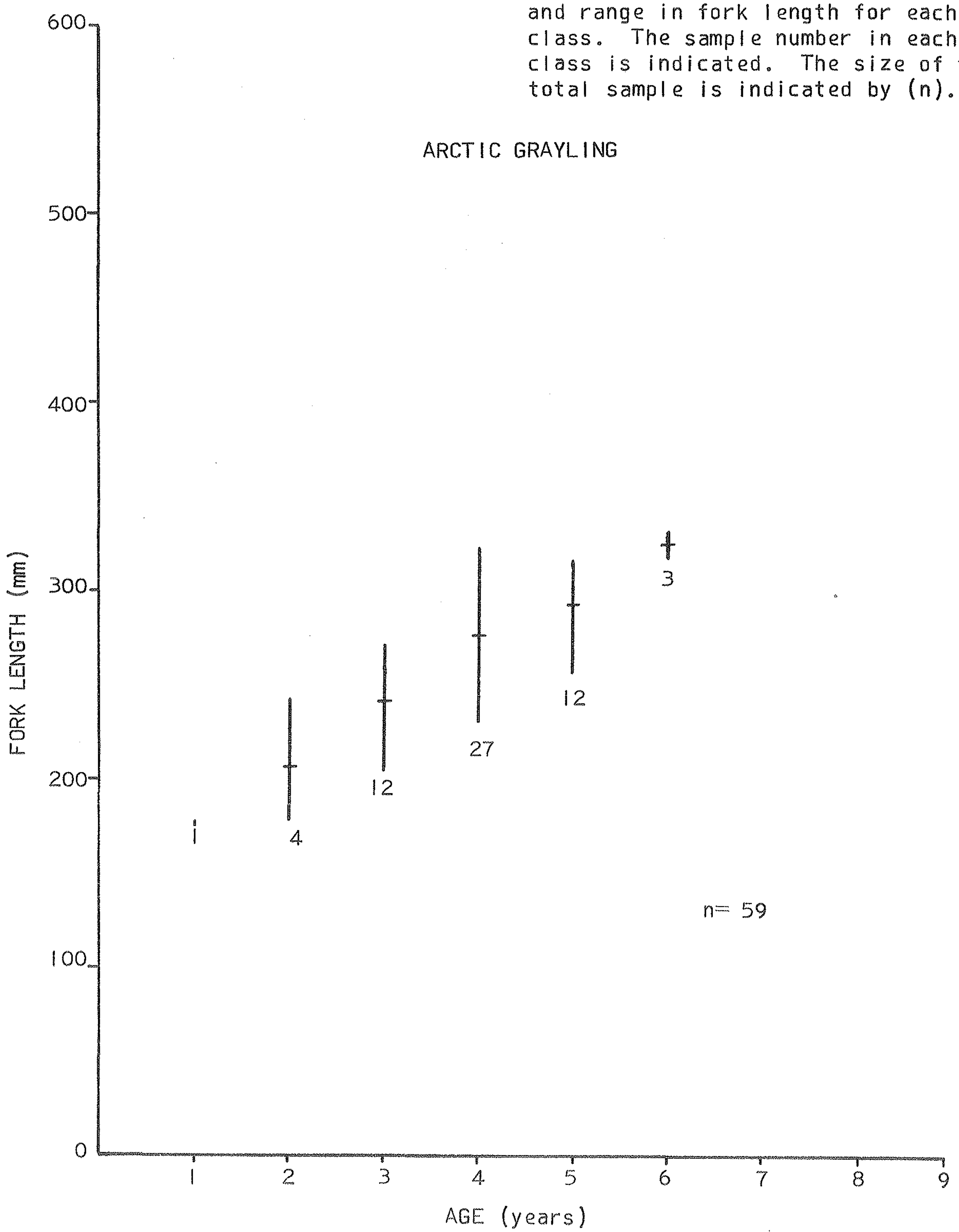
List of species collected:

Prosopium williamsoni	Mountain Whitefish
Thymallus arcticus	Arctic Grayling

TABLE 20. Arctic Grayling from High Hill River

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
I	1	1.7	176	40
II	4	6.8	206 (178-241)	87 (40-150)
III	12	20.3	239 (225-272)	124 (75-200)
IV	27	45.8	276 (231-324)	215 (100-355)
V	12	20.3	293 (256-320)	266 (160-380)
VI	3	5.1	326 (319-332)	336 (260-390)

Figure 39. Arctic grayling from High Hill River, Sept. 1972. The figure shows the mean and range in fork length for each age class. The sample number in each age class is indicated. The size of the total sample is indicated by (n).



Station #3 - High Hill River

Survey date: August 27, 1972

Location: Sec. 25 Twp. 89 Rge. 4

The mouth region of High Hill River appears to have excellent fish habitat. The water is clear and cold with an average depth of 1 to 2 feet. A few of the pools have depths as great as 4 feet. The average width of the river is 30 feet and there is a very favorable pool to riffle ratio (approximately 1:1). The bottom substrate is a combination of rubble and gravel in the riffles with sand, silt and gravel in the pools. The banks appear to be very stable with signs of high water only 1 to $1\frac{1}{2}$ feet above the present water level. The banks are covered with grass, alder and a forest of poplar and spurce. Nutrients are high and fish refugia in the form of overhanging brush, logs, etc. is excellent.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	5		
Frequency of Pools	5		
Refugia	5		
Nutrients	3		
Bank Cover	5	Total - 36	
Substrate	5	Class	1

Water Chemistry

TABLE 21. Water chemistry of the High Hill River

LAB SAMPLE NO. 6491

GRAB SAMPLE

DATE SAMPLED 27/8/72 DATE COMPLETED 19/9/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	14°C
DISSOLVED OXYGEN		-	8.6 p.p.m.
pH		8.30	8.8
SPECIFIC CONDUCTANCE		270 umho/cm	-
HARDNESS, TOTAL		140	-
ALKALINITY, TOTAL		138	-
SULFATE		14	-
CHLORIDE		1	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.4	-
CALCIUM		34	-
MAGNESIUM		12	-
SODIUM		10	-
POTASSIUM		1.1	-
PHOSPHATE		0.4	-
AMMONIA - N		0.2	-
TURBIDITY		4 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Fish Fauna

Both prima cord and rotenone were used at this station to collect fish. The northern pike and a few of the suckers were mature fish. The Arctic grayling and mountain whitefish were taken in large numbers but all were young-of-the-year.

List of species collected:

Esox lucius	Northern Pike
Prosopium williamsoni	Mountain Whitefish
Thymallus arcticus	Arctic Grayling
Catostomus Commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Couesius plumbeus	Lake Chub
Notropis hudsonius	Spottail Shiner
Rhinichthys cataractae	Longnose Dace

E. Georges Lake

TABLE 22. Commercial Fishing Record, Georges Lake, catch recorded in Pounds.

Year	Lic.	Mixed	Tullibee	Pike	Perch	Walleye	Total
42/43	1	2,200		7,450			9,650
43/44							
44/45							
45/46	1			1,900			1,900
46/47	1			18,675			18,675
47/48	1			17,542			17,542
48/49	1		6,891	1,301			8,192
49/50	1	1,000	7,890	8,395		940	18,225
50/51	1		3,815	1,370		2,910	8,095
51/52	1	1,225	8,564	7,278			17,067
52/53	2		3,860	5,425			9,285
53/54	1		800	9,120	260	310	10,490
54/55	1		1,010	7,950	200		9,160
55/56	1		1,610	8,870		570	11,050
56/57			2,800	3,540			6,340
57/58	1		2,460	3,570			6,030
58/59	1		400	400			800
59/60							
60/61	4		905	816	169		1,890
61/62							
62/63	4		(No returns)				

F. Gregoire Lake

Gregoire Lake is located about 20 miles south-southeast of Fort McMurray in Township 86, Ranges 7 and 8, west of the fourth meridian (approximately 66° 30' N latitude and 111° 5' W longitude) (Fig. 6). The lake is at an altitude of 1,559 feet (m.s.l.), and is drained by the Gregoire River, a tributary of the Athabasca River. The lake was surveyed during the period 17-22 May, 1969 and is accessible by road. (Bradley 1969)

The lake is located in a gently sloping basin. The sides of these slopes are covered by deciduous forest consisting mainly of poplar with some birch.

Commercial fishing records indicate that this lake has been fished sporadically in the past with decreasing success.

Morphometry

Gregoire Lake has a surface area of 13.08 square miles (8,371 acres), a shoreline length of 20 miles and shoreline development factor of 1.56. The maximum effective length of the lake is 5.25 miles in a northwest-southeast direction parallel to the direction of the prevailing summer winds and the maximum effective width is 1.04 miles.

Depths were taken with a Furuno echo sounder and the results were used to plot a bottom contour map (Fig. 43). From this data, a volume of 116,208 acre feet was calculated giving a mean depth of 13.9 feet. The maximum depth recorded was 25 feet.

The shoreline of the lake is composed mainly of rubble and gravel with the exception of three large sandy beaches. Both emergent and submergent aquatic vegetation were abundant around the shoreline.

Physical and Chemical Data

A single limnology station was set up 22 May, 1969. The air temperature was 14°C. The sky was clear and there was a light wind at this time. The Secchi disc reading was 5 feet. The temperature was 10.6°C at the surface and 9.6°C at 23 feet. The pH was 7.8 at the surface, and 7.6 at the bottom. The total dissolved solids was 95 ppm at the surface and 96 ppm at the bottom.

These results indicate that the lake was in spring overturn and no thermocline had yet been established.

Plankton

One plankton haul of 23 feet was taken at the limnology station. This sample revealed a bloom of phytoplankton with *Microcystis* and *Nostoc* (blue-green algae) being dominant. The green algae *Pediastrum*, *Scenedesmus*, *Staurastrum*; the diatom *Fragilaria*; the glue-green algae *Anabaena*; and the dinoflagellate *Ceratium* were all common. The diatoms *Asterionella* and *Stephanodiscus* were present only in trace amounts.

Zooplankton made up a considerably smaller portion of the sample than did phytoplankton. Cladocerans, copepods, and rotifers were fairly abundant with lesser numbers of ostracods also being present. (Table 26)

Bottom Fauna

A total of 34 bottom samples were taken, each consisting of a single dredge sample from each location. The samples indicated that most of the deeper lake bottom (15 feet or greater) consists of brown mud, with sand being dominant in shallower areas (10 feet or less). The standing crop of bottom fauna is estimated to be 3,154 organisms per square meter, with a volume displacement of 45.5 c.c. per square meter.

In both numbers and volume, chironomids were the dominant organisms. Other groups found in the sample are shown in Table 25.

Fish Fauna

Six 12-hour net sets were made during the survey at the locations shown in Figure 42. The mesh sizes, net lengths, and catch record are shown in Table 27. Six species of fish were netted: lake whitefish (Coregonus clupeaformis), cisco (Coregonus artedii), northern pike (Esox lucius), walleye (Stizostedion vitreum), yellow perch (Perca flavescens), longnose suckers (Catostomus catostomus), and burbot (Lota lota). Several seine hauls were made and spottail shiners (Notropis hudsonius), and yellow perch were collected.

Lake Whitefish

Eighteen lake whitefish were netted and worked (Table 30). The fish taken were six years of age or older and all were mature. Eleven of sixteen fish examined were found to be infected with cysts of Triaenophorus crassus. In total, 59.2 pounds of fish were found to contain 44 cysts, producing and infestation rate of 74 cysts per 100 pounds of fish.

Cisco

Thirteen cisco were netted and worked (Table 32). These fish were quite small and mature at 3 to 4 years of age. Nine of 13 fish examined were found to be infected with cysts of Triaenophorus crassus. In total, 4.2 pounds of fish contained 41 cysts, giving an infestation rate of 976 cysts per 100 pounds.

Northern Pike

A total of 57 northern pike were taken and of these 40 were worked (Table 28). These fish varied in age from 3 to 13 years and appeared to mature between 4 and 5 years of age. The fish taken were not especially large with the heaviest individual weighing 7 pounds.

Walleye

Sixteen walleye were netted and worked (Table 29). These fish were of a moderate size and appeared to mature at 3 to 5 years of age, although this is based on a very small sample.

Other Species

Five perch, three longnose suckers, and five burbot were also netted but not worked.

Discussion

Using the Ryder morpho-edaphic index, a productivity figure of approximately 3.7 pounds of fish per acre per year can be postulated for Gregoire Lake. This indicates that total annual fish production for this lake is approximately 30,000 pounds. Of this, 10,000 pounds would be piscivorous fish (mainly northern pike) and 20,000 pounds would be cisco, whitefish and suckers. Gregoire Lake is presently being used for domestic and recreational fishing. As previous catch records indicate (Table 33), there is little potential for a commercial fishery on this lake. Cisco and whitefish occur in limited numbers and walleye appear to have been almost eliminated. The lake is intensively used as a recreational area and is very heavily fished mainly by inhabitants of Fort McMurray. It is not uncommon to have 3 to 4 hundred people using the lake on a weekend.

TABLE 23. Morphometry of Gregoire Lake

LOCATION:	Twp. 86 Rges. 7&8 W.4 M
AREA:	13.08 sq. mi. (8,371 acres)
VOLUME:	116,208 acre feet
SHORELINE:	20.03 miles
SHORELINE DEVELOPMENT FACTOR:	1.56
MAXIMUM LENGTH:	5.25 miles
MAXIMUM EFFECTIVE LENGTH:	5.25 miles
MAXIMUM WIDTH:	3.80 miles
MAXIMUM EFFECTIVE WIDTH:	3.80 miles
MEAN WIDTH:	2.46 miles
MAXIMUM DEPTH:	25 feet
MEAN DEPTH:	13.88 feet

DEPTH DISTRIBUTION:

Contour Interval	Acres	% Surface Area
0 - 5 feet	953	11.4
5 - 10 feet	1,428	17.0
10 - 15 feet	1,574	18.8
15 - 20 feet	2,995	35.8
20 - 25 feet	1,261	15.1
25 feet plus	160	1.9
Total Surface Area	8,371	100.0%

TABLE 24. Water Chemistry, Gregoire Lake. Samples I and 2 were taken at the limnology station. May 22, 1969.

Sample No.	I	2
Date	22-V-69	22-V-69
Depth (feet)	surface	23
Temperature (°C)	12	8.4
Dissolved oxygen (ppm)	9	9
Phenolphthalein alkalinity	nil	nil
Total alkalinity	50	55
Calcium hardness	40	40
Total hardness	50	50
pH	7.6	7.8
Total dissolved solids (ppm)	96	95

ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE.

TABLE 25. Bottom fauna analysis, Gregoire Lake. A total of 35 - $\frac{1}{4}$ sq. ft. dredgings were taken. The following figures are standardized to square meters.

Organisms	No./m^2	% Total No.	Volume/m^2 (mls)	% Total Volume
Chironomidae	2410	76.4	40	87.9
Ephemeroptera	39	1.2	1.1	2.4
Trichoptera	20	0.6	-	-
Amphipoda	207	6.6	1.0	2.2
Oligochaeta	134	4.2	-	-
Hirudinea	16	0.5	-	-
Pelecypoda	316	10.0	3.4	7.5
Gastropoda	10	0.3	-	-
Annelida	1	-	-	-
Hydracarina	1	-	-	-
TOTALS	3154	99.8	45.5	100.00

TABLE 26. Plankton sample, Gregoire Lake

Group	Relative Abundance*
A. Phytoplankton	
Chlorophyta	
Pediastrum sp.	4
Scenedesmus sp.	3
Staurastrum sp.	3
Chrysophyta	
Asterionella sp.	1
Fragilaria sp.	4
Stephanodiscus sp.	tr.
Cyanophyta	
Anabaena sp.	3
Microcystis sp.	blm.
Nostoc sp.	blm.
Pyrrophyta	
Ceratium sp.	4
B. Zooplankton	
Arthropoda	
Cladocerans	3
Copepods	3
Ostrocods	2
Rotifera	
Rotifers	3
Settled Volume of Sample (mls)	0.51

*Relative Abundance Scale - trace, 1, 2, 3, 4, 5, bloom.

Total Vertical Haul (23')

TABLE 27. Summarized catch record for Gregoire Lake

Date Set & Pulled	Set No.	Mesh Size	Set Length	Set Depth (ft.)	Perch	Lake Whitefish	Northern Pike	Walleye	Tullibee	Burbot	Longnose Sucker	Total
17-18-V-69	1	1½	50 yds	12	5	0	2	0	3	0	0	10
17-18-V-69	1	3½	50 yds	13	0	0	14	2	1	0	0	17
17-18-V-69	1	5½	50 yds	14	0	1	1	2	0	0	0	4
17-18-V-69	2	2½	50 yds	18	0	0	5	1	3	0	0	9
17-18-V-69	2	4½	50 yds	25	0	1	4	1	0	0	0	6
19-20-V-69	3	4½	50 yds	5	0	5	4	6	0	0	0	15
19-20-V-69	3	2½	50 yds	10	0	0	13	3	1	0	0	17
21-22-V-69	4	4½	50 yds	16	0	3	2	0	0	0	1	6
21-22-V-69	4	2½	50 yds	18	0	0	10	0	7	0	0	17
21-22-V-69	5	5½	50 yds	21	0	8	1	0	0	5	0	14
22-22-V-69	6	5½	50 yds	12	0	1	0	0	0	0	0	1
22-22-V-69	6	4½	50 yds	14	0	0	1	0	0	0	2	3
TOTALS					5	15	57	15	15	5	3	119

TABLE 28. Northern pike from Gregoire Lake

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.	% Female
IV	3	7.5	537 (520-559)	977 (919-1110)	33
V	17	42.5	580 (510-656)	1313 (980-1710)	25
VI	12	30	600 (548-682)	1502 (1140-2180)	58
VII	3	7.5	595 (560-648)	1460 (1220-1760)	33
VIII	2	5	683 (666-700)	2125 (1910-2340)	100
IX	1	2.5	730	2520	100
X	1	2.5	786	3250	100
XIII	1	2.5	774	3050	100

TABLE 29. Walleye from Gregoire Lake

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.	% Female
III	1	6	432	900	0
V	2	12.5	482 (459-505)	1260 (1090-1430)	0
VI	6	37.5	484 (447-520)	1338 (1070-1620)	50
VII	5	31	498 (454-526)	1278 (1000-2000)	40
VIII	2	12.5	551 (544-559)	1835 (1700-1970)	100

TABLE 30. Lake whitefish from Gregoire Lake

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.	% Female
VI	2	11.1	414 (405-423)	1235 (1010-1460)	
VII	3	16.7	474 (451-512)	1860 (1630-2180)	
VIII	8	44.4	463 (430-498)	1684 (1300-2020)	
IX	3	16.7	457 (450-467)	1667 (1590-1780)	
X	2	11.1	471 (468-475)	1745 (1660-1830)	

TABLE 31. Lake whitefish from Gregoire Lake, December 1960 and December 1963.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.	% Female
III	1	1.9	335	455	0
IV	4	7.7	373 (340-410)	812 (685-1025)	25
V	8	15.4	419 (399-467)	1076 (885-1310)	50
VI	8	15.4	472 (427-508)	1453 (1195-1825)	87.5
VII	27	52	500 (447-731)	1624 (1170-2250)	44.4
VIII	4	7.7	485 (447-508)	1673 (1370-1880)	25

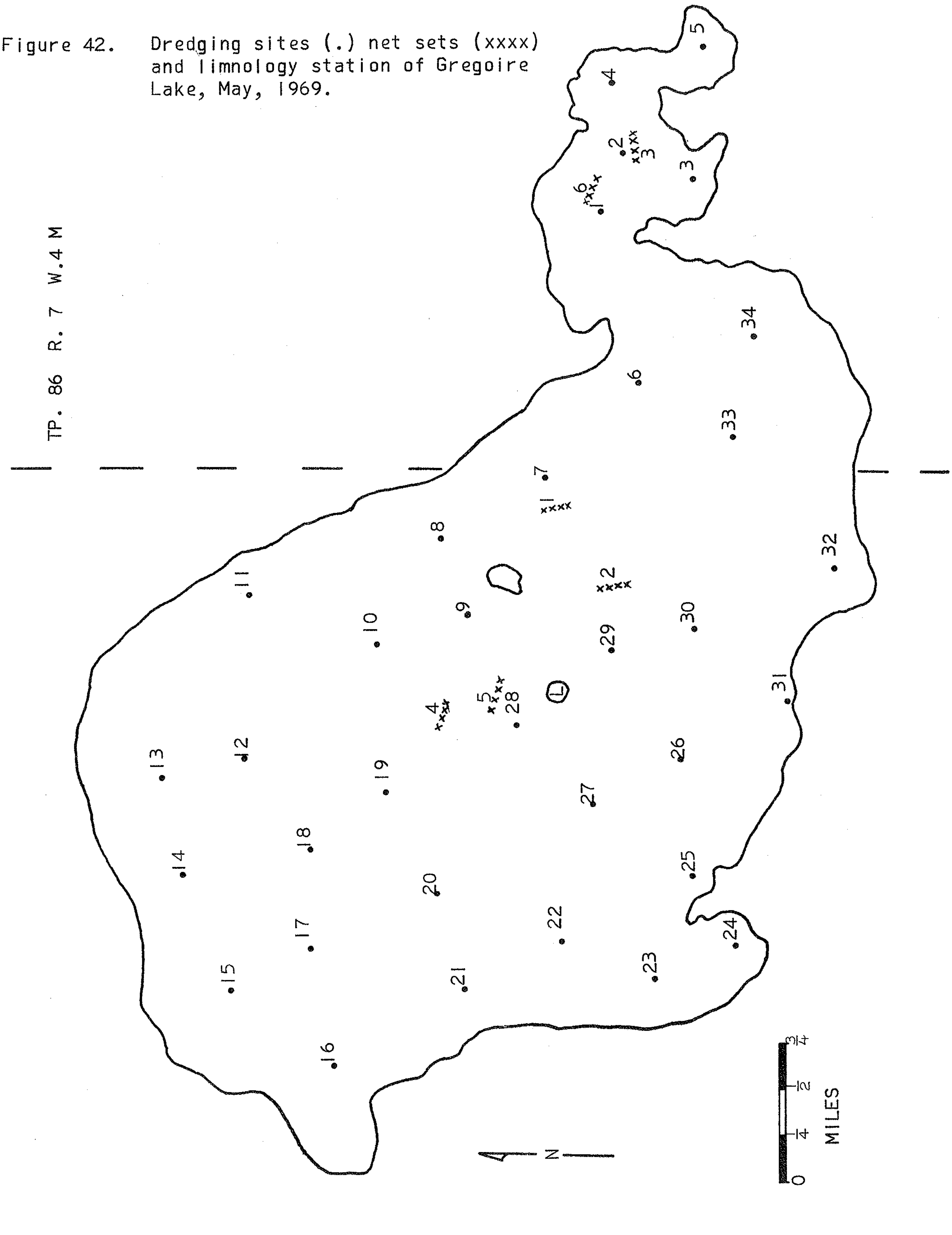
TABLE 32. Cisco from Gregoire Lake

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.	% Female
III	11	84.6	214 (180–234)	128 (60–170)	82
IV	2	15.4	259 (250–268)	255 (220–290)	50

TABLE 33. Commercial fishing record, Gregoire Lake

Year	Lic.	Cisco	Perch	Pike	Walleye	Whitefish	Total
44/45	5	1,480		1,580	11,413	3,560	18,033
45/46	2			355	3,514		3,869
46/47	2			3,332	2,445		7,577
47/48	2			540	1,153		1,693
48/49	1				725		725
54/55	11			510	13,400	11,800	25,710
55/56	2		360		660	3,350	4,370
57/58	3		60	180	1,990	7,250	9,750
64/65	2			1,200			1,200
65/66	2			1,700		2,000	3,700

Figure 42. Dredging sites (.) net sets (xxxx) and limnology station of Gregoire Lake, May, 1969.



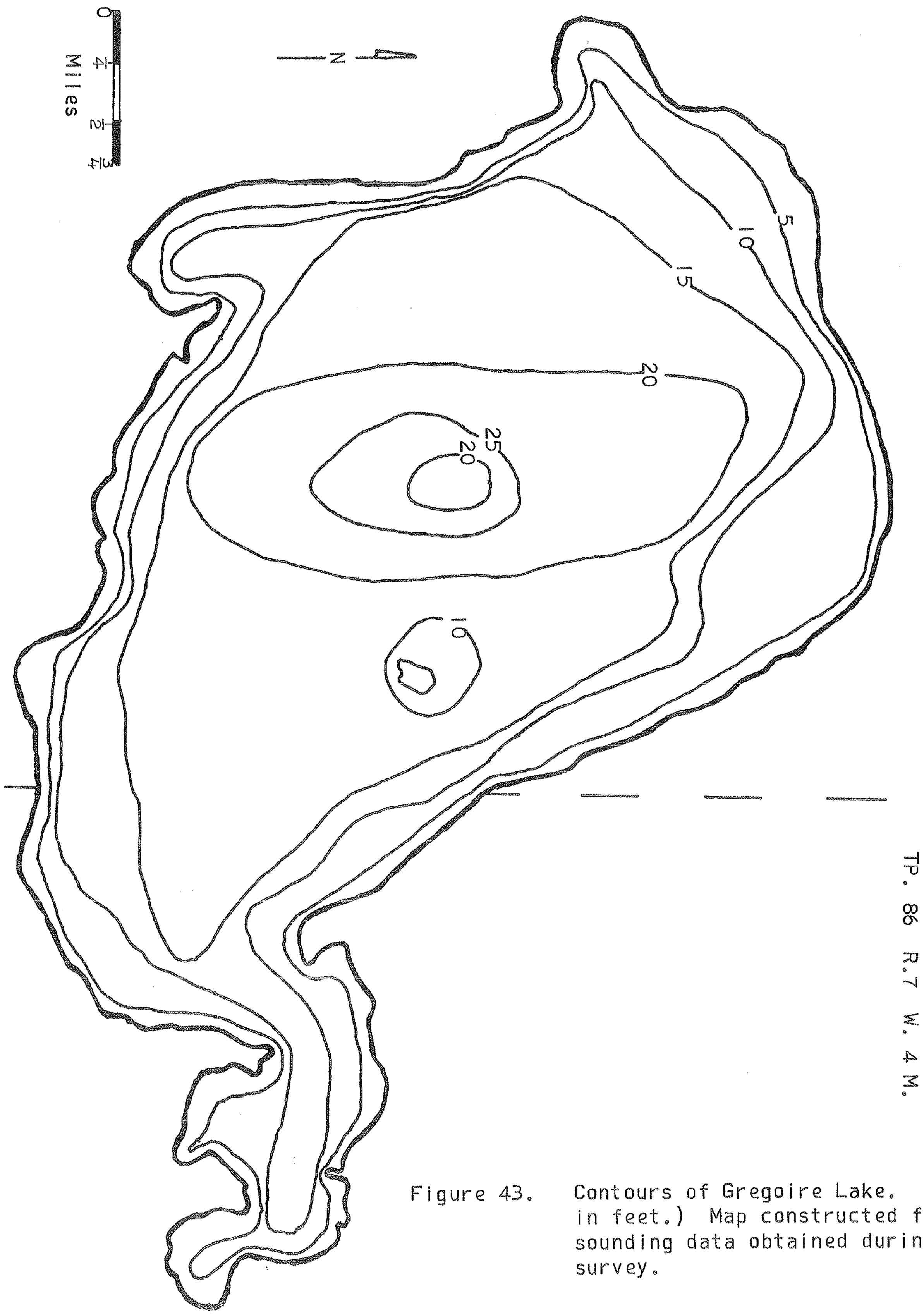


Figure 43. Contours of Gregoire Lake. (Depths in feet.) Map constructed from sounding data obtained during the survey.

VII. MINOR WATERSHEDS ON THE EAST SIDE OF THE ATHABASCA RIVER

A. Algar River

Total Length: not calculated

Length Surveyed: entire length

Watershed Area: 139 square miles

The Algar River is a typical muskeg stream. A high percentage of its watercourse is blocked by beaver dams and has high summer temperatures, periodic algae blooms and is often weed choked. A few miles from its mouth the gradient steepens as it descends to the level of the Athabasca River and its flow becomes torrential. The rating for this entire stream is Class 4. Algar Lake was looked at in 1969 and in 1972 and was rated as low in fisheries potential. The lake is shallow and would probably only support a fishery for northern pike.

B. Clark Creek

Total Length: not calculated

Length Surveyed: 3 miles

Watershed Area: not calculated

Clark Creek has favorable fish habitat for much of its length. It was found to contain a population of immature grayling, but was rated Class 3 to Class 4 because of its small size.

Algar River

Survey Date: September 19, 1972

Location: Sec. 1 Twp. 87 Rge. 15

The Algar River has little or no sports fisheries potential. Most of the river is blocked by beaverdams and has a minimal flow. At this location there are a few gravel and boulder riffles but the flow is almost intermittent. Pool depths range from 1 to 3 feet. The bottom substrate for most of the river is silt.

Score Sheet Rating

Flow	1		
Temperature	3		
Pool Depth	3		
Frequency of Pools	1		
Refugia	1		
Nutrients	3		
Bank Cover	5	Total –	18
Substrate	1	Class	4

Water Chemistry

TABLE 77. Water chemistry of the Algar River

LAB SAMPLE NO.

GRAB SAMPLE

DATE SAMPLED 19/9/72 DATE COMPLETED

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	6°C
DISSOLVED OXYGEN	-	9.0 p.p.m.
pH	-	78
SPECIFIC CONDUCTANCE	-	240 umho/cm
HARDNESS, TOTAL	-	-
ALKALINITY, TOTAL	-	-
SULFATE	-	-
CHLORIDE	-	-
NITRATE & NITRITE	-	-
IRON, TOTAL	-	-
CALCIUM	-	-
MAGNESIUM	-	-
SODIUM	-	-
POTASSIUM	-	-
PHOSPHATE	-	-
AMMONIA - N	-	-
TURBIDITY	-	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Fish Fauna

Rotenone and prima cord were used to collect fish on the Algar River. The rotenone was ineffective because of the cold water temperatures.

List of species collected:

Catostomus catostomus	Longnose Sucker
Couesius plumbeus	Lake Chub
Semotilus margarita	Pearl Dace

Clark Creek

Survey date: September 21, 1972

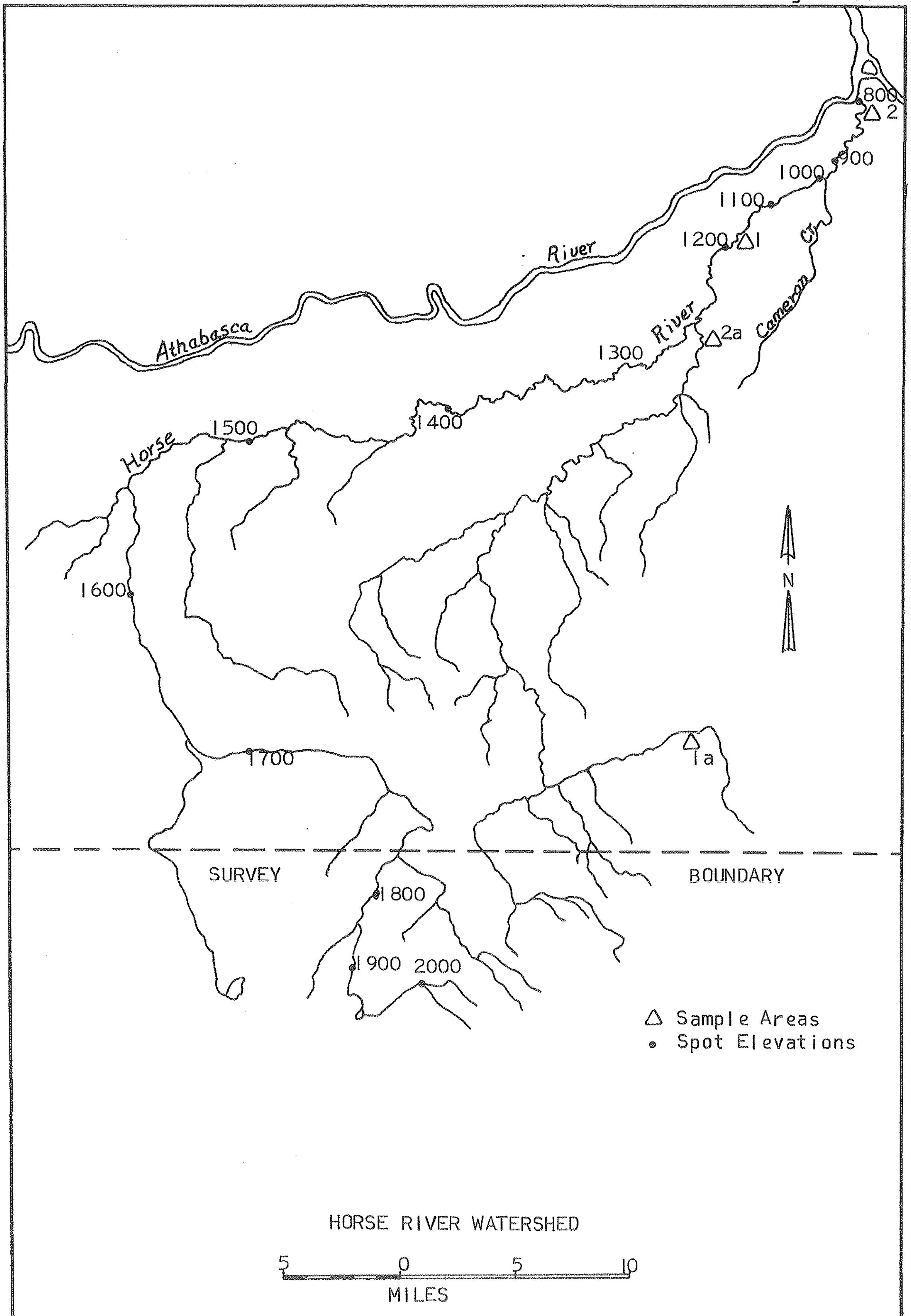
Location: Sec. 35 Twp. 89 Rge. 9

Clark Creek was looked at only because of reported good grayling fishing. The creek is small (8 feet wide) with very low flow at this time. The average depth would be 1 foot or less. One pool was sampled and a few small grayling were taken.

Score Sheet Rating

Flow	1		
Temperature	3		
Pool Depth	1		
Frequency of Pools	3		
Refugia	1		
Nutrients	5		
Bank Cover	3	Total - 20	
Substrate	3	Class	3

Figure 89



HORSE RIVER WATERSHED

VIII. HORSE RIVER WATERSHED

The Horse River watershed lies to the southwest of Fort McMurray (Figure 89). Portions of this watershed were surveyed in August with the remainder surveyed in September 1972. All of the lakes in this watershed are small and insignificant and none of them were surveyed.

A. Horse River

Total Length: 133 miles

Length Surveyed: 118 miles

Watershed Area: 822 square miles

The Horse River drains a large muskeg area in the southwest portion of its watershed, and a series of low hills and muskeg in the southeast. It has limited sports fisheries potential over much of its length. Small populations of Arctic grayling were found in the mouth region and in the headwaters of the southeast tributary. These areas have suitable pool to riffle ratios, spawning gravel and flow rates but are only typical of 25 to 30% of the river. The remainder of the river has low gradients with almost 100% pool water and is rated as Class 4. Most of the channel in this region has little or no flow rate, is heavily choked with weeds and is expected to have high summer temperatures.

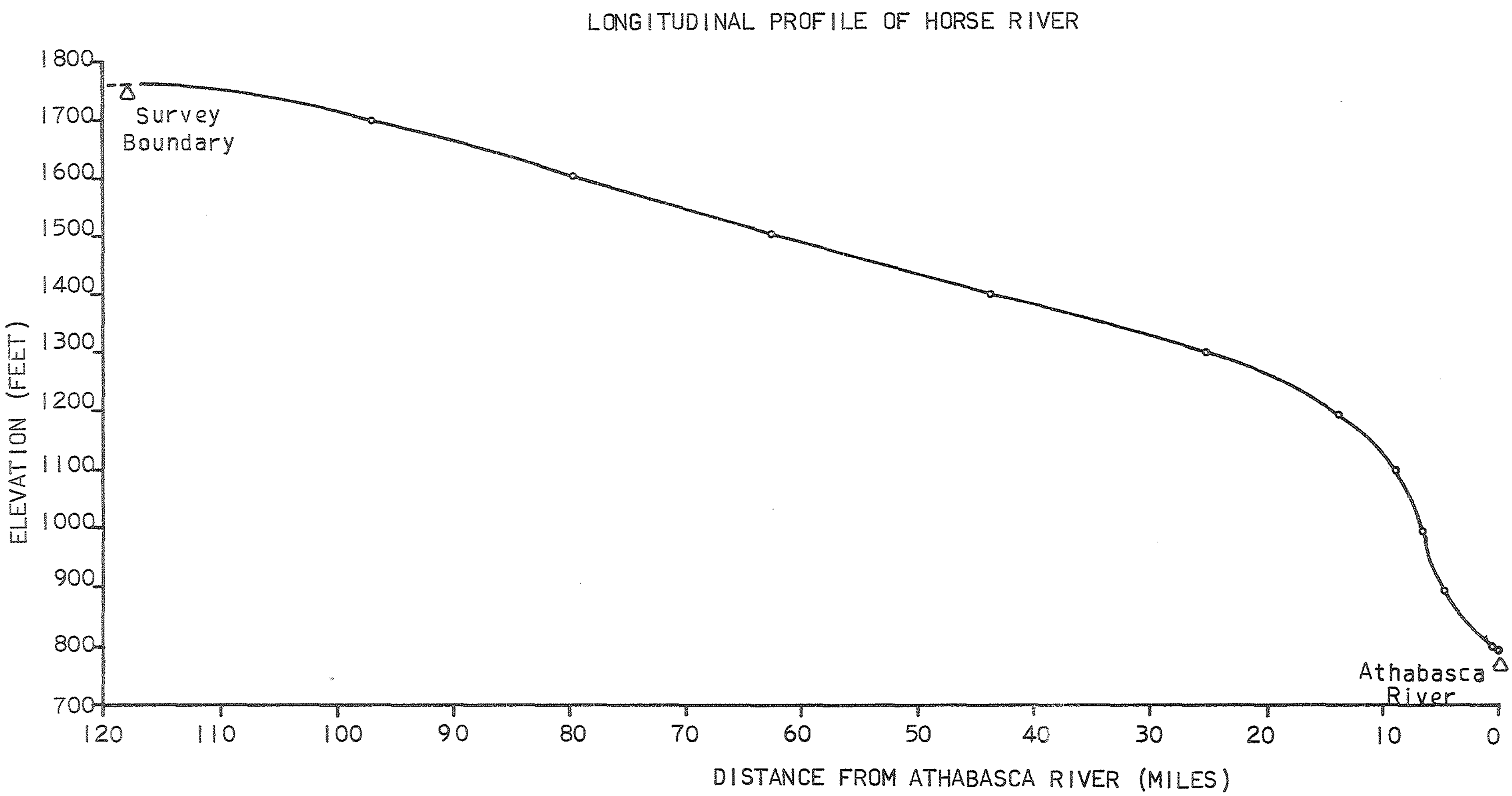


Figure 90. Longitudinal Profile of Horse River

Station # 1 - Horse River

Survey date: September 21, 1972

Location: Sec. 22 Twp. 88 Rge. 10

The Horse River is a good looking river at this location. The average width is 30 feet with depths ranging from 1 to 3 feet. The water is a dark tea brown and fish refugia is quite good. There are definite signs of high water erosion at this location but generally the banks are fairly stable. The bottom substrate is mainly boulders and rubble with small areas of sand and silt. The riffle to pool frequency is approximately 1:1.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	3		
Frequency of Pools	5		
Refugia	3		
Nutrients	5		
Bank Cover	3	Total -	30
Substrate	3	Class	2

Bottom Fauna

TABLE 79. Bottom fauna from the Horse River

Order	Family	Genus
Ephemeroptera	Baetidae	*Ameletus* sp.
Ephemeroptera	Heptagenidae	*Heptagenia* sp.
Odonata	Gomphidae	*Hagenius* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.
Diptera	Rhagionidae	–

Fish Fauna

Both prima cord and rotenone were used at this station to collect fish. A few of the Arctic grayling were large mature fish.

List of species collected:

Thymallus arcticus	Arctic Grayling
Catostomus commersoni	White Sucker
Percopsis omiscomaycus	Trout Perch
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

Station # 2 - Horse River

Survey date: August 29, 1972

Location: Sec. 17 Twp. 89 Rge. 9

The mouth of the Horse River has a good flow rate with an average width of 30 to 35 feet and an average depth of 1 foot. There are a few pools with depths between 1 to 2 feet. The water is a dark tea brown. The pool to riffle frequency is approximately 1:2. The substrate of the riffles is mainly boulders and rubble and a little sand and silt in the pools. At this location there are high water marks 4 to 5 feet up the bank. The banks show signs of high water erosion, but appear to be stable above this point. The banks are covered with grass, willow and a poplar forest. Nutrients appear to be high.

Score Sheet Rating

Flow	3	
Temperature	3	
Pool Depth	3	
Frequency of Pools	1	
Refugia	1	
Nutrients	5	
Bank Cover	3	Total - 22
Substrate	3	Class 3

Water Chemistry

TABLE 80. Water chemistry of the Horse River

LAB SAMPLE NO. 6489

GRAB SAMPLE

DATE SAMPLED: 29/8/72 DATE COMPLETED 19/9/72

PARAMETER		LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE		-	16°C
DISSOLVED OXYGEN		-	9.4 p.p.m.
pH		8.10	8.8
SPECIFIC CONDUCTANCE		325 umho/cm	-
HARDNESS, TOTAL		120	-
ALKALINITY, TOTAL		141	-
SULFATE		36	-
CHLORIDE		10	-
NITRATE & NITRITE	LESS THAN	0.1	-
IRON, TOTAL		0.6	-
CALCIUM		35	-
MAGNESIUM		7	-
SODIUM		24	-
POTASSIUM		1.6	-
PHOSPHATE		0.3	-
AMMONIA - N		1.0	-
TURBIDITY		5 JTU	-
BALANCE			

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 81. Bottom fauna from the Horse River

Order	Family	Genus
Ephemeroptera	Heptagenidae	*Heptagenis* sp.
Ephemeroptera	Baetidae	*Ameletus* sp.
Odonata	Gomphidae	*Hagenius* sp.
Diptera	Rhagionidae	-

Fish Fauna

Prima cord was used at this station to sample the fish population.

List of species collected:

Perca flavescens	Yellow Perch
Catostomus commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Cottus ricei	Spoonhead Sculpin
Couesius plumbeus	Lake Chub
Notropis hudsonius	Spottail Shiner
Notropis atherinoides	Emerald Shiner

Station # Ia - Unnamed Tributary of the Horse River

Survey date: September 16, 1972

Location: Sec. 25 Twp. 84 Rge. 11

The Horse River is quite small at this location. It has an average width of 15 feet with a mean depth of 1 foot. There are very few pools with depths greater than 2 feet. The pool to riffle frequency is 1:1 and there is extensive cover in the form of logs, banks and overhanging brush. The bottom substrate is composed of moss covered boulders in the riffles with sand and silt in the pools. The silt is soft and overlays boulders and rock by 5 to 6 inches. The banks are stable and covered with alder and willow. The surrounding forest is poplar and spruce.

Score Sheet Rating

Flow	3	
Temperature	3	
Pool Depth	3	
Frequency of Pools	5	
Refugia	3	
Nutrients	3	
Bank Cover	5	Total - 26
Substrate	1	Class 3 because of its small size

Water Chemistry

TABLE 82. Water chemistry of Unnamed Tributary of the Horse River

LAB SAMPLE NO. 7532

GRAB SAMPLE

DATE SAMPLED 16/9/72 DATE COMPLETED 20/10/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	6°C
DISSOLVED OXYGEN	-	5.0 p.p.m.
pH	8.20	8.4
SPECIFIC CONDUCTANCE	395 umho/cm	320
HARDNESS, TOTAL	182	-
ALKALINITY, TOTAL	198	-
SULFATE	31	-
CHLORIDE	1	-
NITRATE & NITRITE	0.1	-
IRON, TOTAL	0.2	-
CALCIUM	60	-
MAGNESIUM	7	-
SODIUM	17	-
POTASSIUM	2.6	-
PHOSPHATE	0.5	-
AMMONIA - N	0.3	-
TURBIDITY	2 JTU	-

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 83. Bottom fauna from the Horse River

Order	Family	Genus
Plecoptera	Perlodidae	*Isogenus* sp.
Plecoptera	Pteronacidae	*Peteronacys* sp.
Plecoptera	Nemouridae	*Nemoura* sp.
Ephemeroptera	Baetidae	*Ephemerella* ap.
Trichoptera	Phryganeidae	*Brachycentrus* sp.
Trichoptera	Hydropsychidae	*Hydropsyche* sp.

Fish Fauna

The small size of the stream at this station made fish collection with both rotenone and prima cord extremely easy. Only Arctic grayling were collected but they varied greatly in size and sexual maturity.

List of species collected:

Thymallus arcticus Arctic Grayling

Station # 2a - Unnamed Tributary of the Horse River

Survey date: September 19, 1972

Location: Sec. 29 Twp. 87 Rge. 10

The average width of this tributary of the Horse River is approximately 35 feet. The mean depth is 2 to 3 feet with some pools 5 feet or deeper. The flow is excellent and the water is a light tea brown. The pool to riffle frequency is approximately 2:1 and there is excellent fish refugia (deep holes, many logs and overhanging brush). The banks are generally stable and are densely covered with willow, alder, poplar and spruce. The bottom substrate is rubble and gravel in the riffle with gravel and silt in the pools. The nutrients in the river appear to be high.

Score Sheet Rating

Flow	5		
Temperature	3		
Pool Depth	5		
Frequency of Pools	3		
Refugia	5		
Nutrients	3		
Bank Cover	5	Total -	34
Substrate	5	Class	2

Water Chemistry

TABLE 84. Water chemistry of Unnamed Tributary of the Horse River

LAB SAMPLE NO. 7531

GRAB SAMPLE

DATE SAMPLED 19/9/72 DATE COMPLETED 20/10/72

PARAMETER	LAB RESULTS (MG/L)	FIELD RESULTS
TEMPERATURE	-	6°C
DISSOLVED OXYGEN	-	9.8 p.p.m.
pH	8.10	8.4
SPECIFIC CONDUCTANCE	415 umho/cm	-
HARDNESS, TOTAL	154	-
ALKALINITY, TOTAL	180	-
SULFATE	30	-
CHLORIDE	24	-
NITRATE & NITRITE	0.1	-
IRON, TOTAL	0.2	-
CALCIUM	54	-
MAGNESIUM	4	-
SODIUM	32	-
POTASSIUM	2.0	-
PHOSPHATE	0.8	-
AMMONIA - N	0.6	-
TURBIDITY	3 JTU	-
BALANCE		

ALL METAL PARAMETERS EXPRESSED AS TOTALS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRATE & NITRITE AND AMMONIA EXPRESSED AS NITROGEN.

Bottom Fauna

TABLE 85. Bottom fauna from Horse River Tributary

Order	Family	Genus
Plecoptera	Pteronarcidae	*Pteronarcys* sp.
Plecoptera	Perlidae	*Neoperia* sp.
Odonata	Gomphidae	*Hagenius* sp.
Trichoptera	Leptoceridae	*Leptocella* sp.
Trichoptera	Phryganeidae	*Brachycentrus* sp.
Diptera	Rhagionidae	-

Fish Fauna

Both rotenone and prima cord were used to collect fish at this station. The rotenone appeared to be ineffective because of cold water temperatures. Most of the white suckers were large fish.

List of species collected:

Catostomus commersoni	White Sucker
Catostomus catostomus	Longnose Sucker
Percopsis omiscomaycus	Trout Perch
Couesius plumbeus	Lake Chub
Rhinichthys cataractae	Longnose Dace

XVI MINOR WATERSHEDS ON THE WEST SIDE OF THE ATHABASCA RIVER

A. Buffalo Creek

Total Length: not calculated

Length Surveyed: 5 to 6 miles

Watershed Area: 215 square miles

Survey date: September 19, 1972

Location: Sec. 3 Twp. 87 Rge. 17

There were no suitable landing spots on this river in the one small stretch that looked favorable. The upper portion of the creek is almost 100% pool water winding through a large muskeg. Near the Athabasca River the creek gradient becomes steep and shows the characteristics of a flash flood stream. This creek appeared to have very little fisheries potential and was rated class 4.

B. Conn Creek

Total Length: not calculated

Length Surveyed: entire length

Watershed Area: 39 square miles

Conn Creek was tested at one location and a few immature Arctic grayling were taken. Good fish habitat is limited because of its small size (rating class 3 to 4).

XVIII. Age and Growth Analysis from Rivers in the Fort McMurray Area

Aging of fish from the study area was done by mounting their scales between acetate slides and reading them on an Eberbach scale projector. Most of the scales were read only once but any problem scales were reread then cross checked by two independent observers. The annuli were easily read on all scales except those of the walleye. The aging of the walleye scales is probably questionable especially in the older age classes.

The restrictive schedule of this preliminary survey made it difficult to obtain large samples of fish from any one survey location. Because of this it was necessary to combine samples from a number of locations to obtain age-length relationships for the various fish species. Growth curves were only plotted for the fish that were considered to be of direct importance to the sports or commercial fisheries. In most instances the sample size is so small that these graphs only represent a generalized picture of the age-length relationships that exist in the rivers. Combining fish samples from different locations can also be questioned since growth patterns may be different in the various river systems. None the less these graphs do indicate general relationships and compare favorably to other data compiled from similar northern areas or from lakes in the Fort McMurray area.

A much larger sample size was obtained of Arctic grayling (143 fish) than for any of the other species and the growth curves are therefore of greater value (Figure 182). The combined sample was made up of four to five sub-samples. Two of these sub-samples are large enough to present valid growth data on their own. A sample of fifty-nine fish was collected at one location of the High Hill River (Figure 39) and fifteen fish were taken at one location on the Ells River. Both of these growth curves are similar to the growth curve for the combined sample, which would indicate that growth relationships are consistent for this species throughout the entire area.

Grayling from the Fort McMurray area appear to have almost identical growth patterns to those from streams in the southern tributaries of the Athabasca River (Figure 177). The Fort McMurray fish reached a maximum age of six years while the South Athabasca fish reached a maximum age of seven years. (Ward, 1951) This difference in maximum age could possibly be attributed to either the small sample size taken at Fort McMurray or to a difference in the aging of the fish scales.

Grayling from the Fort McMurray area appear to grow slower than grayling from Great Slave Lake and do not attain either the large size or old age of those fish. (Bishop 1967) From the ages of two to three, Fort McMurray grayling show evidence of a definite decrease in growth in comparison with the Great Slave Lake grayling (Figure 177).

It would appear that conditions for the growth of Arctic grayling are similar over most of northern Alberta and that similarities in fisheries production could be expected. It may in fact be possible to extrapolate from other work done in northern Alberta or northern Saskatchewan to estimate features such as abundance and seasonal movements for the Fort McMurray area. It would appear that comparisons cannot be made with more remote areas since it is evident that areas such as Great Slave Lake have differences in growth rates and probably vary in productivity.

Growth curves were also plotted for Northern pike (Figure 178), Lake whitefish (Figure 179), Walleye (Figure 180), and Mountain whitefish (Figure 181), but as previously mentioned sample sizes were small. The growth curves for the Northern pike, Lake whitefish and Walleye from the rivers are comparable to the growth curves of these species in the lakes of the Fort McMurray area. There may in fact be an exchange or a movement of these species from the lakes to the streams or vice versa for feeding or spawning. It has been mentioned earlier in this report that many of the rivers or creeks are considered to be of importance as spawning routes and for the natural re-stocking of some of the shallow lakes that winter kill.

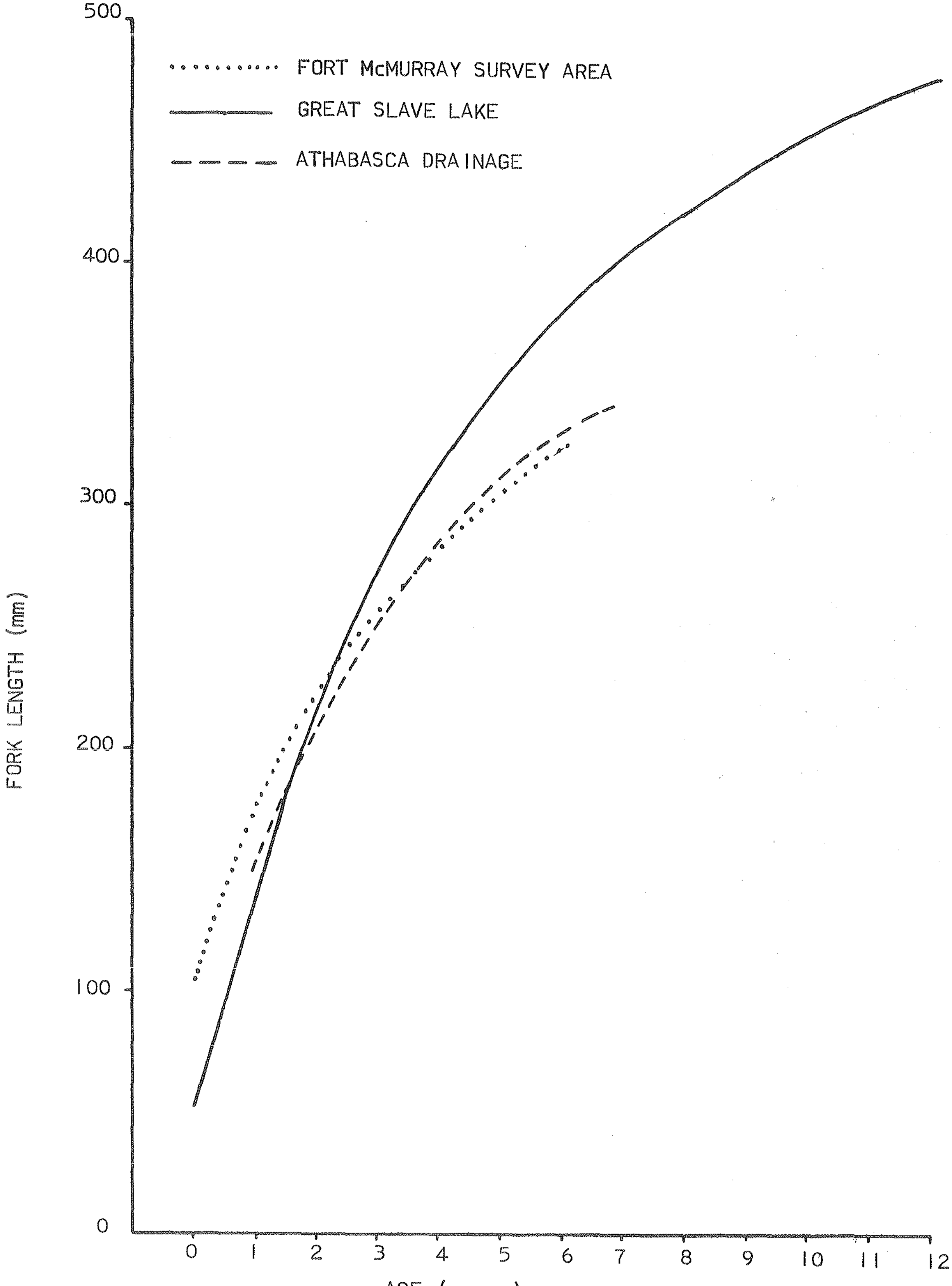


Figure 177. Comparative growth curves of Arctic grayling from Alberta and Great Slave Lake.

TABLE 176. Combined samples of Northern Pike from all survey locations; August to October 1972.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
I	1	9.1	212	80
II	2	18.1	427 (340-514)	1000 (260-1740)
III	1	9.1	592	1410
IV	4	36.4	555 (506-655)	1132.5 (450-2140)
V	3	27.3	650	2000 (1740-2380)

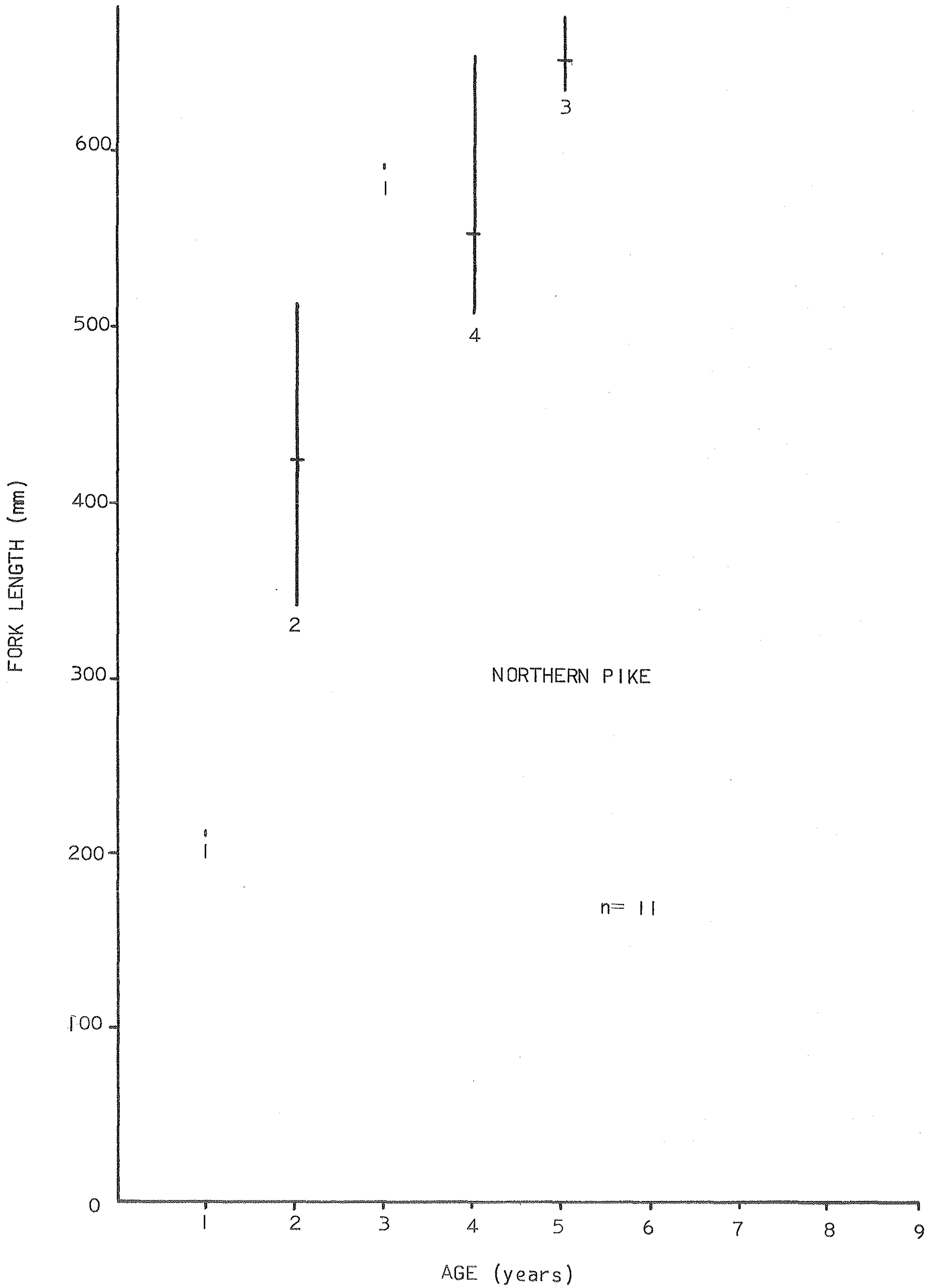


Figure 178. Growth curve of the combined sample of Northern pike from the study area.

TABLE 177. Combined sample of Lake Whitefish from all survey locations; August to October 1972.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
III	2	18.1	32.4 (31.5-33.4)	660 (560-760)
IV	4	36.4	37.92(35.4-41.7)	833 (720-1120)
V	4	36.4	37.95(35.9-41.8)	765 (640-1020)
VI	0			
VIII	1	9.1	43.6	1190

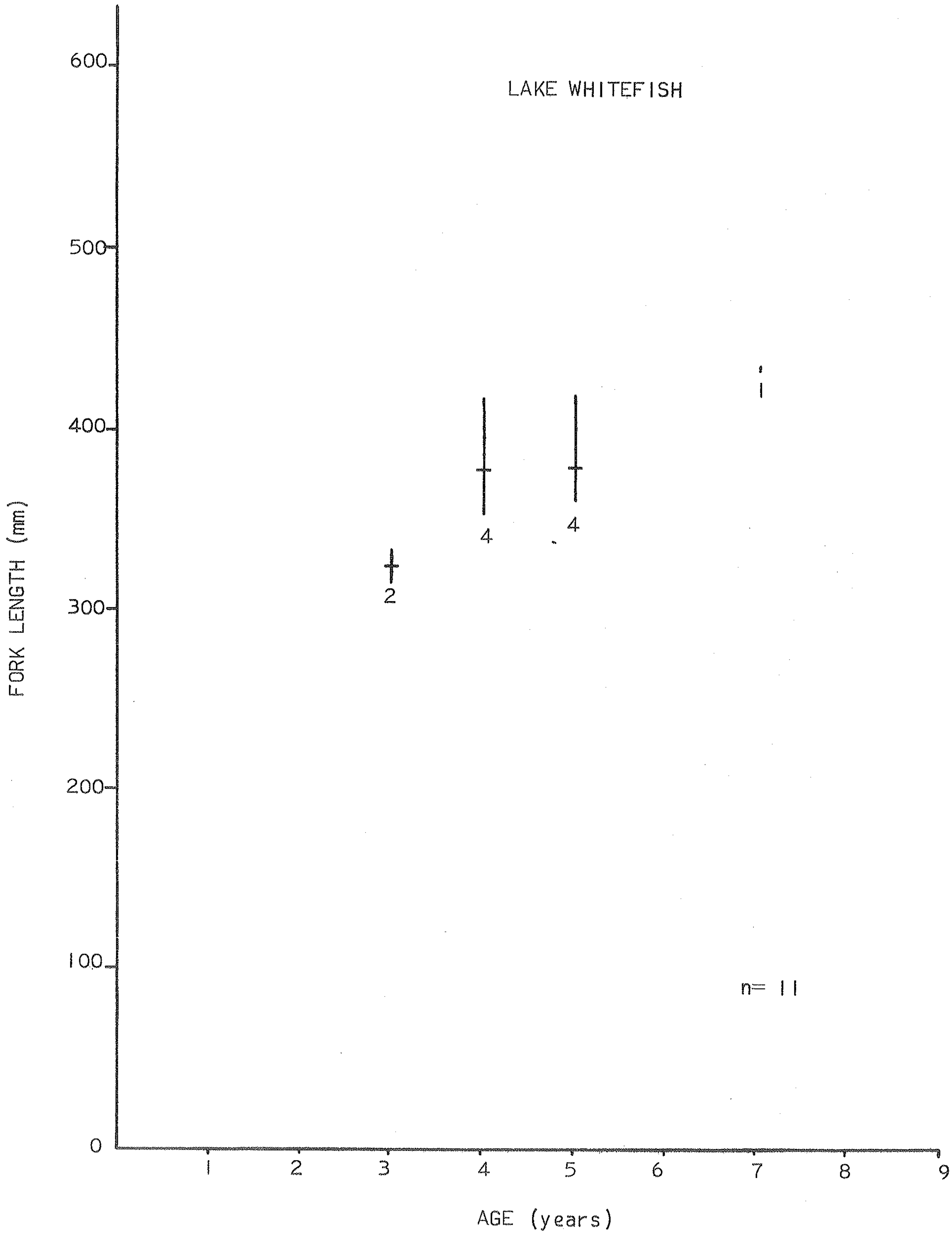


Figure 179. Growth curve of the combined sample of Lake Whitefish from the study area.

TABLE 178. Combined sample of Walleye from all survey locations; August to October 1972.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
II	1	3.4	309	240
III	1	3.4	272	200
IV	1	3.4	375	520
V	1	3.4	385	600
VI	2	6.9	491 (472-510)	1250 (1040-1460)
VII	9	31.03	420 (384-463)	834 (710-1090)
VIII	4	13.8	429 (405-457)	865 (710-1020)
IX	9	31.0	452 (374-510)	1017 (600-1500)
XIII	1	3.4	715	3620

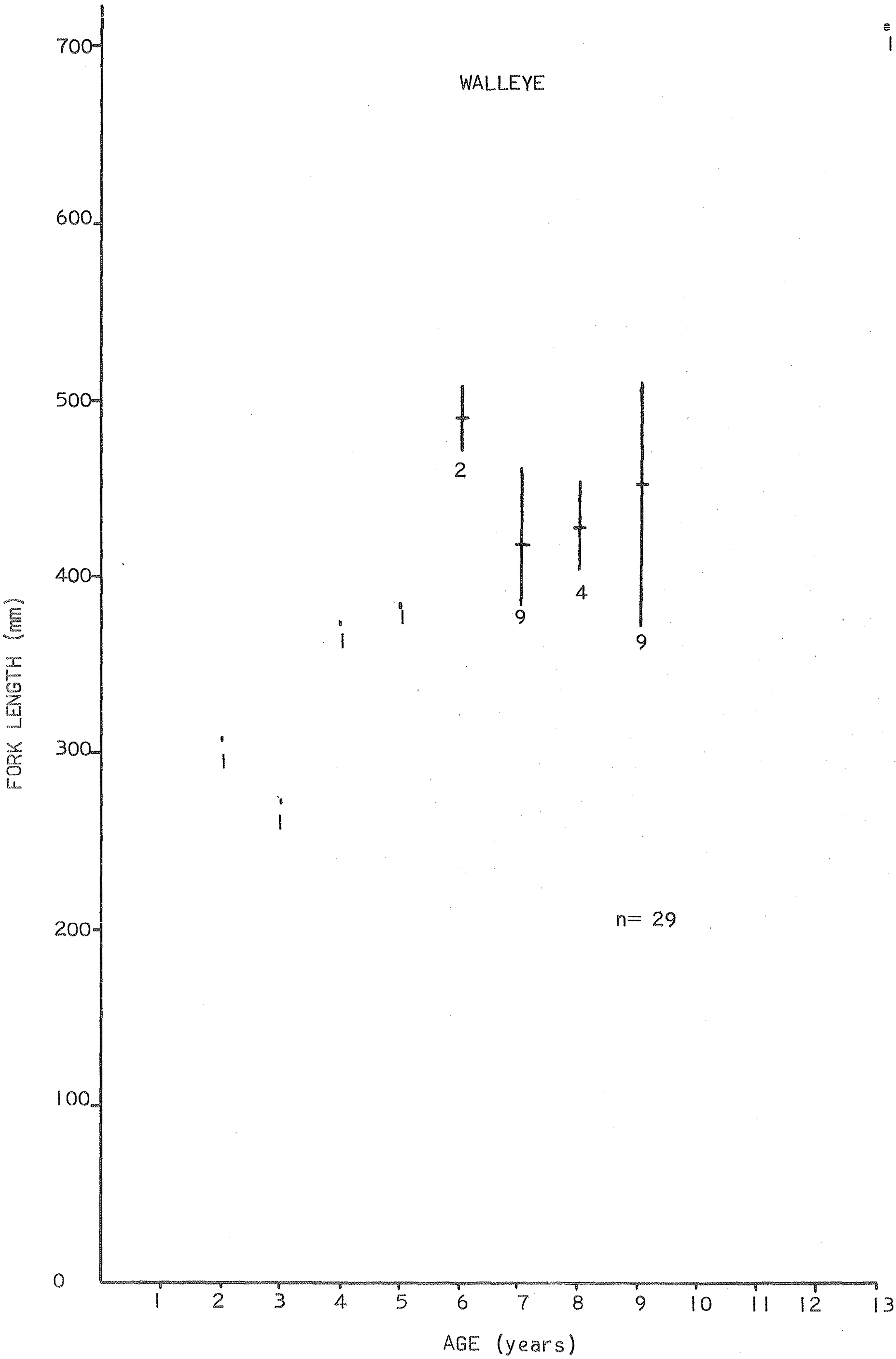


Figure 180. Growth curve of the combined sample of Walleye from the study area.

TABLE 179. Combined sample of Mountain Whitefish from all survey locations; August to October 1972.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
I	1	7.7	20.2	75
II	5	38.5	19.7 (16.4–23.4)	72 (25–125)
III	4	30.7	23.7 (20.9–28.1)	135 (80–200)
IV	1	7.7	29.9	320
V	2	15.4	36.4 (34.4–38.5)	670 (560–780)

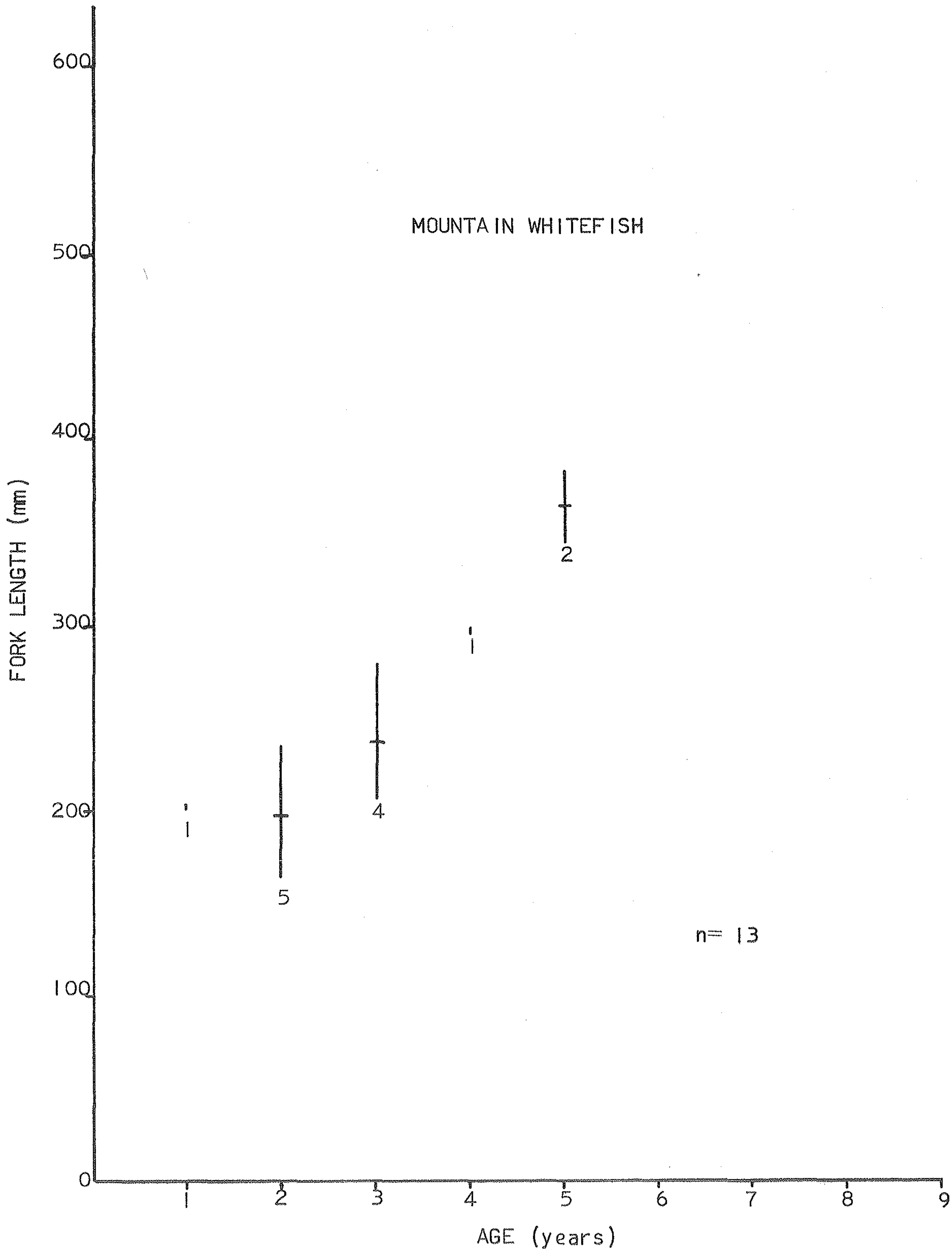


Figure 181. Growth curve of the combined sample of Mountain Whitefish from the study area.

TABLE 180. Combined sample of Arctic Grayling from all survey locations; August to October 1972.

Age Class	Sample Size	% of Sample	$\bar{x}$ fork length (range) mm.	$\bar{x}$ weight (range) gms.
0	1	.7	106	3
I	51	25.7	167 (120-217)	48 (18-100)
II	17	11.9	231 (178-279)	142 (40-265)
III	21	14.6	255 (205-310)	176 (75-350)
IV	34	23.8	281 (231-324)	230 (100-375)
V	16	11.2	303 (256-356)	301 (160-380)
VI	3	2.1	326 (319-332)	326 (319-332)

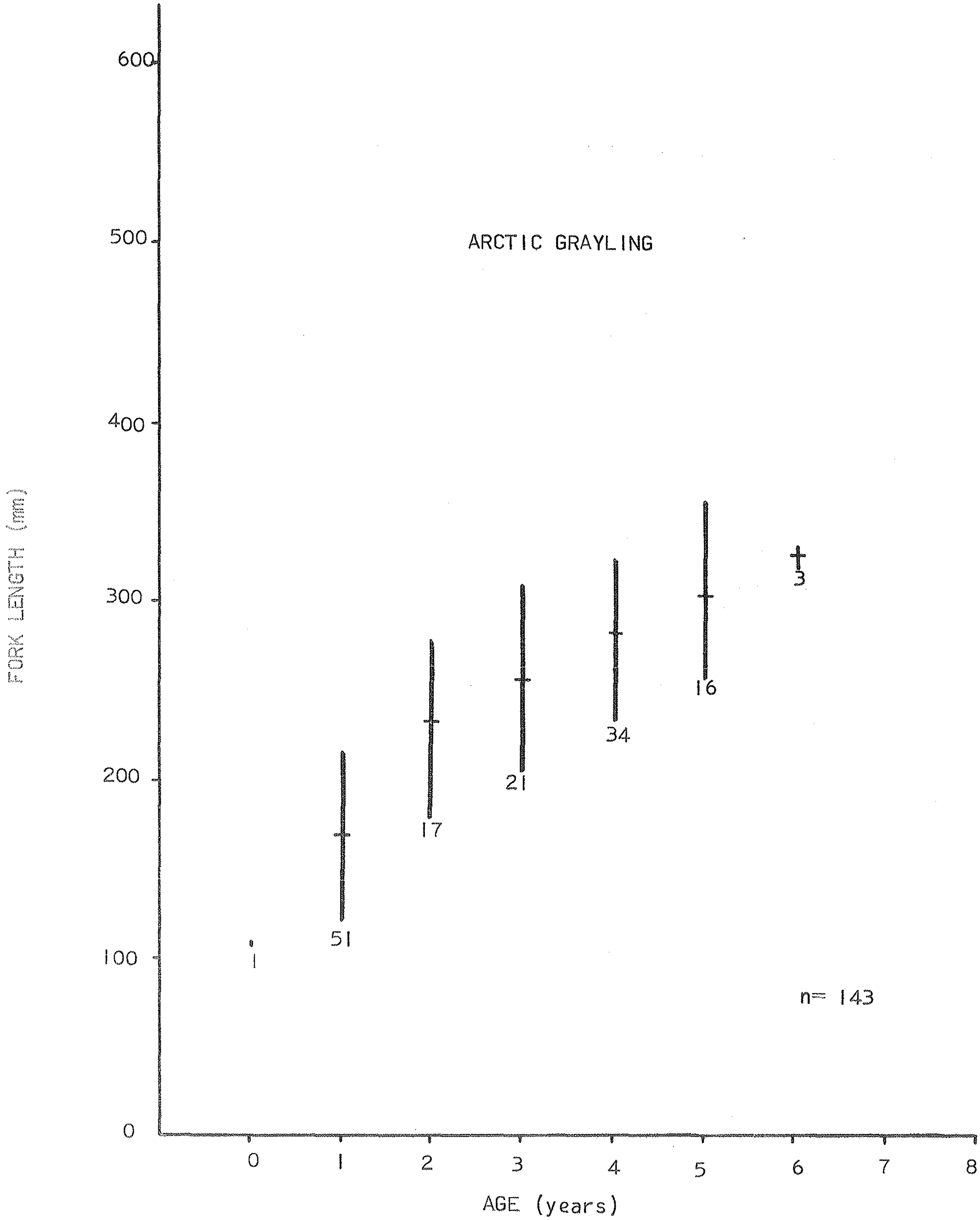


Figure 182. Growth curve of the combined sample of Arctic grayling from the study area.

TRANSPORTATION CORRIDOR STUDY

FORT McMURRAY to EDMONTON

CHAPTER II

SOILS

Prepared for:

Alberta
Environment
The Honorable
William Yurko

By:

Tom Peters & Associates
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

SOILS

INTRODUCTION

This is the preliminary portion of a more detailed study of the multi-use transportation corridor study from the Athabasca Tar Sands to Edmonton. It gives a general picture of the cultivation pattern (Figure 1), the soil capability for agriculture (Figure 2) and a map showing soil and topographic factors affecting terrain sensitivity (Figure 3).

The area north of Lac La Biche to Fort McMurray has been covered by exploratory soil surveys (1,2) while the area south of Lac La Biche to Edmonton has been covered by reconnaissance soil survey (3,4,5) which have been published or are in the process of being published.

The soil capability for agriculture has been published for the Edmonton Sheet 83H, the Tawatinaw Sheet 83I and the Pelican Sheet 83P and the Sand River Sheet 73L are in the process of being published. The soil capability for the remainder of the area was determined by interpretation of aerial photographs, exploratory surveys and field traverses.

The general agroclimatic areas were outlined by W.E. Bowser on the map Agroclimatic Areas of Alberta and the areas more accurately established by examination of the terrain and from weather records.

The map showing soil and topographic factors affecting terrain sensitivity was prepared by utilizing all the existing information plus aerial photographic interpretation.

PHYSIOGRAPHY

The corridor study area lies mainly in the Alberta Plains region except for the Cheecham Hills south of Fort McMurray which are considered to be in the Alberta Plateau physiographic region. The Cheecham Hills are the main elevations in this area and rise to heights over 2500 feet above sea level. The general slope of the area is to the northeast, Edmonton having an elevation of 2175 feet and the airport at Fort McMurray having an elevation of 1211 feet. The level of the Athabasca River at Fort McMurray is approximately 790 feet.

CLIMATE

The climatic data for the area is presented in the hydrology report.

VEGETATION

A brief description of the vegetation is included in Chapter III - Wildlife.

GLOVIAL GEOLOGY

The Laurentide ice sheet covered the entire area leaving large areas of uniformly medium textured glacial till and associated glacial lacustrine and alluvial deposits. The general direction of the movement of ice was south, southwest as evidenced by the glacial flutings adjacent to the Athabasca River. The largest fine textured glacial lacustrine area is the Edmonton laking basin. Large sand areas occur along the North Saskatchewan River at Vinca, along Redwater Creek and Tawatinaw River and on the lower slopes of the Cheecham Hills.

SOILS

As the vegetation varies from a forest-grassland transition in the southern portion to the forested area in the northern portion, a wide variety of soils occur. In the forest-grassland area around Edmonton, Chernozemic soils are found and these are the most productive and suitable for arable agriculture. Further north these soils are replaced by Luvisolic soils which predominate in the wooded areas.

Areas of Brunosolic and Podzobic soils occur in localized areas throughout forested areas. As much of the area is characterized by level topography, large areas of Organic soils are found and these are often associated with wetlands in which Gleisolic soils predominate. Solonetzic soils are confined mainly to the area adjacent to Edmonton, Vegreville and Morinville. Various combinations of these soils are found depending upon relief and vegetation.

Figure 1: Shows the cultivation pattern for the area under study. As to be expected, the areas of good arable soils are intensely cultivated and as the soils and climate become more limiting for the range of crops ordinarily grown, cultivation becomes more scattered. Islands of fairly good soils occur in the wooded area and the cultivation map illustrates this; for instance, the Wandering River area.

Figure 2: The soil capability map for agriculture shows the areas suitable for agriculture as now practiced. Soil capability classes 1, 2 and 3 are grouped together as the limiations to crop growth are less severe in these classes. Class 4 is separated out because these soils are considered marginal arable and have severe limitations that restrict the range of crops or require special conservation practices or both.

The third group is Pasture (improved or native) and includes soil capability classes 5 and 6. Class 7 soils have no capability for arable agriculture or permanent pasture.

Organic soils have not been placed in capability classes.

For more detailed definitions of soil capability classes refer to the soil capability for agriculture report on the Edmonton Sheet 83H.

THE MAP SHOWING SOIL AND TOPOGRAPHIC FACTORS AFFECTING TERRAIN SENSITIVITY

Terrain sensitivity as used in this report refers to those factors such as inherent soil characteristics, land form, drainage and vegetation which may influence the location and construction of oil lines, power lines, highways or railways in order to minimize the impact of these transportation facilities on the environment.

Factors that are considered in developing this terrain sensitivity are soil texture, soil profile development, salinity, slope, wetness and thickness of organic material on the surface or combinations of these. No attempt was made to place these groups in order of sensitivity as the purpose was to show where sensitive areas occur.

Figure 3: Is a generalized map of soil and topographic factors affecting the terrain sensitivity of the area.

I. Minimal Terrain Sensitivity

These are areas where impact of construction on the terrain is minimal.

2. Saline Soils

These are soils, mostly Solonetzic, which have undesireable physical characteristics as a result of the saline material on which they have developed. For instance alkali-resistant cement should be used in these areas.

3. Rough Topography

Areas with slopes over 9 percent are included. Hummocky topography creates problems with cut and fill for roads and also erosion becomes a factor once the natural soil surface has been disturbed.

4. Sand Areas

These are sand dune areas and are usually assorted with Organic soils or wetlands. There is difficulty in stabilizing slopes and revegetating areas. Also the extreme from sand to wetlands within a short distance creates construction problems. Slopes may be quite a problem in rolling sand dune areas.

5. Wetlands

These are usually Gleisolic soils. That is the water table is usually close to the surface for extended periods during the year. Drainage is a problem in these areas.

6. Organic Soils

These are areas where the depth of organic material at the surface is over 16 inches. Depth and kind of organic material, wetness and drainage are problems.

7. Rough Broken Land

Areas with steep slopes adjacent to streams or rivers are included in this grouping. Bedrock exposures and slumping of banks create special problems.

As this is a generalized map, small sensitive areas do not show. Terrain sensitivity apparently has been considered in the location of the present highway to Fort McMurray from Edmonton as it passes through a minimum of sensitive areas.

REFERENCES

1. Lindsay, J.D., P.K. Heringa, S. Pawluk and W. Odynsky Exploratory Soil Survey of Alberta Map Sheets, 84-C (east half) 84-B, 84-A and 74D. Report 58-1 Research Council of Alberta.

2. Wynnk A., J.D. Lindsay, P.K. Heringa and W. Odynsky Exploratory Soil Survey of Alberta Map Sheets, 83-O, 83-P and 73-M. Report 64-1 Research Council of Alberta.

3. Bowser, W.E., A.A. Kjearsgaard, T.W. Peters and R.E. Wells Soild Survey of Edmonton Sheet (83-H) 1962.

4. Kjearsgaard, A.A. - Soil Survey of Tawatinaw Sheet (83-I) 1972.

5. Kocaoglu,S.S. - Soil Survey of Sand River Sheet (73-L) not published.

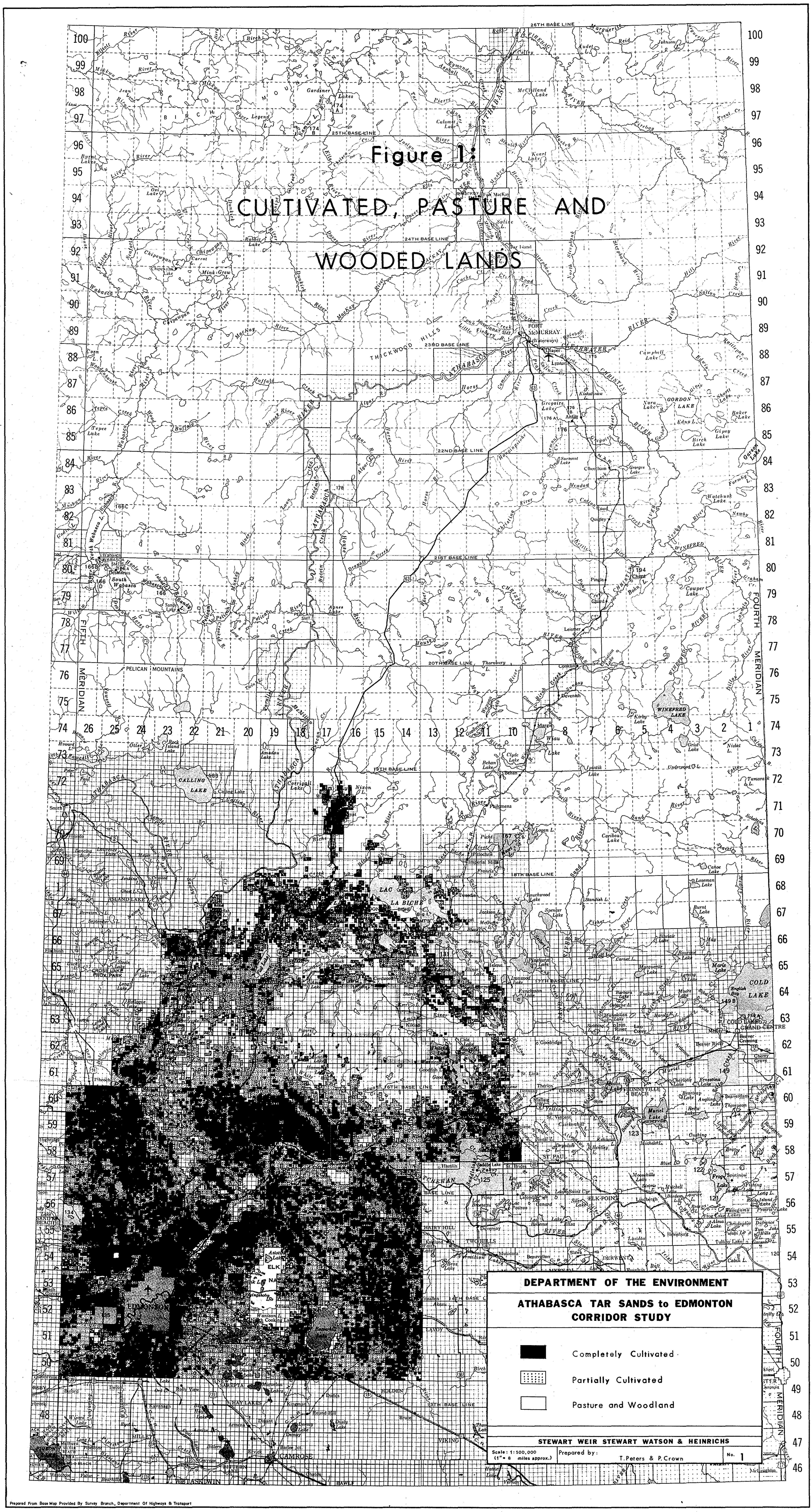
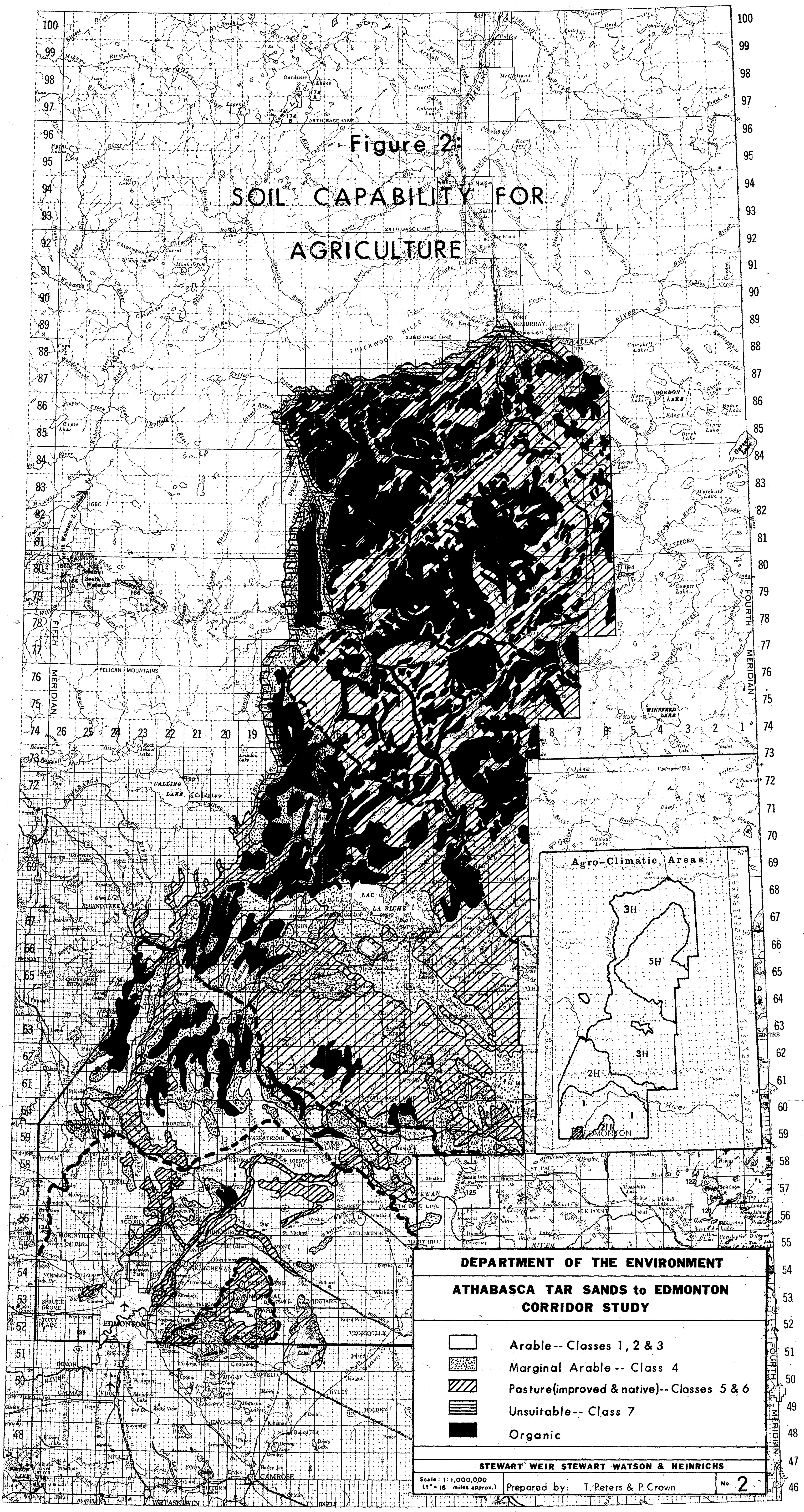


Figure 1:
CULTIVATED, PASTURE AND WOODED LANDS
DEPARTMENT OF THE ENVIRONMENT
ATHABASCA TAR SANDS to EDMONTON CORRIDOR STUDY
Completely Cultivated
Partially Cultivated
Pasture and Woodland
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1:500,000 (1" = 8 miles approx.)
Prepared by: T. Peters & P. Crown
No. 1
Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport



Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport

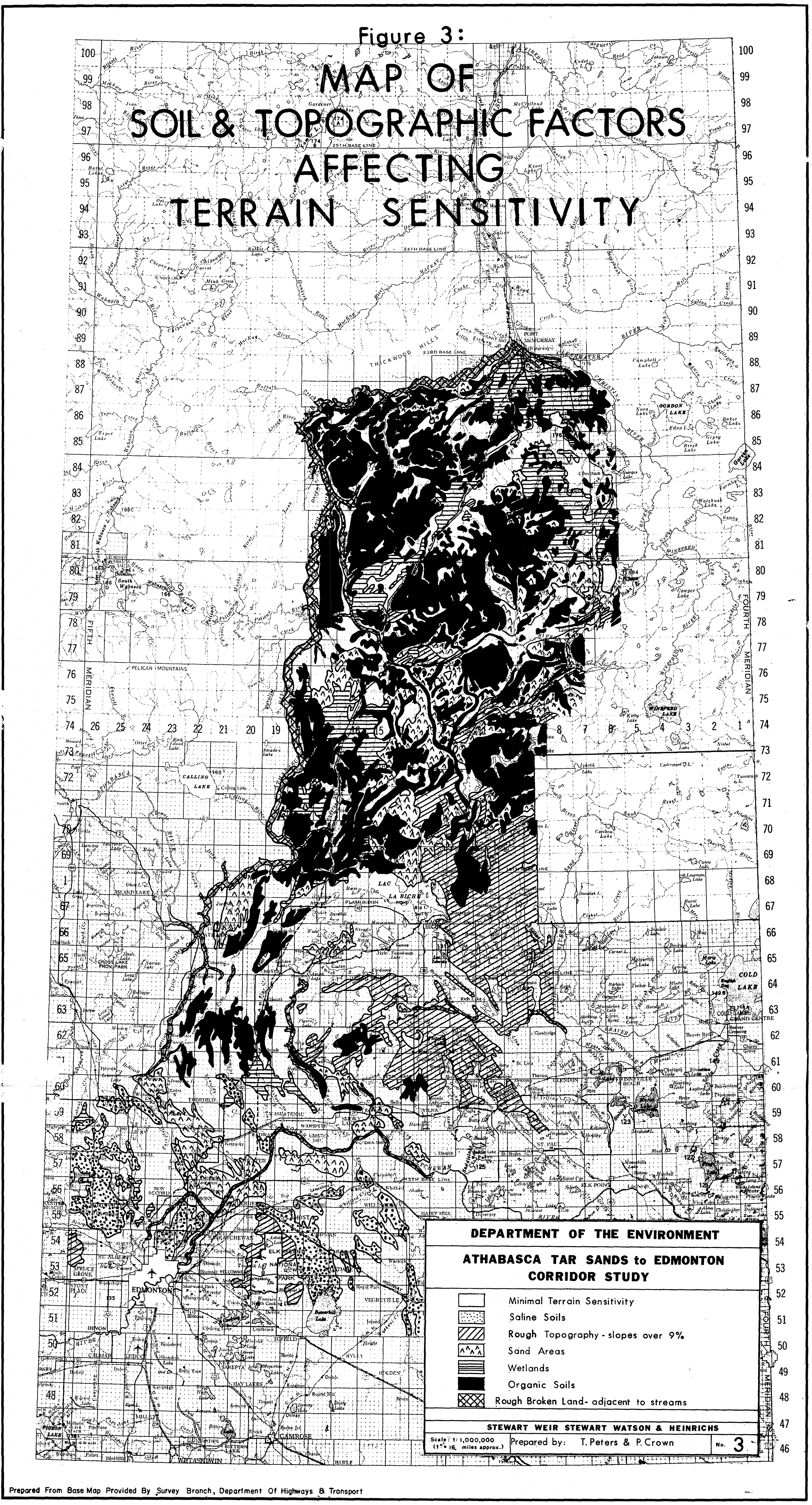


Figure 3:
MAP OF
SOIL & TOPOGRAPHIC FACTORS
AFFECTING
TERRAIN SENSITIVITY
DEPARTMENT OF THE ENVIRONMENT
ATHABASCA TAR SANDS to EDMONTON
CORRIDOR STUDY
Minimal Terrain Sensitivity
Saline Soils
Rough Topography - slopes over 9%
Sand Areas
Wetlands
Organic Soils
Rough Broken Land - adjacent to streams
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1:1,000,000 (1" = 16 miles approx.)
Prepared by: T. Peters & P. Crown
No. 3
Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport

TRANSPORTATION CORRIDOR STUDY

FORT McMURRAY to EDMONTON

CHAPTER III

WILDLIFE

Prepared for:

Alberta
Environment
The Honorable
William Yurko

By:

Stewart Weir Stewart
Watson & Heinrichs

Ducks Unlimited (Canada)
Edmonton, Alberta

INTRODUCTION

This report, with the exception of the section on waterfowl habitat, is based on a rather limited amount of data. Very little is known of the distribution of birds and mammals over large portions of the study area. The information presented in our checklists is based on sightings from localized areas. In addition to the two main sources, 'Birds of Alberta' and 'Mammals of Alberta', field notes from three trips into the Fort McMurray region were made available to us by Dave Spalding, Head Curator of Natural History and Julie Hrapko, Curator of Botany at the Provincial Museum and Archives of Alberta.

Ducks Unlimited (Canada) were asked to comment on the route of the proposed corridor in relation to waterfowl and their habitat. The immediate problem was to examine the existing highway and railroad and determine which route would have the least impact on waterfowl. Data collected on a field trip May 28-30, 1973 from Edmonton to Fort McMurray and return were used for the assessment. Other sources of information include Canada Land Inventory, Canadian Wildlife Service and Ducks Unlimited files.

DESCRIPTION OF THE STUDY AREA

The vegetation of the study area is classified as mixed-wood (Wonders et al 1969). The southern portion, lying within the Transition Parklands Life Zone (Fig. 2), is characterized by aspen stands interspersed with pasturelands, wetlands and cultivated fields. Bird and Bird (1967) describe the large variety of plants associated with the aspen community. Typical small trees and large shrubs are the red-osier dogwood, beaked willow, saskatoon, chokecherry and pincherry. The prickly rose, snowberry, beaked hazelnut and low-bush cranberry are smaller shrubs often found within the community. Taller shrubs such as Lindley's aster, northern bedstraw, pea vine, fringed brome and wild rye are also typical. Plants of the forest floor are the Western Canada violet, lili-of-the-valley, dewberry, bunchberry, and several species of mosses.

Variations in temperature and humidity are reflected in the type of plant life found along river and stream valleys. Aspen and white spruce are found on the cooler and moister north-west slopes. The drier, warmer south-east slopes are likely to be grass-covered. Edges of streams may support various species of grasses and sedges. In quiet pools where the flow of water is minimal, submerged and emergent plants such as the pondweeds, filamentous algae, rushes and water plantain may be found. The characteristic trees of the lower valley near the stream margins are the willows and balsam poplar. River alder and western birch are also commonly found here (Bird and Bird 1967).

Some wetlands in the Transition Parklands Zone overlie strongly alkaline soils (Chapter 2, Fig. 3). Examples of the salt-tolerant plants inhabiting these areas are samphire, salt grass, sea blite, lance-leaved orache and arrow-grass (Bird and Bird 1967). Wetlands overlying soils lower in salinity will support plants similar to those found within backwaters and along the margins of slow-moving streams. The most common emergent plants of marshes and shallow lakes are the cattails and bulrushes. If the shores are steeply sloping, colonization by emergent plants will be confined to the damp soils above the waterline.

Tracts of muskeg are found on the northern edge of the Transition Parklands Zone (Figs. 1, 2). This area corresponds to the limit of intensive cultivation (Chapter 2, Figs. 1,2,3) and marks the southern extremity of the Canadian Life Zone (Fig.2). Stands of aspen and white spruce are found on higher ground, but the poorly-drained lowlands are characterized by black spruce and larch bogs, marshes and muskegs. The acidic muskeg soils consisting of up to several feet of peat are classified as organic (Chapter 2, Fig. 3). Areas of sand hills found in this zone support stands of jackpine though few species occupy the understory because of the soil characteristics and the shaded conditions (Chapter 2, Fig. 3) (La Roi 1967).

Less light will diffuse through a white spruce canopy than a more open aspen canopy resutling in fewer numbers and less diverse ground cover of shrubs or herbaceous plants in a spruce-dominated forest. Feather mosses are very common in the humid white spruce habitat. Shrubs which persist are the green alder, mooseberry and prickly rose.


FORT McMURRAY
CHARD
CONKLIN
WANDERING RIVER
LAC LA BICHE
ATHABASCA
BOYLE
THORHILD
SMOKY LAKE
REDWATER
FORT SASKATCHEWAN
EDMONTON
DEPARTMENT OF THE ENVIRONMENT
ATHABASCA TAR SANDS to EDMONTON
CORRIDOR STUDY
WETLANDS MAP
WETLANDS
LAKES
MAJOR RIVERS
HIGHWAYS
RAILWAY
PIPELINE
POWERLINE
72 KV
138 KV
240 KV
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1: 500,000
(1" = 8 miles approx.)
No. 1

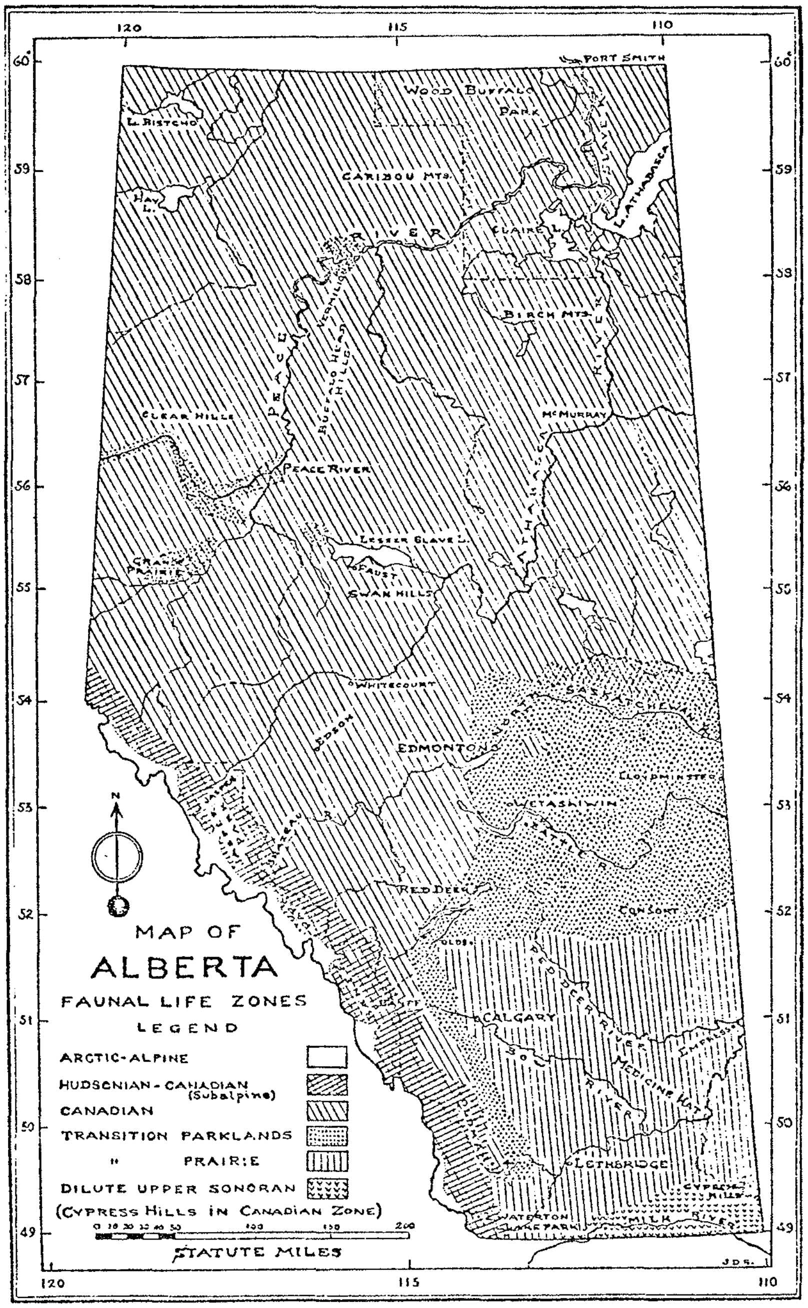


Figure 2. Faunal life zones of Alberta. (after Soper 1964)

Herbs and smaller shrubs found here include the bunchberry, twin-flower, horsetails, wintergreens, lili-of-the-valley, cowberry and northern comandra (La Roi 1967). The typical flora of the aspen community have been described under the Transition Parklands Life Zone.

Willows and dwarf birches are the common large shrubs of bog areas. Typical smaller shrubs are the blueberries and bog cranberries. Mosses and sedges are normally found covering the ground where few herbaceous plants are able to tolerate the cool, moist conditions. Arboreal lichens commonly dwell on the dead trees (Hrapko, Smith and Spalding 1971).

An interesting point concerning the revegetation of these areas was related to me by Julie Hrapko, Curator of Botany at the Provincial Museum and Archives of Alberta. While on a field trip to the Fort McMurray area in August, 1972, she noted that an area near Anzac which had been bulldozed and abandoned nearly twenty-five years ago was in sharp contrast to the untouched region bordering it. The latter was a black spruce forest with labrador tea, a low shrub, covering the forest floor. The cleared area contained only a very few low spruce saplings. No labrador tea grew there. The characteristic plants were sedges and cotton grass. Both areas also contained sphagnum moss, bog cranberry and cloudberry. Observations of tracts recovering from forest fires reveal that labrador tea does not disappear from these areas because the fires do not destroy the roots of this plant. A forestry officer working on forest management plots near Anzac added another point to the problems encountered in revegetation. He stressed that spruce and pine seedlings used for reforestation should be wildlings. Ten percent mortality can be expected from these plantings while

85–90% mortality on three-year-old nursery seedlings has been observed.

The communities described for the Transition Parklands and the Canadian Life Zone are 'home' to various species of birds and mammals. A brief account of the distribution of fauna in the study area follows.

DISTRIBUTION OF BIRDS

A list of the species occurring in the study area has been adapted from 'Birds of Alberta' (Salt and Wilk 1966) and appears as Table 2. Of the 252 species listed, 113 or 45% of these occur as breeding birds throughout the area. Some are more commonly found in the Canadian Life Zone while others are more common in the Transition Parklands Zone. If we include the number of birds which are year-round residents, the figure for breeding species rises to 130 (52%). Twenty-one percent of the total number of birds in our study area occur only as migrants. The majority of these are waterbirds travelling to and from their Arctic breeding grounds. Birds which overwinter in the study area number 59 (29%). Eleven of these utilize this region only during the winter months while the remainder are year-round residents.

The status of endangered species is of particular concern to us. The whooping crane breeds in Wood Buffalo National Park but travels through the study area on its way to wintering grounds in Texas. It is not known which of the lakes and marshes in our area are host to this extremely rare bird. Salt and Wilk mention that this bird is most often observed during the fall in grain fields beside ponds and sloughs. Other pertinent information appears to be lacking.

The numbers of peregrine falcon have dwindled drastically in recent years. A survey conducted by the Canadian Wildlife Service in 1969 revealed that known nesting sites along the high cliffs of the Athabasca River south of Fort McMurray no longer appeared to be in use. It is not known whether the birds have nested here since 1969. Peregrines have been observed recently within our study area. Ernie Ewaschuk of Ducks Unlimited (Canada) reported seeing this bird during a 'float' trip down the Wabiskaw River this past summer (pers. comm.).

Other species of concern are the bald and the golden eagles, the double-crested cormorant, turkey vulture and white pelican. All of these are scarce in Alberta. Human interference is usually cited as the reason for this. Scattered records in our study area are available for the bald eagle whose typical nest site is in the top of a tall tree near a large body of water. Colonies of nesting cormorants were observed at Frog Lake and at Lower Therien Lake in 1967 (Vermeer 1969a). These large birds nest in colonies on rocks or cliffs of islands or shores and only occasionally in spruce trees. The turkey vulture is very rare in our study area. Two new records of nesting pairs were recorded in 1956, one on an island in a small lake near St. Paul and the other on an island in Lower Man Lake near Ashmont, approximately 80 miles from St. Paul (Oeming 1957). It is possible that this species is slowly extending its range northward as these records are the most northerly for the province (to 1956). Colonies of white pelicans have also become extremely localized. The only active colony observed in our study area in 1967 was found on an island in Lower Thierien Lake. Only two nests were located (Vermeer 1969a).

Other species also suffer as a consequence of human interference. The great blue heron which nests in colonies requires tall trees near water for nesting sites. The destruction of heronries by drainage, tree cutting and harassment of nesting birds has resulted in a decrease in the number and size of colonies. Seven heronries were still active in 1967 at the following lakes: Frenchman, Frog, Island, Islet, Lower Mann, Meyer and Pelican. The colony size varied from 1 to 45 nesting pairs (Vermeer 1969b). The common loon and western grebe are steadily retreating farther into the remote regions of the Canadian Life Zone, away from human activity

DUCKS AND GEESE

INTRODUCTION

In general, the most productive waterfowl habitat in Alberta is found on the prairies, with the parklands, and mixed and boreal forest regions following in that order. Although, production in the boreal forest is considered low per unit area, the vastness of this region gives it considerably more importance to waterfowl. In addition, production of young is only one aspect in the life history of waterfowl; other important phases include staging and migration, and molting. The purpose of this report, therefore, is to discuss waterfowl in the study area, in relation to migration, habitat, and production. A secondary purpose is to describe both existing facilities (Northern Alberta Railroad and Highway #63) as they relate to waterfowl and their habitat.

DISCUSSION

Migration

Traditionally, waterfowl journey northward in the spring, to breed, raise their young, molt, then return to the southern latitudes to winter. Nearly as regularly, do they use the same familiar wetlands to rest, feed, or disperse from. Therefore, though these areas may be unimportant for nesting, they do play a significant role in the seasonal cycle of waterfowl. This is the case of many of the lakes in the study area as shown in Table I. Schick and Ambrock (1972), emphasized the importance of Gordon, Garson, Mildred, and Ruth Lakes as stopping areas because of their geographical location to the Peace-Athabasca Delta. They report counts of 100,000 ducks and several

Table I Numbers of ducks estimated from aerial surveys conducted from 1964–67 in northeastern Alberta. (Ducks Unlimited files)

LAKE	1964	1965	1966	1967
Garson	3,400	27,200	–	8,500
Gypsy	430	650	–	185
Birch	1,100	3,400	–	2,000
Gordon	25,000	18,000	–	9,500
McLelland	1,300	360	–	260
Limon	1,200	640	–	5,000
Blanche	6,800	1,470	–	1,175
Richardson	15,800	1,200	–	1,250
Welstead	11,500	5,300	–	27,800
Watchusk	7,700	1,600	–	3,600
Cawper	3,300	2,000	–	14,800
Bohn	7,500	1,500	–	1,800
Wiau	3,000	1,300	–	4,200
Logan	16,400	10,800	–	35,600
Heart	5,100	3,100	–	22,400
Lac La Biche	21,500	9,200	9,200	8,100
Missawawi	8,300	5,800	18,700	5,800
Kinosui	5,500	4,200	4,600	6,900
Burnt	4,200	100	620	1,500
Flat	38,000*	10,300	25,000	25,000
Tawakwato	1,200	1,100	1,450	2,800
Buck	–	200	240	400
Charron	2,900	1,300	6,500	6,300
Horse	3,100	100	740	900
Lacroix	3,400	7,100	18,000	1,700
Huppie	2,100	2,600	4,600	9,800
Rich	4,000	280	2,460	500
Whitefish	250	230	700	700
Reed	15,300	6,700	4,500	2,700
Bunder	6,300	800	7,300	3,200
Mann (2)	1,950	–	220	425
Therien (2)	9,300	7,100	5,400	4,250
Sinking	3,300	190	–	7,700
Jessie	10,000	1,100	–	4,550
Charlotte	12,400	4,800	–	3,000
Smoky	59,000	24,300	19,110	38,685

* also 30,000 coots

thousand whistling swans (Olor Columbianus) using Gordon Lake and the surrounding area. The Lac La Biche area also showed importance to migrating waterfowl (Table I) although the number of water bodies in the area tended to spread the birds to a greater extent. Further to the south, the important staging areas include: Flat, Smoky, Whitford, Manawan, Big, Vermilion, and Beaverhill Lakes. Flat Lake is particularly important as a molting and staging area for canvasbacks (Aythya valisineria), lesser scaup (Aythya affinis), and mallard (Anas platyrhynchos). A Ducks Unlimited control structure on this lake regulates flood waters and maintains levels to enhance the growth of sago pondweed (Potamogeton pertinatus), which appears important to the canvasback. Smoky Lake, valuable to staging pintails (Anas acutus) and mallards, is presently being considered for stabilization by the Department of Environment. Whitford and Beaverhill have added significance since they contain Fish and Wildlife grain baiting stations as part of a program to reduce crop depredation by waterfowl. Beaverhill Lake has been particularly noted for its attraction to migrating birds for many years. Most species of waterfowl along with a multitude of shorebirds use the area spring and fall.

Habitat and Production

Approximately the southern third of the study area is located in the aspen parkland and contains 6 to 15 breeding pairs of waterfowl per square mile (based on United States Fish and Wildlife Service data). The remaining two thirds, with the exception of the Peace-Athabasca Delta has one to five breeding pairs per square mile.

Wetlands in the boreal and mixed forests are characterized by low fertility soils and poorly drained lands in various stages of bog formation. Waterfowl use of these areas is largely unknown, but some evidence suggests that birds overfly southern regions during periods of drought. Ducks Unlimited has been studying different habitat types in the boreal forest to determine the value of these to waterfowl. These types include: lakes with sedge (*Carex* spp.) and cattail (*Typha latifolia*) shorelines, ponds with cattail emergence, muskeg and floating sedge shorelines, and streams. Results are not available at this time but preliminary findings indicate greater nesting densities than were previously estimated. Species using different habitats varied but most common dabblers throughout all habitats were mallard, blue-winged teal (*Anas discors*), green-winged teal (*Anas carolinensis*), baldpate (*Mareca americana*), shoveler (*Spatula clypeata*), gadwall (*Anas strepera*), and pintail in that order. Most common divers were lesser scaup, bufflehead (*Bucephala albeola*), ring-necked duck (*Aythya collaris*), ruddy duck (*Oxyure jamaicensis*), redhead (*Aythya americana*), canvasback, and common goldeneye (*Bucephala clangula*), Breeding populations varied from 5 to 50 pairs per mile of shoreline while production varied from 0 to 15 broods per mile of shoreline.

Existing Facilities

Northern Alberta Railroad

The existing railroad, between Lac La Biche and Fort McMurray, was examined on a field trip, in late May 1973, travelling by 'speeder'. In general, the route passes through low boggy areas alternately with drier upland areas crossing numerous creeks and rivers. The bog was characterized by sphagnum moss, bog birch and black spruce (*Picea mariana*), while the uplands contained aspen poplar (*Populus tremuloides*), white spruce (*Picea glauca*), and associated shrubs and forbs. The majority of lakes and ponds were bordered with sedge, contained little aquatic growth, with the exception of water lily (*Nuphar variegatum*), and lacked invertebrates. These types of habitat were among the lease productive in the

Ducks Unlimited study. Many wetlands were void of waterfowl, while others held lesser scaup, ringed-necked ducks, and buffleheads. Mallard, blue-winged teal, and green-winged teal were the most common dabblers observed, although in total, their numbers were low. Both species of teal were most often sighted along streams, in the ditches associated with the railroad grade, or near beaver dams. Other species sighted were white-winged scoter (*Melanitta deglandi*), common loon (*Gavia immer*), and common merganser (*Mergus merganser*).

Highway 63

The highway, south of Fort McMurray, appeared to follow upland topography for the greater portion of its length. The reverse of this situation applied to the railroad. Wetlands along the highway consisted mainly of borrow pits created during construction. Beaver dams, streams and few lakes were other forms of wetlands present. As along the railroad, habitat was of low quality e.g. Marianna Lake has a sandy bottom, no aquatic growth, sedge and horsetail (*Equisetum* spp.) emergence, and bordered by black spruce. No waterfowl were observed on this lake. The borrow pits were among the better habitat types found adjacent to the highway, particularly, in the northern portion of the road. Many had emergent cattails with some aquatic flora. Approximately 50% of the borrow pits held waterfowl; mainly mallard, lesser scaup, and ring-necked ducks. The quality of the habitat improved considerably to the south of Lemiseau Lake. Lemiseau exhibited many characteristics of more productive parkland lakes, with its 'open' nature, and cattail and sedge shoreline. Both dabblers and divers were abundant. Further to the south, some oxbows of the Lac La Biche River, Charron Lake, and a small pond east of Atmore, provided some excellent habitat, as was evidenced by both numbers and diversity of species.

If the proposed utility corridor was to be constructed along one of the existing facilities, then the highway route would certainly offer the least resistance, environmentally. Since the highway follows upland topography to a greater extent, and crosses far fewer streams than the railroad, it is the logical choice.

Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport

Plate 1 — Cottonwood Creek exhibits poor waterfowl habitat. Note the steep banks and the lack of aquatic vegetation (Appendix Table 1, Station 27)

Plate 2 — This section of the Wiau River is a fertile, productive area for waterfowl (Appendix Table 1, Station 16)

Plate 3 This unnamed lake is typical of many deep northern lakes. Note the sedge border surrounded by black spruce. Ring-necked ducks and common loons often inhabit these waters (Appendix Table I, Station 33)

Plate 4 Number 5 Drain, north of Bonnyville is a productive area typical of many wetlands in the Transition Parklands Life Zone. Gently sloping shores provide a foothold for emergent plants such as the cattails and rushes pictured here.

TABLE 2. A check-list of birds occurring in the study area. (adapted from Salt and Wilk 1966)

NAME	DISTRIBUTION*			OCCURRENCE
Common Loon	N		B	common
Arctic Loon	N	S	M	scarce transient
Red-throated Loon	N	S	M	scarce transient
Red-necked (Holboell's) Grebe	N	S	B	common
Horned Grebe	N	S	B	common
Eared Grebe	N	S	B	fairly common
Western Grebe	N	S	B	fairly common – N scarce – S
Pied-billed Grebe	N	S	B	fairly common – N scarce – S
White Pelican	N	S	B	scarce
Double-crested Cormorant	N		B	scarce
Great Blue Heron	N	S	B	fairly common
American Bittern	N	S	B	common
Whistling Swan	N	S	M	fairly common
Canada Goose	N	S	M B	common fairly common
White-fronted Goose	N	S	M	fairly common
Snow Goose	N	S	M	common
Blue Goose	N	S	M	scarce transient
Ross' Goose	N	S	M	scarce
Mallard	N	S	B	common

NAME	DISTRIBUTION*			OCCURRENCE
Gadwall	N	S	B	scarce – N fairly common – S
Pintail	N	S	B	fairly common – N common – S
Green-winged Teal	N	S	B	common
Blue-winged Teal	N	S	B	common
American Widgeon	N	S	B	common
Shoveler	N	S	B	fairly common – N common – S
Redhead	N	S	B	fairly common – N scarce – S
Ring-necked Duck	N	S	B	scarce – N fairly common – S
Canvasback	N	S	B	scarce – N fairly common – S
Lesser Scaup	N	S	B	common
Common Goldeneye	N	S	B	common – N fairly common – S
Barrow's Goldeneye	N	S	M	scarce transient
Bufflehead	N	S	B	common – N fairly common – S
Oldsquaw	N	S	M	scarce
Harlequin Duck	N	S	B?	scarce transient
White-winged Scoter	N	S	B	common – N fairly common – S
Surf Scoter	N	S	M	scarce
Ruddy Duck	N	S	B	fairly common
Hooded Merganser		S	M	scarce
Common Merganser	N		B	fairly common

NAME	DISTRIBUTION*			OCCURRENCE
Red-breasted Merganser	N		B	fairly common
Turkey Vulture		S	B	scarce
Goshawk	N	S	R	fairly common
Sharp-shinned Hawk	N	S	B	scarce
Cooper's Hawk		S	B	scarce
Red-tailed Hawk	N	S	B	fairly common
Broad-winged Hawk		S	B	fairly common
Swainson's Hawk		S	B	common
Rough-legged Hawk	N	S	M	common
Golden Eagle	N		R	scarce
Bald Eagle	N		B	scarce
Marsh Hawk	N	S	B	scarce – N common – S
Osprey	N		B	scarce
Peregrine Falcon	N		B	?
Pigeon Hawk	N	S	B	scarce
Sparrow Hawk	N	S	B	fairly common – N common – S
Spruce Grouse	N		R	fairly common
Ruffed Grouse	N	S	R	fairly common
Willow Ptarmigan	N		W	fairly common
Sharp-tailed Grouse	N	S	R	fairly common
Ring-necked Pheasant		S	R	fairly common
Gray (Hungarian) Partridge		S	R	scarce
Whooping Crane	N	S	M	very scarce
Sandhill Crane	N	S	M	fairly common

NAME	DISTRIBUTION*	OCCURRENCE
Virginia Rail	S B	fairly common
Sora Rail	N S B	common
Yellow Rail	S B	scarce
American Coot	N S B	common
Semipalimated Plover	N S M	fairly common
Piping Plover	S B	scarce
Killdeer	N S B	fairly common – N common – S
American Golden Plover	N S M	fairly common
Black-bellied Plover	N S M	fairly common
Ruddy Turnstone	N S M	scarce
Common (Wilson's) Snipe	N S B	fairly common
Whimbrel	N S M	scarce
Upland Plover	N S B	scarce
Spotted Sandpiper	N S B	common
Solitary Sandpiper	N B	scarce
Willet	S B	scarce
Greater Yellowlegs	N B	scarce
Lesser Yellowlegs	N S B	common
Knot	N S M	scarce
Pectoral Sandpiper	N S M	common
White-rumped Sandpiper	N S M	scarce
Baird's Sandpiper	N S M	common
Least Sandpiper	N S M	common
Dunlin	N S M	scarce

NAME	DISTRIBUTION*	OCCURRENCE
Long-billed Dowitcher	N S M	common
Stilt Sandpiper	N S M	fairly common
Semipalmated Sandpiper	N S M	common
Buff-breasted Sandpiper	N S M	scarce
Marbled Godwit	S B	fairly common
Hudsonian Godwit	N S M	scarce
Sanderling	N S M	common
Red Phalarope	S M	scarce transient
Wilson's Phalarope	S B	fairly common
Northern Phalarope	N S M	common
Parasitic Jaeger	N S M	scarce wanderer
Long-tailed Jaeger	N S M	scarce wanderer
Glaucous-winged Gull	N S M	scarce wanderer
Herring Gull	N S M	scarce
California Gull	N S B	common
Ring-billed Gull	N S B	fairly common
Mew Gull	N S M	scarce
Franklin's Gull	N S B	common
Bonaparte's Gull	N S B	fairly common
Sabine's Gull	N S M	scarce wanderer
Forster's Tern	S B	scarce
Common Tern	N S B	scarce - N fairly common - S
Caspian Tern	N S M	scarce visitor
Black Tern	N S B	fairly common - N common - S

NAME	DISTRIBUTION*			OCCURRENCE
Domestic Pigeon (Rock Dove)	N	S	R	scarce – N common – S
Mourning Dove	N	S	B	scarce
Black-billed Cuckoo		S	B	scarce
Great Horned Owl	N	S	R	fairly common
Snowy Owl	N	S	W	irregular visitor
Hawk Owl	N		R	scarce
Barred Owl	N	S	R	scarce
Great Gray Owl	N		R	scarce
Long-eared Owl	N	S	B	scarce – N fairly common – S
Short-eared Owl	N	S	B	scarce – N fairly common – S
Boreal (Richardson's) Owl	N		R	scarce
Saw-whet Owl		S	R	fairly common
Common Nighthawk	N	S	B	fairly common
Ruby-throated Hummingbird	N	S	B	scarce – N fairly common – S
Belted Kingfisher	N	S	B	scarce
Yellow-shafted Flicker	N	S	B	common
Pileated Woodpecker	N	S	R	scarce
Yellow-bellied Sapsucker	N	S	B	fairly common
Hairy Woodpecker	N	S	R	fairly common
Downey Woodpecker	N	S	R	scarce
Black-backed Three-toed Woodpecker	N		R	scarce
Northern Three-toed Woodpecker	N		R	scarce

NAME	DISTRIBUTION*	OCCURRENCE
Eastern Kingbird	N S B	common
Eastern Phoebe	N S B	fairly common
Say's Phoebe	S B	scarce
Yellow-bellied Flycatcher	N S B	fairly common - N scarce - S
Traill's (Alder) Flycatcher	N S B	fairly common
Least Flycatcher	N S B	common
Western Wood Pewee	N S B	fairly common
Olive-sided Flycatcher	N B	fairly common
Hoyt's Horned Lark	N S M	fairly common
Tree Swallow	N S B	fairly common - N common - S
Violet-green Swallow	S B	scarce
Bank Swallow	N S B	fairly common
Barn Swallow	N S B	scarce - N fairly common - S
Cliff Swallow	N S B	fairly common
Purple Martin	N S B	scarce - N common - S
Gray (Canada) Jay	N S R	common - N scarce - S
Blue Jay	N S R	fairly common
Black-billed Magpie	N S R	scarce - N common - S
Common Raven	N R	fairly common
Common Crow	N S B	fairly common - N common - S

NAME	DISTRIBUTION*	OCCURRENCE
Black-capped Chickadee	N S R	fairly common
Mountain Chickadee	S W	scarce wanderer
Boreal Chickadee	N S R	fairly common – N scarce – S
White-breasted Nuthatch	S R	scarce
Red-breasted Nuthatch	N S B	fairly common
Brown Creeper	S R	scarce
House Wren	N S B	fairly common – N common – S
Winter Wren	N B	scarce
Long-billed Marsh Wren	N S B	fairly common
Short-billed Marsh Wren	S B	rare straggler
Catbird	S B	fairly common
Brown Thrasher	S B	scarce
Robin	N S B	fairly common – N common – S
Varied Thrush	S B	scarce
Hermit Thrush	N S B	common – N scarce – S
Swainson's Thrush	N S B	common – N scarce – S
Gray-cheeked Thrush	N S M	fairly common
Veery	S B	fairly common
Mountain Bluebird	N S B	scarce – N fairly common – S
Eastern Bluebird	S B	scarce
Townsend's Solitaire	S M	scarce

NAME	DISTRIBUTION*	OCCURRENCE
Golden-crowned Kinglet	N S W	scarce
Ruby-crowned Kinglet	N S B	fairly common - N scarce - S
Water (American) Pipit	N S M	common
Sprague's Pipit	N S B	scarce
Bohemian Waxwing	N B S W	fairly common - N/S
Cedar Waxwing	N S B	scarce - N common - S
Northern Shrike	N S M	fairly common
Loggerhead Shrike	S B	fairly common
Starling	N S B	scarce - N fairly common - S
Solitary Vireo	N S B	scarce
Red-eyed Vireo	N S B	common
Philadelphia Vireo	N S B	fairly common
Warbling Vireo	N S B	fairly common
Black and White Warbler	N S B	fairly common
Tennessee Warbler	N S B	common
Orange-crowned Warbler	N S B	scarce
Yellow Warbler	N S B	fairly common - N common - S
Magnolia Warbler	N S B	scarce
Cape May Warbler	N B	scarce
Black-throated Blue Warbler	S B	status unknown
Myrtle Warbler	N S B	common
Audubon's Warbler	S M	scarce wanderer

NAME	DISTRIBUTION*			OCCURRENCE
Black-throated Green Warbler	N		B	scarce
Blackburnian Warbler		S	B	scarce
Bay-breasted Warbler	N		B	scarce
Blackpoll Warbler	N		B	scarce
Pine Warbler	N		B	scarce
Palm Warbler	N		B	scarce
Ovenbird	N	S	B	fairly common
Northern Waterthrush	N		B	fairly common
Connecticut Warbler	N	S	B	fairly common
Mourning Warbler	N	S	B	fairly common
Yellowthroat	N	S	B	fairly common – N common – S
Wilson's Warbler	N		B	fairly common
Canada Warbler	N		B	scarce
American Redstart	N	S	B	fairly common – N common – S
English (House) Sparrow	N	S	R	scarce – N common – S
Bobolink		S	B	scarce
Western Meadowlark		S	B	fairly common
Yellow-headed Blackbird	N	S	B	scarce – N fairly common – S
Redwinged Blackbird	N	S	B	common
Baltimore Oriole	N	S	B	scarce – N common – S
Rusty Blackbird	N	S	B	fairly common
Brewer's Blackbird	N	S	B	scarce – N common – S

NAME	DISTRIBUTION*	OCCURRENCE
Common Grackle	N S B	fairly common
Brown-headed Cowbird	N S B	scarce – N common – S
Western Tanager	N S B	fairly common – N scarce – S
Rose-breasted Grosbeak	N S B	fairly common
Evening Grosbeak	S W N B	scarce – N fairly common – S
Purple Finch	N S B	fairly common
Pine Grosbeak	N S W	fairly common
Gray-crowned Rosy Finch	S W	scarce wanderer
Hoary Redpoll	N S W	fairly common
Common Redpoll	N S W	common
Pine Siskin	N S B	scarce – N fairly common – S
American Goldfinch	N S B	scarce – N fairly common – S
Red Crossbill	N S R	scarce
White-winged Crossbill	N S R	fairly common
Savannah Sparrow	N S B	common
Leconte's Sparrow	N S B	fairly common
Nelson's (Sharp-tailed) Sparrow	N S B	scarce
Vesper Sparrow	N S B	fairly common
Slate-coloured Junco	N S B	common
Oregon Junco	S M	scarce wanderer
Tree Sparrow	N S M	common
Chipping Sparrow	N S B	fairly common – N common – S

NAME	DISTRIBUTION*	OCCURRENCE
Clay-coloured Sparrow	N S B	fairly common
Harris' Sparrow	N S M	fairly common
White-crowned Sparrow	N S M	fairly common
White-throated Sparrow	N S B	common
Fox Sparrow	N S B	scarce
Lincoln's Sparrow	N S B	fairly common
Swamp Sparrow	N S B	fairly common
Song Sparrow	N S B	fairly common - N common - S
McCowan's Longspur	S B	scarce wanderer
Lapland Longspur	N S M	common
Smith's Longspur	N S M	scarce
Snow Bunting	N M S W	common - N/S

*	N	northern 2/3 of study area - Canadian Life Zone (Fig. 2)
	S	southern 1/3 of study area - Transition Parklands Life Zone
	B	resident during breeding season
	W	winter resident
	R	year-round resident
	M	migrates through study area

DISTRIBUTION OF MAMMALS

A list of the sixty species and subspecies of mammals occurring in the study area is included as Table 3. Fifty percent of the mammals occur regularly, although only 28% can be found throughout the study area. Of the remaining 50% which occur sporadically, 28% of these are found only in the Canadian Life Zone. The ranges of four of these mammals are included to show the former and present (1959) distribution in Alberta (Figs. 5,6,8,9). The grizzly bear, wapiti (elk) and woodland caribou, in particular, occupy only remnants of their former ranges. Destruction of habitat and other forms of human interference are generally cited as the reasons for their dwindling numbers.

The Alberta Department of Lands and Forests will be conducting a survey of ungulates in the study area to determine the winter ranges and numbers of animals utilizing these areas. Their report, however, will not be available before May, 1974. Until then, the distribution of these mammals as illustrated in Figures 6,7,8, and 9 should be used for reference.

The status of fur-bearing mammals in the study area is not known in any detail. A summary of the 1972/73 trap returns is being compiled and will be presented in a later volume. The distribution of traplines and trapline boundaries is included in this paper (Fig. 10).

TABLE 3 A check-list of mammals occurring in the study area. (adapted from Soper 1964)

NAME	DISTRIBUTION *	OCCURRENCE
Common Cinereous Shrew	N	regular
Hayden Cinereous Shrew	S	regular
American Saddle-backed Shrew	N S	regular
Dusky Mountain Shrew	N	sporadic
American Water Shrew	N S	regular
Northern Pigmy Shrew	N	sporadic
Little Brown Bat	N S	regular
Silver-haired Bat	N S	regular
Pale Big Brown Bat	N S	regular
Hoary Bat	N S	sporadic
White-tailed Prairie Hare	S	sporadic
American Varying Hare	N S	regular
Canada Woodchuck	N S	regular
Richardson Ground Squirrel	S	regular
Striped Ground Squirrel	S	regular
Franklin Ground Squirrel	S	regular
Little Northern Chipmunk	N S	regular
Mackenzie Red Squirrel	N S	regular
Hudson Bay Flying Squirrel	N S	sporadic
Richardson Pocket Gopher	S	sporadic
Canada Beaver	N S	regular
Boreal White-footed Mouse	N S	regular

NAME	DISTRIBUTION *			OCCURRENCE
Richardson Lemming Vole	N			sporadic
Athabasca Red-backed Vole	N	S		regular
Prairie Phenacomys Vole		S		sporadic
Mackenzie Phenacomys Vole	N			sporadic
Drummond Meadow Vole	N	S		regular
Chestnut-cheeked Vole	N			sporadic
Little Upland Vole		S		sporadic
Northwestern Muskrat	N	S		regular
House Rat		S		sporadic
House Mouse		S		regular
Hudson Bay Jumping Mouse	N	S		sporadic
Saskatchewan Jumping Mouse		S		sporadic
Alaska Porcupine	N			sporadic
Prairie Coyote		S		sporadic
Northwestern Coyote	N	S		regular - N sporadic - S
Northern Timber Wolf	N			regular
Saskatchewan Timber Wolf	N			sporadic
Northern Plains Red Fox		S		regular
British Columbia Red Fox	N			sporadic
American Black Bear	N	S	(Fig. 4)	regular - N sporadic - S
Emperor Grizzly	N		(Fig. 5)	sporadic
Hudson Bay Marten	N			sporadic
Alaska Marten	N			sporadic
British Columbia Fisher	N			sporadic
Richardson Weasel	N	S		regular

NAME	DISTRIBUTION *			OCCURRENCE
Least Weasel	N	S		sporadic
Prairie Long-tailed Weasel		S		regular
Hundson Bay Mink	N			regular
American Wolverine	N			sporadic
American Badger		S		sporadic
Northern Plains Skunk	N	S		regular
Mackenzie Otter	N			sporadic
Canada Lynx	N			sporadic
Manitoba Wapiti	N		(Fig. 6)	sporadic
Rocky Mountain Mule Deer	N	S		regular
Dakota White-tailed Deer	N	S	(Fig. 7)	sporadic
Northwestern Moose	N		(Fig. 8)	regular
Western Woodland Caribou	N		(Fig. 9)	sporadic

* N northern 2/3 of study area - Canadian Life Zone (Fig. 2)

S southern 1/3 of study area - Transition Parklands Life Zone

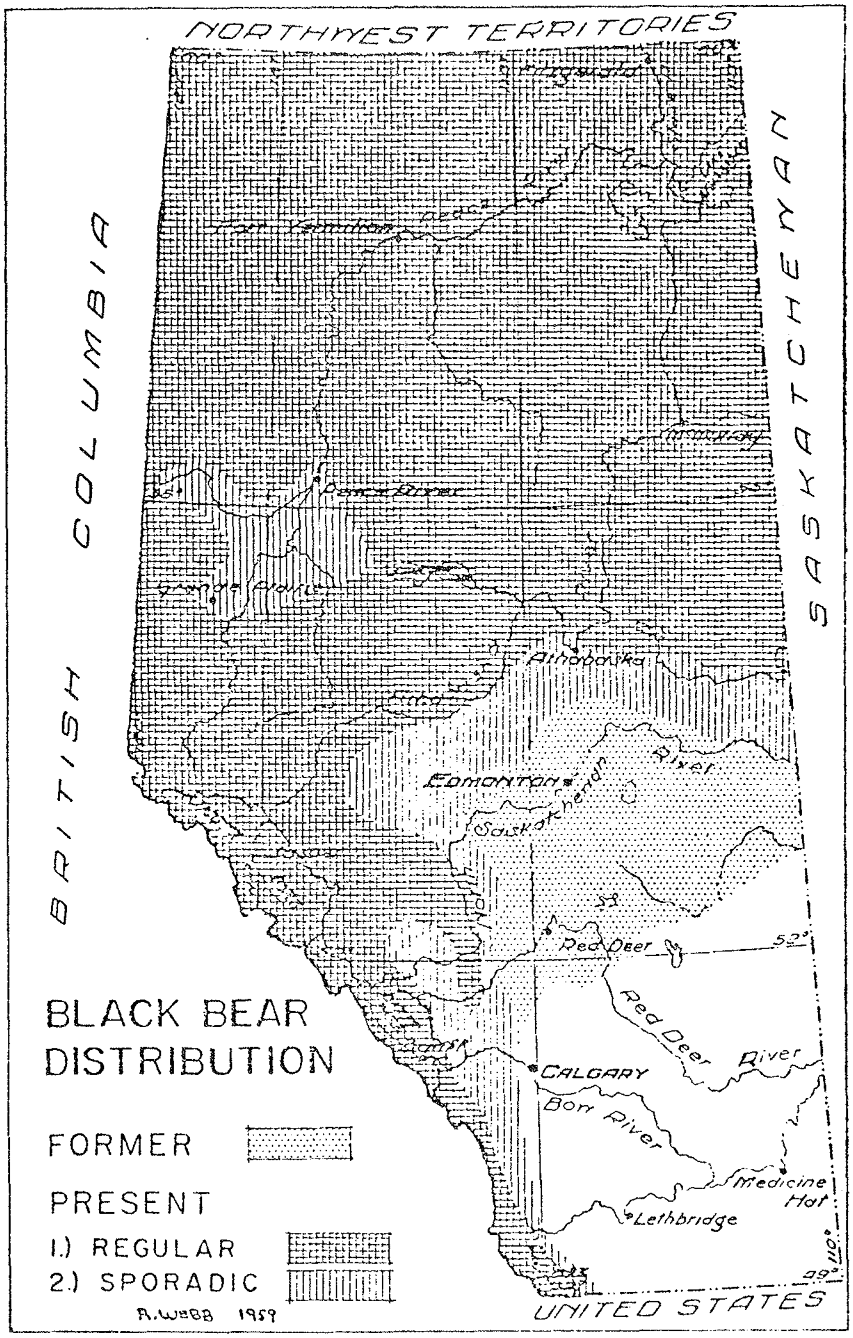
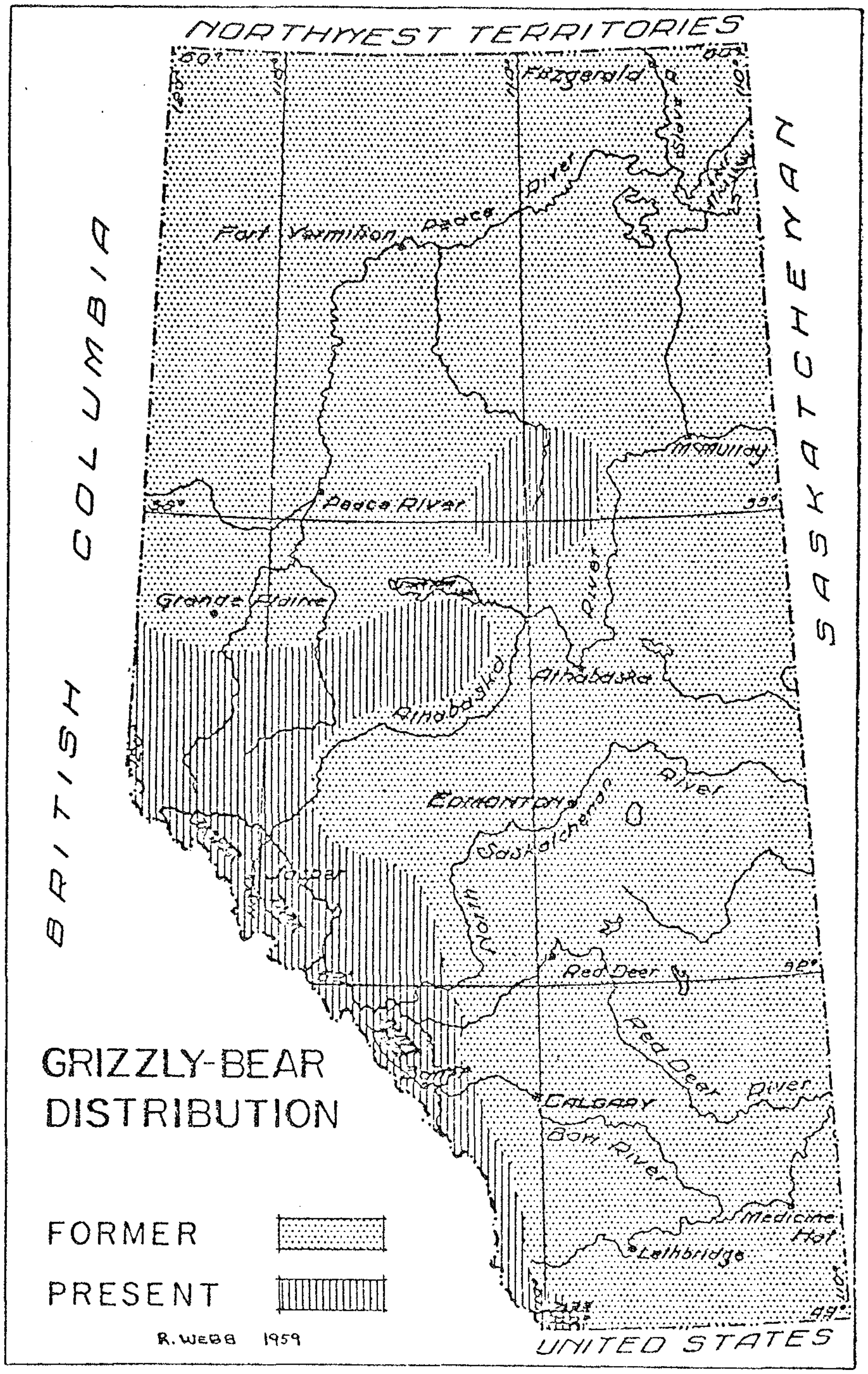
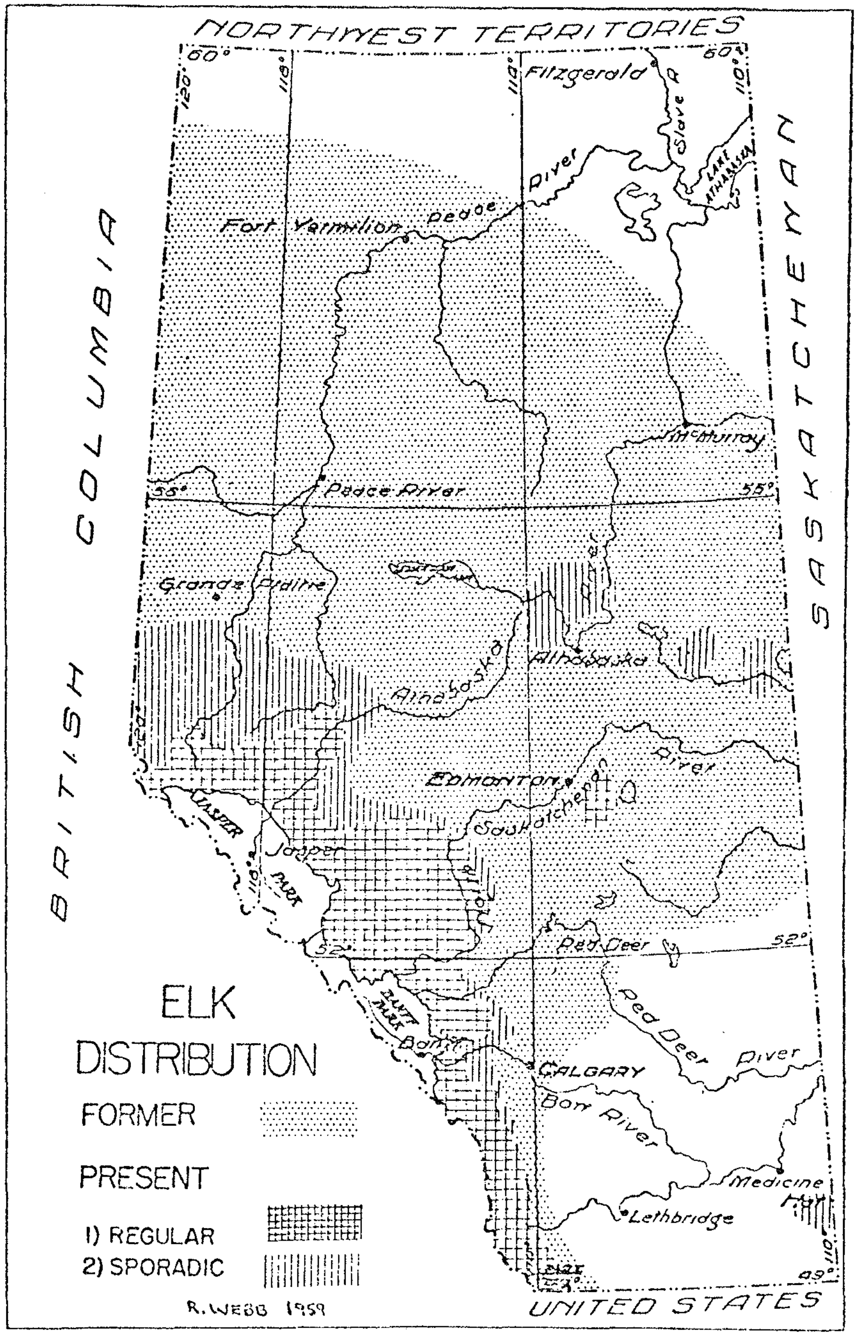


Figure 4. Distribution of the black bear in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



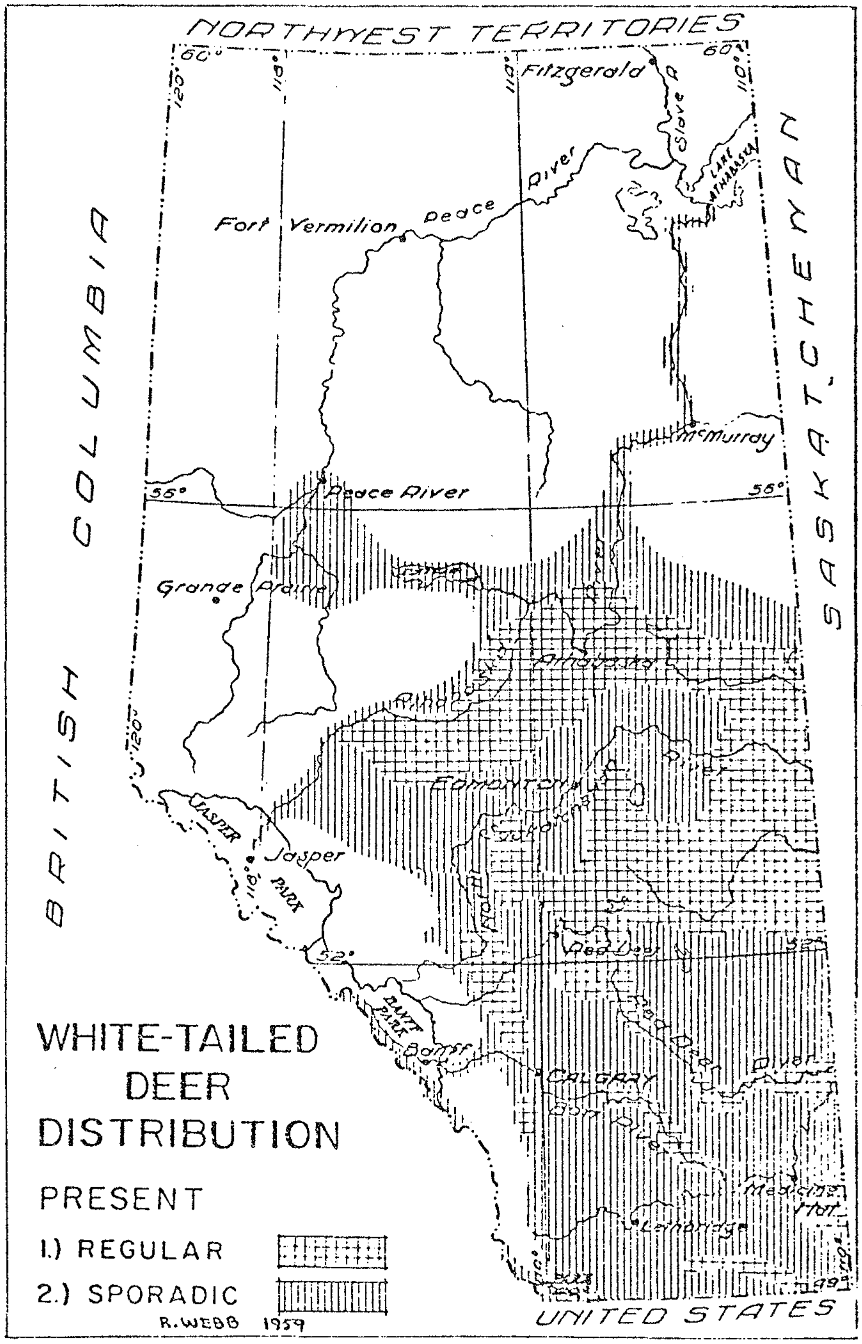
ALBERTA FISH AND WILDLIFE DIVISION

Figure 5. Distribution of the grizzly bear in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



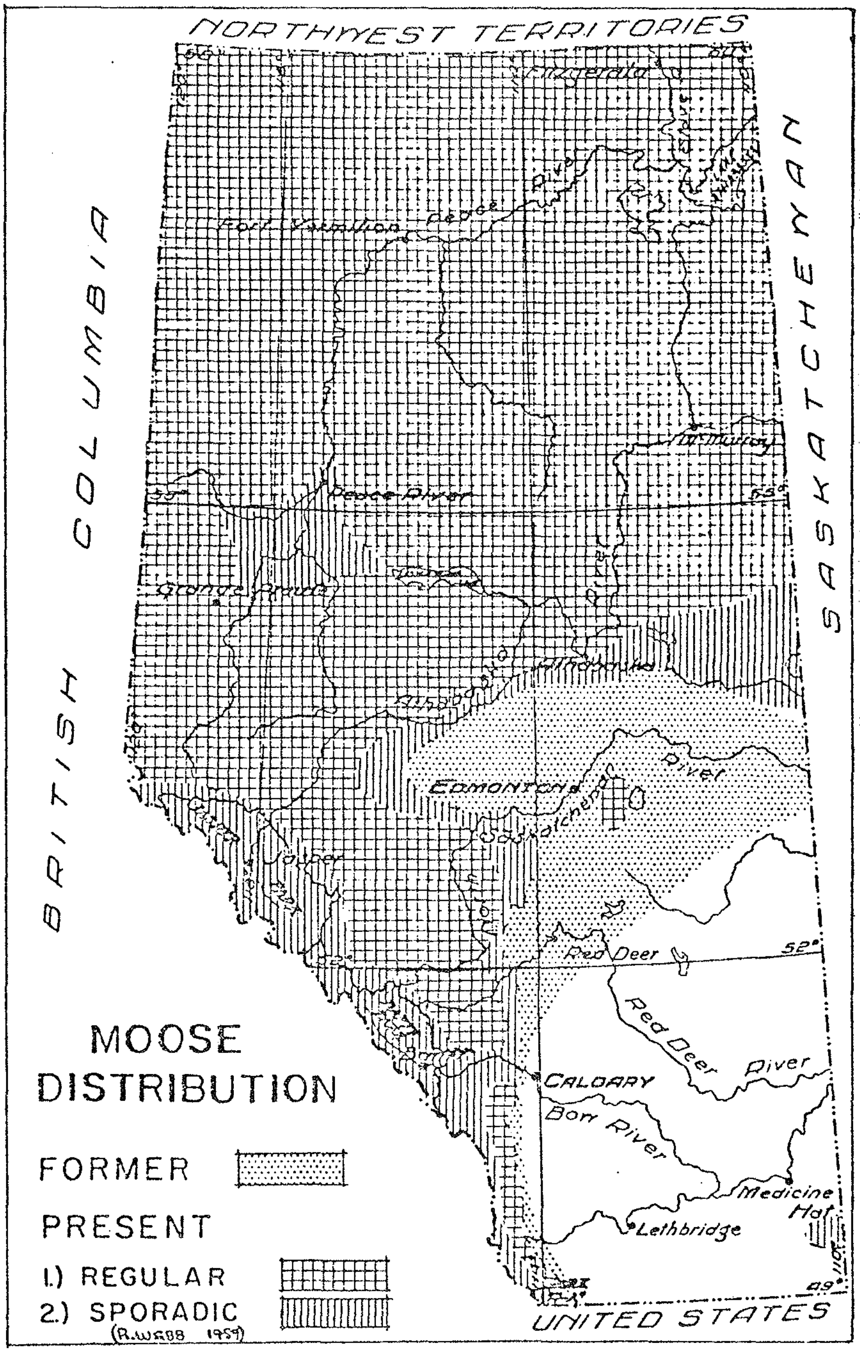
Alberta Fish and Wildlife Division

Figure 6. Distribution of elk (wapiti) in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



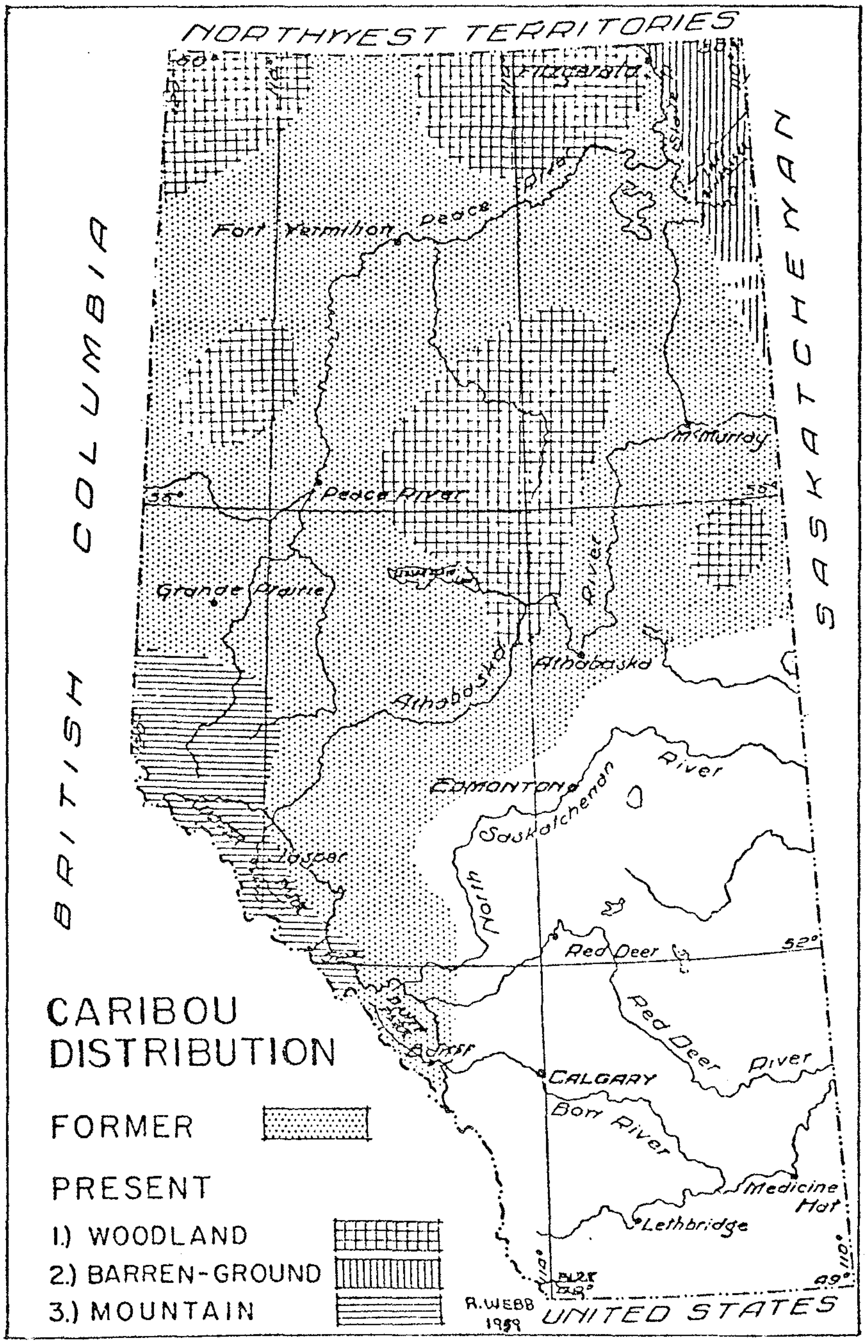
Alberta Fish and Wildlife Division

Figure 7. Distribution of white-tailed deer in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



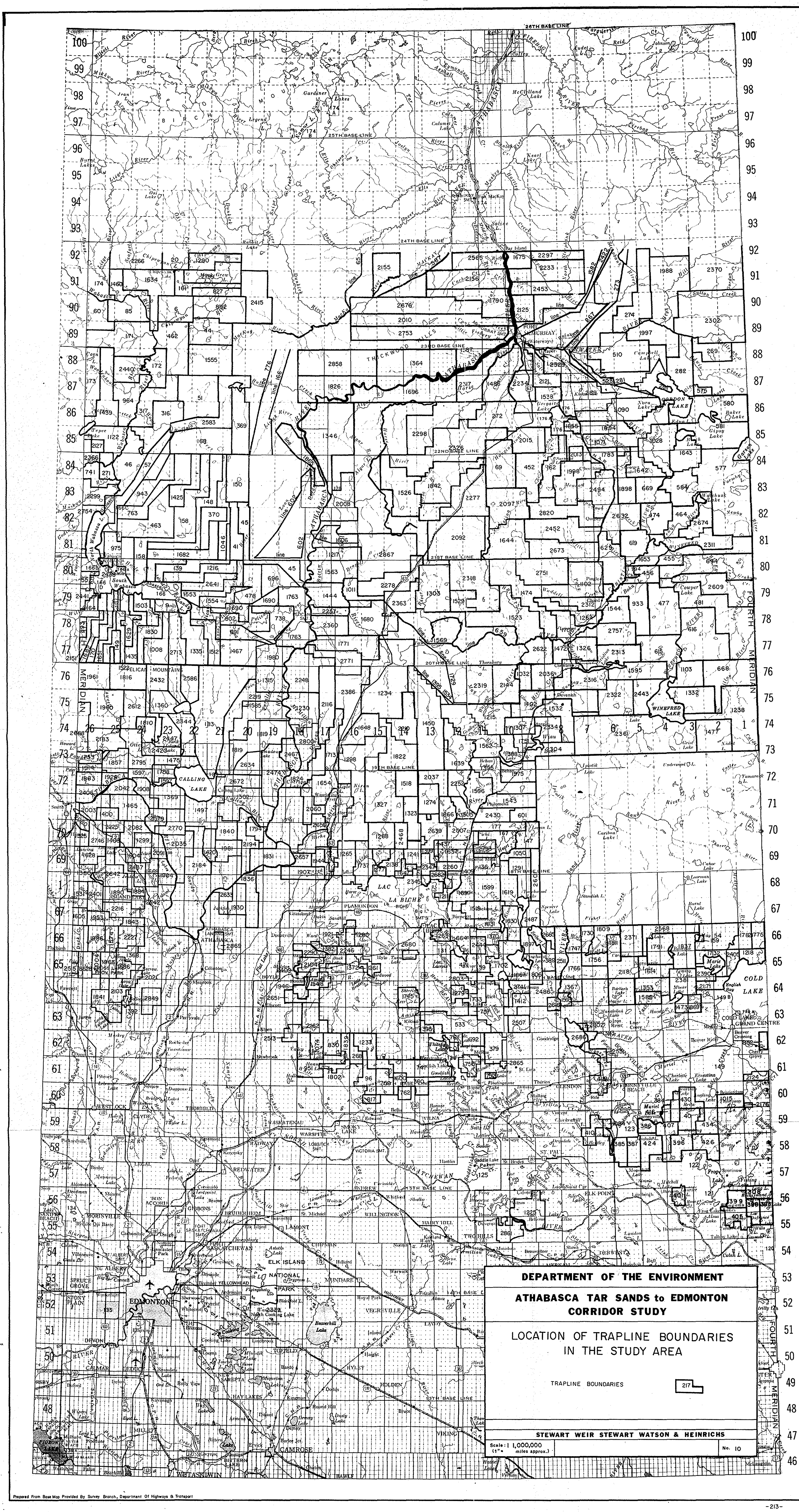
Alberta Fish and Wildlife Division

Figure 8. Distribution of moose in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



Alberta Fish and Wildlife Division

Figure 9. Distribution of caribou in Alberta. (Alberta Fish and Wildlife Division, in Soper 1964)



Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport

APPENDIX

Field notes: Lac la Biche to Fort McMurray to Atmore, May 29-30, 1973.
(Ducks Unlimited, Canada)

Table I Field notes: Lac la Biche to Fort McMurray via N.A.R., May 29, 1973. (Ducks Unlimited, Canada)

Station (Fig. 3)	Remarks
1	Birkland L. - poor waterfowl habitat woodchuck killdeer red-tailed hawk white-winged scoter
2	Claude L. - poor waterfowl habitat lesser scaup
3	Wet area S.E. of Claude L. blue-winged teal American widgeon mallard
4	Wet area near Barnegat - poor waterfowl habitat - cattail border American coot white-winged scoter American widgeon
5	South of Square L. - poor habitat American widgeon American coot
6	Pond - cattail/sedge border- no ducks
7	Brewer's blackbird marsh hawk yellow-shafted flicker
8	Sedge/bog/stream habitat blue-winged teal

Station	Remarks
9	Sedge/lily pads/stream habitat ring-necked duck lesser scaup mare and foal
10	<u>Piche R.</u> no birds/mammals observed
11	<u>Small lake</u> 8 pr. ring-necked ducks 1 pr. buffleheads
12	<u>Stream</u> barnswallows slate-coloured junco robin great-horned owl
13	Caribou crossing area - observed by operator of "Speeder" in spring
14	<u>N. of Clyde R.</u> - lily pads/sedge ring-necked duck
15	<u>Clyde L.</u> - sedge border - poor waterfowl habitat beaver lodge
16	<u>Wiau R.</u> - good waterfowl habitat: submerged/emergent vegetation - lily pads, duckweed, sedges, cattails, mare's tail, clasping leaf 1 pr. blue-winged teal 1 pr. ring-necked ducks mallard (male) bufflehead (female) red-winged blackbirds unidentified sandpiper

Station	Remarks
17	Glover L. - bog, treed shoreline, some sandy bottom no birds/mammals observed.
18	Edwards L. - deep 22 pr. lesser scaup
19	Birch Creek - sandy bottom, steep banks, no aquatic vegetation - poor waterfowl habitat no birds/mammals observed
20	Jackfish R. 1 pr. common mergansers
21	Christina R. - poor habitat mourning dove
22	Wadell Creek golden-crowned kinglet white-throated sparrow unidentified vireo
23	Pony Creek no birds/mammals observed
24	Stream - sedge border - fair habitat 1 pr. green-winged teal beaver dam
25	Stream - sedge border - fair habitat no birds/mammals observed
26	Beaver dam red fox tree swallow

Station	Remarks
27	Cottonwood Creek no birds/mammals observed - met a trapper who earned $4000 last year trapping part-time: fox, wolf, weasel, lynx, squirrel.
27-28	black bear
28	Unnamed L. - small - sedge border no birds/mammals observed
29	Small pond 1 pr. ring-necked ducks
30	Pond - shallow, sedge border 8 pr. mallards 6 pr. blue-winged teal 2 pr. green-winged teal 5 pr. lesser scaup 1 pr. bufflehead
31	Robert Creek - steep banks - poor waterfowl habitat
32	Small pond - sedge border ring-necked ducks
33	Unnamed L. - small - lily pads, sedge border, black spruce to sedge common loon
34	Gregoire R. - steep banks - poor waterfowl habitat
35	Saprae Creek - steep banks - poor waterfowl habitat Canada jay

Station	Remarks
36	Clearwater R. no birds/mammals observed

Table 2 — Field notes: Fort McMurray to Atmore via Highway 63, May 30, 1973 (Ducks Unlimited, Canada)

Station (Fig. 3)	Remarks
37	Dugout beside highway - cattail border mallard (male) sparrow hawk
38	Beaver dam - flooded trees, sedge border no birds/mammals observed
39	Dugout no birds/mammals observed
40	Dugout no birds/mammals observed
41	Flooded area - fair waterfowl habitat - flat; flooded sedges to poplars no birds/mammals observed
42	Beaver dam no birds/mammals observed
43	Flooded area - shallow - flooded sedges - fair waterfowl habitat 1 pr., 1 male ring-necked ducks 1 pr. American widgeons
44	Dugout no birds/mammals observed
45	Dugout 3 pr. mallards 4 American widgeons (male) 10 mallards (male)
46-52	Dugouts no birds/mammals observed

Station	Remarks
53	Dugout I pr. lesser scaup
54	Dugout I pr. mallards 2 pr., I male ring-necked ducks
55	Unnamed L. - black spruce to sedge border no birds/mammals observed
56	Dugout no birds/mammals observed
57	Marianna L. - sandy bottom, sedge border, horsetails no birds/mammals observed
58	Dugout I pr. ring-necked ducks
59	Dugout no birds/mammals observed
60	Lyle L. - sedge/sparse willow no birds/mammals observed
61	Lemiseau L. - flooded sedges and cattails; some loafing areas on open uplands - good waterfowl production area many divers/dabblers
62	Old Oxbow - good marsh - cattails, duckweed I pr., I male mallards

Station	Remarks
63	<u>Dugout</u> 2 mallards (male)
64	<u>Dugout</u> a few mallards
65	<u>Charron L.</u> - important production and staging area for waterfowl; -good interspersion of sedge/cattail cover and water numerous dabblers/divers
66	<u>Small pond</u> - flooded willows and cattails - very good waterfowl habitat lesser scaup ring-necked ducks bufflehead shoveler gadwall ruddy duck American widgeon mallard (flocks of 25-30 males) pintail (15 males)

REFERENCES

Bird, C. D. and R. D. Bird. 1967. The aspen parkland. In Alberta – A Natural History. (W. G. Hardy, ed.). Hurtig, Edmonton. 343 pp.

Hrapko, J. D., H. C. Smith and D. A. E. Spalding. 1971. Moose in the Swan Hills. Provincial Museum and Archives of Alberta Notes No. 6. 3 pp.

La Roi, G. H. 1967. The boreal forest. In Alberta – A Natural History. (W. G. Hardy, ed.). Hurtig, Edmonton. 343 pp.

Oeming, A. F. 1957. Turkey vultures nesting in northern Alberta. Can. Field Nat. 71:152.

Salt, W. R. and A. L. Wilk. 1966. The birds of Alberta (second ed., revised). Department of Industry and Development, Edmonton. 511 pp.

Soper, J. D. 1964. The mammals of Alberta. Department of Industry and Development, Edmonton. 402 pp.

Vermeer, K. 1969a. Colonies of double-crested cormorants and white pelicans in Alberta. Can. Field Nat. 83:36-39.

_____1969b. Great blue heron colonies in Alberta. Can. Field Nat. 83:237-242.

Wonders, W. C. et al (eds.). 1969. Atlas of Alberta. Government of Alberta and the University of Alberta. 162 pp.

TRANSPORTATION CORRIDOR STUDY

FORT McMURRAY to EDMONTON

CHAPTER IV

PRELIMINARY REVIEW AND LAND EVALUATION

Prepared for:

Alberta
Environment
The Honorable
William Yurko

By:

Siemens Realty and
Appraisal Services Ltd.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

INTRODUCTION AND BACKGROUND

Canada's energy requirements are the subject of discussion, rhetoric and extensive study at all levels of government and throughout the energy providing, transporting and using industries. The ultimate consumer, a variety of organizations and others, often called special interest groups, show more interest and are being accommodated by governments and industry as never before in our history, thus it is necessary that a practical approach to transportation requirements be as comprehensive and detailed as possible.

Since land, including all that that term encompasses, has long been considered as the basis of a country's real wealth, not only in monetary terms, it is essential to study possible solutions to problems of energy production, transportation and consumption in the context of preservation, at least, and possible enhancement of that land wealth.

Western Canada, and in particular Alberta, is extremely well off in terms of energy resources, land wealth and in respect of their stages of development. Alberta can take time seriously to look at developments in more settled and developed areas of Canada and other countries in order to gain the benefit of experience and studies and thereby profit from those apparent errors which are the concomitants of most human activity, no matter how well intentioned.

Alberta has a very large source of energy in the Athabasca tar sands which, although known about since the early 1700's, have not been successfully developed till fairly recently in spite of repeated attempts over the last fifty years or more. Estimates of in situ and recoverable reserves show variations but there are at least several hundreds of billions of barrels which may ultimately be recoverable.

As energy demands and prices increase, sources previously considered uneconomic become useful to exploit in order to maintain and enhance our standards of living. Alberta conventional oil production has recently changed from being in excess of market demand to the reverse situation. The result is increased conventional exploration and further enhanced recovery of existing sources. While costs also have escalated the increasing feasibility of tar sands synthetic (unconventional) production is apparent from the Athabasca and other fields, dependent, of course, on suitable royalty and other agreements.

Governmental and industry sources currently expect major developments in the Athabasca and other fields with accompanying requirements of expanded services for extraction, construction and transportation. While it may be merely stating the obvious, all of these activities require land usage, but the effects of timing and the scope of such activities are far from being so. The inter-action of social and economic forces has profound effects on our land wealth from many points of view, not the least of which, by any standard, is the frequently ignored owner of the land and those who negotiate with him.

Engineering considerations apart, to some extent, the major transportation corridor concerns, from the point of view of our part in the study, are:

1. The timing of facilities.
2. The nature of such facilities.
3. The compatability of different types of facilities with one another.
4. The ownership of a combined facilities right-of-way and the resultant extra costs and savings.

5. The advisability of such a corridor.

6. The descriptions of the areas necessary to be traversed (A–E), possible routes and existing facilities.

7. Purchase methods and land owner dealings.

In any discussion of land usage and the effects of change upon that usage, it is necessary seriously to consider the items listed above and the following pages are devoted to discussion of them in the order shown.

I. Timing of Facilities Needs:

Requirements for facilities, dictated primarily by economic and technological factors such as market price and demand for, in this case, energy, the state of extraction technology, compatability in dealings (primarily with government) and supplies of energy and transportation to the extraction facilities and neighboring communities, will require time to resolve.

Various projections indicate that plants (after the Great Canadian Oil Sands existing structures) may be constructed every two to three years commencing in all probability after 1974 to, say, eight in number. Whether of not each will require its own pipeline is a subject of current debate. Great Canadian Oil Sands Ltd. (GCOS) now has a 16 inch, 58,000 barrel per day pipeline from Fort McMurray to Edmonton (initially used to ship gasoline from Edmonton to Fort McMurray) accompanied in the same right-of-way by the Albersun Gas pipeline in the north half of its length to supply natural gas to the Fort McMurray area.

Obviously, with the planning by Syncrude of a 125,000 barrel per day production, a new pipeline will be required by 1976 or so if their plans go ahead.

Whether or not Syncrude does go ahead as planned, it is likely that economic forces will dictate at least two new pipelines of large diameter within the next ten years. Any right-of-way planning, therefore, should take these into account along with possibilities for other systems.

2. The Nature of Such Facilities:

There is current thinking that extra power line transmission facilities will be required and there is a good possibility that the transmission line will originate in the Edmonton area. Should the line originate in the Mitsue area it could well be that the right-of-way would be located in near proximity to the highway north from Atmore through the wilderness area to Fort McMurray.

Highway and railway rights-of-way are already well established from Edmonton to Fort McMurray and should be carefully considered in connection with any new facilities, not only from the viewpoints of construction and maintenance access, but also on the basis of most effective land use. The viewpoint is held that an already disturbed ecosystem is preferable for further disturbance than new disturbance of another (Dr. B. Willard, American Right-of-Way Association Phoenix Conference, May 14, 1973 - reported in Right-of-Way Magazine, August, 1973).

3. Compatability of Various Facilities:

One author writing on this subject has put it that misinformation may be harder to overcome than lack of information.

There are many examples of pipelines co-existing in the same right-of-way but most commonly these are owned by the same company or the owning companies are commonly controlled, e.g. GCOS oil pipeline in the same right-of-way as the Albersun gas pipeline. In crossings of pipe, the common requirement is that they be one foot apart. Where they are laid parallel with one another their distance apart is based upon technological considerations primarily having to do with corrosion with the cathodic type being commonly employed.

Where soil conditions are a problem, especially true of acidic soils, the main problem is protection from corrosion with the cathodic type being commonly employed.

Corrosion problems are also the main difficulties to be overcome in siting high voltage electric power transmission lines in common rights-of-way with pipelines, accentuated in the case of direct current lines. There are a sufficient number of examples of these problems having been overcome, however, as to make them essentially a function of cost and design.

The major problems, other than cost, concern liability amongst the parties in the right-of-way and those resulting from external causes. While design may overcome the most probable dangers to other pipeline and power lines inherent in possible pipeline explosions, the settling of liability responsibility, especially as newer facilities come into an existing occupied right-of-way, can be of great complexity and hard to establish.

An illustrative situation was described in the American Right-of-Way Association Multiple Right-of-Way Use conference in Phoenix last May. In the situation as described a power line was to be brought on to an existing gas pipeline right-of-way. The gas pipeline company provided the power line officials, contractors and all others concerned with as-built drawings of the exact location of the pipeline within the right-of-way. In addition the ditch line of the pipeline was staked. A bulldozer operator, while clearing some brush from the right-of-way, struck the pipe and was killed in the resulting explosion. His estate sued the gas pipeline company and recovered something over $200,000.00 which, on appeal by the pipeline company, was raised by some $55,000.00.

4. <u>Ownership and Control of Combined Facilities of Right-of-Way</u>:

Allied to the question of liability, discussed above, is that of ownership.

Problems occur with government ownership as exemplified by the situation in Great Britain where, as one writer puts it, conflicts between the National Electrical Board and the Natural Gas Board are more difficult to resolve than when the private owners were dealing with these matters, due to the vested interests of the government Boards. One can infer that there was a lack of economic forces to drive them together.

It might well be worth considering a special act of the Province of Alberta setting up something like the Alberta Gas trunk Line situation with the difference being that facilities would actually be owned by the individual company.

The Alberta Transportation Corridor Company, for want of a better descriptive name, would initially acquire the corridor land in fee simple. Where some of the corridor contained existing facilities, other than those owned by Government which are provided for the public use (which includes industry) the possessor of the right-of-way rights would be paid for them along with land owners and others' interests.

The Corridor Company, on acquisition of a right-of-way containing existing facilities, would simultaneously sell back to the existing company a strip of land containing the physical structure. New facilities coming into the right-of-way would purchase a narrow strip of land of width sufficient only to contain their facilities such that, in both cases, there would be land against which to register the necessary financing instruments. Necessary working room rights in the corridor would be provided to the facilities' owners. Administration, taxes and other costs would be borne out of government funding initially with later division being made on the proportion of corridor occupation (width and length) owned by the various facilities including their proportionate and/or fractional entitlement to working room rights.

The Board of Directors would, in this concept, be comprised of government members from essential departments such as Mines and Minerals, Telephones and Utilities, Environment, Municipal Affairs, Lands and Forests, Agriculture, Regional Planning Commissions, Counties, Municipal Districts and Improvement Districts, with each bearing their own expenses. Facilities owners each would have members on the Board, at their own expense and the vote would be split such that all government members, from whatever level, and all industry members would cumulatively, have exactly equal votes. If there was a deadlock between the government and the industry members it would have to be resolved before anything could be done. Such a combination of the vested interests of government and industry would prevent each from over riding the other.

Such an organization, while complex, can surely be made more simple than many current business and governmental combinations. It would, however, provide for the essentials of ownership of land on which or in which facilities were situated, as is necessary for financing purposes. Additionally, there would be effective management of the total corridor lands from the technological, economic and social (includes environmental) points of view. With right-of-way costs reaching ever higher proportions of total facilities expense, it is possible that there might even be savings over and above the extra design and construction costs inherent in a corridor concept. Certainly right-of-way management costs should be reduced as against those for individual rights-of-way for each facility.

5. Corridor Advisability - Right-of-Way Width:

From the points of view of land use, environmental and otherwise, most indications and studies favor the corridor concept. There are some areas where such is not feasible and some consider that it is esthetically displeasing in wilderness areas whereas others, more concerned about forest preservation and ecosystem disturbance, advocate corridors as being preferred over a multitude of single rights-of-way.

From an economic viewpoint corridors seem eminently desirable when the beginning and end points are roughly similar and terrain difficulties do not preclude co-existence of the various facilities.

In the subject instance, where the movement of people, goods and energy sources between Edmonton and Fort McMurray is the main point, there seems little doubt about the advisability of the corridor concept providing insurmountable engineering difficulties are not encountered. From the current literature it seems that these difficulties are relatively easily solvable although possibly very costly if, for instance, direct current high voltage transmission lines are included.

Total corricor right-of-way width would be determined as a function of facilities compatability (costs of putting close together) and their numbers and type. Ontario Hydro, for instance, has a 400 foot right-of-way in the Metro-Toronto area which is none too wide. Possibly 500 feet would not be too much to consider for our current purposes, i.e. 60.6 acres per mile or roughly 9.5% of each section of land crossed in a north-south or east-west direction.

In the immediate Edmonton area the expense of land and relocation factors versus the costs of compatibility in close proximity would likely be the major width determining factors if environmental concerns (e.g. creek and shallow valley crossings, etc.), can be reconciled.

6. <u>Area Description (A-E), Possible Routes and Existing Facilities</u>:

Other reports in our consortium group include a detailed description of the land character, rivers and streams and climate of the Edmonton - Fort McMurray area.

Generally speaking, however, the area between Edmonton and Fort McMurray can usefully be divided into five separate areas:

A. Industrial-residential area in the immediate environs of Edmonton.

B. Transitional agricultural area, from, say, Highway 55 to the North Saskatchewan River east of Fort Saskatchewan.

C. Agricultural area from the North Saskatchewan River north to the Lac La Biche region.

D. Wilderness area from C to the environs of Fort McMurray.

E. Immediate Fort McMurray area.

In the Addenda hereto is the map which includes the five areas. Some existing facilities such as highways, railways, power transmission lines and the GCOS and Albersun pipelines are shown.

In areas A, B and C, the land use capability from the ARDA maps is shown, with capabilities 1 and 2 (the best productive land) in white, 3, 4 and 5 shaded (those lands having moderate to severe limitations), 6 and 7 with dash lines (severe to very severe limiations) and organic soils shown with crosses.

Baseline price contours are plotted for areas A, B, and C with rounded figures for the mean Assurance Fund Values per acre for new titles recorded in the Edmonton Land Titles Office for 1972 (top figure) and 1971 (lower figure).

The user of the contoured price figures is cautioned as to their value: they do not necessarily reflect prices at which land can be bought or sold and have been extrapolated for baseline purposes only and are not, in any sense, to be considered as the result of the application of appraisal techniques. The Resource Economics Branch of the Department of Agriculture, Province of Alberta, puts out an annual booklet titled Real Estate Values in Alberta. The raw data for their publication are obtained from the Assurance Fund Values recorded on each new Certificate of Title created during the reporting year. No attempt is made to find out if these values result from payout of agreements for sale (frequently not recorded), estate settlements (resulting from transmission titles) or non arms length transactions. There is no distinguishing whether or not buildings or other improvements were included in the sale, whether or not the sale was for cash or on terms, backed by government sponsored mortgages or any other details of the transactions necessary to be investigated in normal appraisal techniques. As between 1971 and 1972 there was no evaluation effort as to the effects of the new Federal Income Tax Act, increased grain markets, etc., and lands purchased for subdivision purposes.

The foregoing is in no way intended as criticism; it is necessary, however, to point out the dangers inherent in use of these figures.

The Resource Economics Branch re-ran their figures on a per Township basis using means rather than averages, the standard deviations from the means for the transactions, the total number of acres transferred in each Township and the number of sales. From this information the price contours were extrapolated with weight being given primarily to the sizes of sales, their numbers and the range of these standard deviations.

When that stage of the corridor study is reached which narrows down the corridor location in even general terms, it will be possible, from the data provided, and on-the-ground inspections, to determine approximate land values within the corridor area. It is expected that the Resource Economics Branch will have the first half of 1973 figures available very shortly.

Tables from the publication mentioned "1972 Rural Real Estate Values in Alberta" are reproduced in the Addenda hereto, providing further indications of Assurance Fund Value figures in the Edmonton vicinity, and again the caution detailed above is repeated.

For convenience of reference the areas between Edmonton and Fort McMurray have been divided as follows:

A: Industrial-residential area east of Edmonton to Highway 55.

Should it appear feasible to have all the terminal facilities moved some miles east of Edmonton the following remarks would not apply and a separate study would be necessary.

The area just east of Edmonton, including the major pipeline termini, east to Highway 55 has long since passed out of agricultural value although the majority of these lands are still farmed. Land values are increasing as they gradually come into usages for industrial and residential purposes.

In this area two possible routes are readily apparent:

1. Near the Canadian Pacific Railway right-of-way alongside of which are the existing GCOS and Chevron (three lines) pipelines, sewer lines, etc. which continue into area B on the east side of Highway No. 55. This route is the shortest feasible one out of the terminals area and would have to be acquired as soon as plans could be formed up because of increasing land utilization to the edges of the existing rights-of-way. Deals would have to be made with the existing facilities owners and it is possible that new facilities might have to be stacked within the existing rights-of-way at some points until Highway No. 55 is reached. Alternatively the right-of-way could be widened by buying out existing adjacent usages with relocation of residents and others necessary to be provided.

The major intersection at the junction of Highways 16 and

16A might present some problems, especially if the area south-east of the railway right-of-way was found not to be suitable.

II. A corridor running due east from the pipeline terminals along existing power and pipeline rights-of-way (east-west center line Sections 4, 3, etc.) to a point east of the extension southerly of Highway No. 55. Purchase and relocation problems could also be experienced on this route and considerable hast would be necessary. It might then be possible to go north along a route one-half to one mile east of Highway No. 55 but detailed examination is necessary for route selection here. Such selection in these areas is premature at this stage of the corridor study and alternate II would require considerably more length of right-of-way than I.

Route I would likely to be the most feasible since it is considerably shorter, has many existing facilities in Edmonton and should pose no greater environmental or individual relocation problems than any other. Most of the facilities in it are relatively new, and, although "dealing" problems with facilities and land owners would be complex and probably difficult, its primary locational values would likely outweigh considerations of other routes. Fragmentation problems were created many years ago by the railway, and although existing problems of that nature would be somewhat increased, such would be preferable to creating new problems in other areas.

B: The transitional area - Highway No. 55 to river crossing east of Fort Saskatchewan.

The area includes some of the best agricultural lands in Alberta, is flat and level for the most part with a few sloughs and shallow valleys. It is under intense pressure for sub-division which many consider to be a mis-use of such high quality agricultural land.

It is already traversed by multi-pipeline (adjoining), power transmission and railway rights-of-way. Power and pipe-line rights-of-way lend themselves well to continuing agricult-ural usages and it might therefore be useful to incorporate these existing rights-of-way into a corridor system.

Alternatively, a corridor alongside the railway right-of-way might be obtained from Highway No. 55 (further frag-mentation at this juncture) to west of Bruderheim, thence northerly to tie in with the GCOS crossing of the North Saskatchewan River. As against the GCOS route, the footage might be two tenths of a mile greater and GCOS may have had topographic or other considerations in their route selection.

There would appear to be no realistic possibility of re-location of GCOS and the three Chevron lines in particular, thus, although the extra right-of-way would be more expensive, land use priorities and the probable incorporation of the existing rights-of-way would more than outweigh such considera-tions. It therefore appears that the GCOS et al route is pre-ferable through area B.

C: Agricultural area - east Fort Saskatchewan to Lac La Biche.

The total area is agricultural, grain and forage crops and livestock raising, with the exception of the peat moss plant at Alpen siding (through which the GCOS right-of-way runs) and possible other endeavours.

From the point of view of corridor selection, the GCOS route is the most direct to Lac La Biche itself (keeping outside of the Metis colony) and generally traverses lands of lesser sales value in the more southern and central areas. There appears to be little point in diverging to the west nor to the east, as will be further explained under D below.

In addition to the GCOS right-of-way there are power, railway and highway rights-of-way in the general area to the vicinity of Boyle (bottom of Township 65, Range 19, West 4). A corridor could likely be tied into one or a combination of these depending on engineering and environmental considerations. It would of course be preferable to incorporate as many other rights-of-way as possible for reasons outlined above.

Until one reaches the vicinity of Newbrook, Township 62, there are only a few scattered parcels of Provincially owned (Crown) lands with the balance in freehold ownership by individuals. North from here to the wilderness area (D) there is an increasing percentage of Crown lands, traplines and trapping areas.

The GCOS route goes through the south-east portion of the Redwater oilfield and small gas fields at Newbrook and north of Boyle.

The area of current consideration is necessarily too broad for consideration of detailed land usage. When it is more localized a search of Crown, County and other records will provide the required detail. The Provincial Land Use Planning Branch has mapping facilities for the recording of such usages.

In the area under consideration there are a number of present and possible archeological and historical sites, the locations of which can be obtained from the Provincial Museum and Archives. Before final route selection it will be necessary to incorporate these on the land use maps mentioned in the preceding paragraph and seek the advice of Mr. John Nicks, the Provincial Director of the Archives.

D: Unsettled Wilderness Area between Lac La Biche - Wandering River and Fort McMurray.

The area north from the most northerly farmed area (see pictures in Addenda), Lac La Biche - Wandering River is forested country with a few scattered Timber Berths all of which are west of the highway (see Addendum). The entire area is covered by trap lines and trap areas licensed from the Department of Lands and Forests as to which maps are available. Many of these near the highway and railway are licensed to white people while those in the more remote areas are held by native peoples.

As can be seen in the insert map of the area in the Addenda, the Athabasca Tar Sands deposits extend south from the Fort McMurray area to the region of Townships 77 to 80 although, as also is shown on the Addendum's map, the actual leases cover an area extending some thirty miles south of Fort McMurray to the bottom of Township 84.

Transportation facilities include Highway No. 63 which traverses the westerly part of the area under consideration and the Northern Alberta Railway, which is in the easterly part. The right-of-way of Great Canadian Oil Sands, which includes its 16-inch pipeline and a 12 5/8-inch diameter gas pipeline of Albersun, closely parallels the highway throughout most of its length to the bottom of Township 85 where there is a wide diversion to the west. There is also an old power line right-of-way near the Athabasca River some twenty or thirty miles west of the highway.

At this point in time an area near the highway seems most advisable for corridor purposes because of the nature of the terrain, the relatively fewer rivers and streams to be crossed and the possibilities of controlled economic development for recreational and other purposes in some proximity to it. While there appear to be roughly twenty settlements between Lac La Biche and Fort McMurray on the railway, three of them, only, are viable; namely Anzac, with about 100 people roughly 90% employed - connected to the highway 14 miles west of it; Conklin, with about 300 people roughly 90% unemployed - connected with a winter road only; and Imperial Mills with a floating population and an all-weather road to Lac La Biche. The remaining places shown on the map contain at the most a few scattered trappers' cabins (see picture in Addenda of those at Margie) and the residences of sectional personnel of the railway. The trappers are almost entirely white and use the cabins for about three months during the winter each year although the usage is increasing as fur prices go up. The buildings which the writer first observed in many of these places in the early 1940's have been razed, without exception. At Cheechum (Township 84, Range 6) Numac have an exploration camp and near Margie, a few miles north of Conklin, Edmonton hunters have set up a lodge from which they commute to nearby Christina Lake.

Generally speaking, the northerly third of the railway right-of-way between Lac La Biche and Fort McMurray, passes through considerably swampy areas coming into sandy areas in the middle third which also becomes quite steeply hilly and contains some heavy stands of spruce and aspen. The south third of the right-of-way is more conducive to agricultural pursuits and there are a few scattered ranches both active and inactive. The center third, however, is not conducive to pipe-line construction and ditch line maintenance because of the great number of side hill cuts which would be required.

Thus from the viewpoints of construction, utility, environmental concerns and services to individuals, the area adjacent to the existing highway is obviously considerably more favorable in connection with the subject study.

In addition, the highway right-of-way was chosen in the middle 1960's using the most modern of right-of-way location techniques from the aspects of soil stability, interference with natural drainage patterns and most direct routings.

On the highway the most northerly settlement (south of Fort McMurray), of an agricultural nature, is a few miles north of Wandering River (Township 72, Range 17) and the farm dwellings are some thirty or more years old (See Addenda pictures).

E: Environs of Fort McMurray.

Primarily of an engineering - environmental nature as to corridor considerations. When a route is generally selected, it will then be useful to investigate land uses and the economics thereof. See also Addenda pictures for Tar Sands outcrop above the railway right-of-way near Draper.

7. Purchase Methods - Land Owner Dealings:

Existing right-of-way, other than railway or highway is held normally under a form of right-of-way easement (grant of right-of-way etc.) although it does not qualify as a pure easement.

Under the terms of the normal right-of-way easement, the grantor (registered owner as per the Certificate of Title at the time of signing) allows the grantee (normally the facility owner) the right to use a strip of land as defined on a Plan registered in the Land Titles Office. Methods of acquisition by option, easement in gross (also a form of option) etc. are used but the result is the same. The strip of land varies from a few feet to a hundred or so feet depending on the grantee's requirements (present and contemplated) and policies.

Under the right-of-way easement the grantee has the right to install, remove, replace and, in most cases, add to his facilities and is obligated to leave the land, after construction, in such shape as not to interfere with drainage or ordinary cultivation. Payment is commonly made (Alberta) on a per acre of right-of-way basis and additional payments are made for crop and other damages during construction, maintenance or operation. For his part, the grantor agrees not to excavate into or build upon the right-of-way but otherwise has the full use and enjoyment of it, except where surface structures may interfere, and pays his taxes on the lands as he did before the granting of the right-of-way.

Where agreement cannot be reached for one or more of a number of reasons application can be made to have one of the Provincial Boards decide the payment to be made and the nature of the interest acquired by the grantee (applicant). Both the easements and the Board's orders are registerable under the Land Titles Act of Alberta and are mortgageable.

The rights under the easements and the Board Orders are roughly similar except that the Board's powers stem from a Provincially granted permit for the facility, therefore cannot apply to additional facilities such as an extra pipeline looped within the existing right-of-way. For the extra pipelines, etc. the Boards make a new Order covering the same right-of-way but normally with no additional right-of-way payment.

Since the late 1940's the Boards' payments have governed easement payments and these are generally one and a half or more times the market value of the land encompassing the right-of-way on the mistaken premises, as stated in the Orders, that there is no residual value left to the land owner in the right-of-way. Numerous appraisals and studies in many areas of North America have shown that land owners, when selling land, accept no less for lands within pipeline or power line rights-of-way than for the surrounding lands, and purchasers pay for them on that basis.

Right-of-way payments in most jurisdictions outside of Alberta are based on ten to fifty percent of market value except in abnormal circumstances where there are significant elements of value other than agricultural. Alberta's Boards normally pay full small parcel or market value where the elements mentioned above are present.

Considering the recommendation made earlier in this report respecting fee simple ownership of the corridor right-of-way, with existing rights-of-way being purchased and incorporated into it, an anomalous situation develops. The holder of the easement should normally expect to recover his costs, often one and a half times the market value of the land as mentioned above, while the land owner would expect to get his full market value (at least) as in a normal sale because he is well aware that his remaining interest in the right-of-way, after granting the easement, closely approximates market value.

No one wants to see a land owner get less than is coming to him (he did not set the price for the right-of-way easement payment). It is probable that the Corridor Company, if such were the vehicle, would negotiate an accommodation with the easement holder, perhaps taking also into account such benefits to him as there may be in corridor management. The latter, of course, would be offset to some extent by the dangers inherent in new facilities being built in proximity to those existing where such had not been contemplated in the original designs.

Fee simple corridor right-of-way payments would have to take into account the value of the land, injurious affection, other severance damages and the like. The timing of successive installations might provide additional injurious affect in the corridor, in some places, were they cut out of other than perimeter areas of farms.

It is probable that the Corridor Company would want to lease the right-of-way back to the adjoining land owners for a nominal sum with the stipulation that he keep the weeds down, waive liability and pay the municipal taxes provided they remained on an agricultural assessment basis. With Counties and Municipalities achieving substantial revenues from direct taxes on the facilities, there might be agreement to maintain the agricultural basis as a gesture in favor of the land use conservation aspects of the corridor method.

From the appraisal point of view the optimum method of determining the loss in value to a land owner is that known as the "before and after method." It generally has little practical application because circumstances are rarely so fortuitous as to make reliable judgements available. Additionally there are no other identical types of corridors with which to make comparisons.

It can safely be predicted that some land owners will resist the corridor idea because some of them like to have a number of rights-of-way for pipeline and power line facilities since they get paid more than the market value of the land granted, find little inconvenience from the facility and suffer no diminution of land value. Others will have the natural human attitude that it should be on someone else's land.

It would be useful, therefore, to implement a program in the country of familiarization with the reasons for the corridor concept in order to elicit as favorable a response as possible to it. Experienced land people could well be brought in at the earliest possible stage to work with the engineers, environmental people and the land owners to select a route which would cause the minimum interference with land owners' operations. As with anyone else, land owners dislike even the appearance of "being pushed around" by industry or the State and much delay, cost and dislocation can be avoided by engendering co-operative attitudes.

At such time as a corridor route or routes can be more closely defined, it will be useful to examine the economic effects of corridor right-of-way purchase on lands representative of the major land usages in the areas traversed and the consequences of possible necessary re-location of some land owners as, for example, with the Leduc Airport acquisitions.

When the route is more defined, matrices can be set up so as more easily to understand and evaluate the various inter-acting factors from the land economics point of view.

SUMMARY AND RECOMMENDATIONS:

1. The need for additional energy transporting facilities between Edmonton and Fort McMurray appears to be inescapable.

2. The optimum method of providing right-of-way for a multitude of uses is the corridor concept.

3. Railway, highway, pipeline and power line facilities can be made compatible with one another in the same right-of-way although there is added expense especially in respect of direct current high voltage transmission lines.

4. A right-of-way width of, say, 500 feet should be considered except in the immediate Edmonton area from the pipeline terminals to Highway No. 55, where 250 feet may be the maximum practicable.

5. The preferred corridor route is that of the existing Great Canadian Oil Sands right-of-way through most of its length. This recommendation is subject to evaluation of the technical detail of the other consortium participants which may dictate otherwise.

6. Land is available for corridor purposes although the relocation of some existing improvements might, unfortunately, be necessary. There is urgency for acquisition in the immediate Edmonton vicinity because of increasing residential and industrial usage and escalating land prices.

7. Corridor ownership, recommended to be in fee simple, might be best held under, e.g., the Alberta Corridor Company Limited, to be provided for in a special Statute such as that setting up the Alberta Gas Trunk Line Company. Ownership of the company would be mixed Governmental and facilities owners with voting control split evenly, i.e. 50-50, between Government and industry and initial funding provided from Government resources under a type of land bank concept.

8. Corridor land, not required for surface structures within it, should be leased back to adjoining land owners or grassed for grazing purposes, also leased where possible, in order to maintain weed control and soil stability.

9. Purchase prices from private owners should exceed the appraisal basis because some owners would be unwilling to lose land ownership and it is necessary to provide for over-compensation to ensure that all items are adequately covered. Crown Lands (with no other interests) should have minimal cost because the corridor is in the public interest, dictates increased facilities costs and the facilities themselves move part of the public's resources.

10. Mixed liability among the corridor owners and with respect to external factors can create severe problems.

11. Special interest groups and land owners must be consulted well in advance of definitive planning in order to secure the benefit of their thinking and encourage co-operation.

12. When (and if) corridor location and timing are better defined, extensive examination, area by area, will be undertaken to arrive at realistic land values (not acquisition prices), possible relocation requirements, existing land use disturbance effects and to consider other pertinent matters.

13. In the areas traversed by the GCOS right-of-way:

A. Edmonton terminals to Highway No. 55, land is expensive and intensively used near the termini - the rest is in agricultural usage primarily but there are industrial and residential usages close to and immediately adjacent to it.

B. Highway No. 55 to the east of Fort Saskatchewan - agricultural to urban transitional area - land is becoming expensive and some is subdivided. Usage is mainly agricultural and the land is highly productive. Some archeological and/or historic sites may be found.

C. Fort Saskatchewan to wilderness in Wandering River area. Mixed farming in southerly half giving way to more grazing land and Crown ownership. Some trap lines in the northerly part and some historial and archeological sites may be found.

D. Wilderness area to Fort McMurray covered by trap lines and trap areas with a few scattered timber berths. There are Bituminous Sands leases extending about 30 miles south of Fort McMurray. Historical or archeological sites are not likely to be found.

ADDENDA

A Area Map

1 The Study Area

2 Caution and Explanation of Land Price Contours

3 Soil Capability Mileages - GCOS Route

B Urban Values

1 Real Estate "Values" in City Peripheries

2 Graphic Illustration of Edmonton Area Prices

C Pictures of

1 Northernmost cultivated area

2 Northernmost farm buildings, south of Fort McMurray

3 Typical trappers' cabins on the Northern Alberta Railway at Margie

4 Tar Sands outcrop near Fort McMurray

Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport

CAUTION AND EXPLANATION OF LAND PRICE CONTOUR FIGURES

The previous Addenda, A-1 shows base line price contours with figures within the contours showing a rounding of the mean Assurance Fund Values per acre for new Titles recorded in the Land Titles Office for 1972 (top figure) and 1971 (lower figure).

The figures are derived from data collected by the Resource Economics Branch of the Department of Agriculture which comprised the Assurance Fund Values from all new Titles created in 1971 and 1972. From that data mean prices per acre per Township were computed along with the standard deviation from those prices in the various transactions, the total number of acres included in the transactions and the total number of sales of which they were comprised.

The base line contour figures were extrapolated on the basis of the sizes of the sales, their number and the standard deviation from the mean as computed.

The dangers which are inherent in the use of these figures stem from the fact that they are Assurance Fund Values only as to which no analysis was performed to determine whether or not they were new titles created on a clean-up basis, including buildings and/or other improvements, culminations of payouts of Agreements for Sale entered into many years ago and frequently not recorded on the Titles, Estate settlements or non-arms length transactions.

Additionally, there is no analysis of the sales to determine whether they were cash transactions or on terms, backed by Government sponsored mortgages, additions to existing farm units (buyer pressure), distress sales (vendor pressure), were resultant from the effects of the new Federal Income Tax Act and all the other factors which have to be determined to assess realistic land values.

While the foregoing is in no way intended as criticism, it is necessary to point out the dangers inherent in the use of these base line contour figures.

ARDA Land Use Capability:

Class I & 2: White, relatively unrestricted cropping;

Class 3,4&5: Shaded, moderate to severe limitations;

Class 6 & 7: Dashed, severe to very severe limitations;

Organic : crosses, muskeg, peat, etc.

MILEAGE OF PIPELINE IN EACH CLASS TAKEN FROM THE FIVE CANADA LAND INVENTORY MAPS FROM EDMONTON TO ATMORE ALONG GCOS LINE

Soil Capability for Agriculture

Class 1	Soils in this class have no significant limitations in use for crops. 7.25 miles
Class 2	Soils in this class have moderate limitations that restrict the range of crops or require special conservation practices. 17.0 miles
Class 3	Soils in this class have severe limitations that that restrict the range of crops or require special conservation practices. 22.25 miles
Class 4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both. 38.00 miles
Class 5	Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. 3.25 miles
Class 6	Soils in this class are capable of only of producing perennial forage crops and improvement practices are not feasible. 9.50 miles
Class 0	Organic Soils 4.75 miles

Land Capability for Recreation

Class 4	Lands in this class have moderate capability for outdoor recreation. 1.0 miles
Class 5	Land in this class have moderately low capability for outdoor recreation. 15.0 miles
Class 6	Lands in this class have low capability for outdoor recreation. 86.0 miles

TABLE 1

REAL ESTATE VALUES IN THE URBAN PERIPHERIES

Region	Size Class (Ac.)	No. of Observ.	Ave. Ac. Per Trans.	Total Acreage Sold No. Acres	Total Acreage Sold Cum. %	Ave. Val. Per Acre ($)
Edmonton	0^+ - 5	69	2.0	135	0.1	8,747
Periphery	5^+ - 35	65	15.6	1,014	1.2	1,664
	35^+ - 150	249	88.4	22,023	23.9	473
	150^+ - 170	318	158.6	50,443	76.1	218
	GT 170	72	321.6	23,153	100.0	155
	*	12	-	-		-
	Total	785		96,768		288
Calgary	0^+ - 5	28	1.8	49	-	5,188
Periphery	5^+ - 35	195	19.1	3,715	3.0	1,084
	35^+ - 150	204	77.4	15,785	15.3	413
	150^+ - 170	222	159.2	35,334	43.1	200
	GT 170	185	392.3	72,575	100.0	184
	*	16	-	-		-
	Total	850		127,458		245

* Acreage unavailable

Copied from 1972 Rural Real Estate Values in Alberta, published by Alberta Agriculture, Resource Economics Branch.

ADDENDUM B - 2.

Photo-copied from 1972 Rural Real Estate Values in Alberta, Published by Agriculture Alberta, Resource Economics Branch.

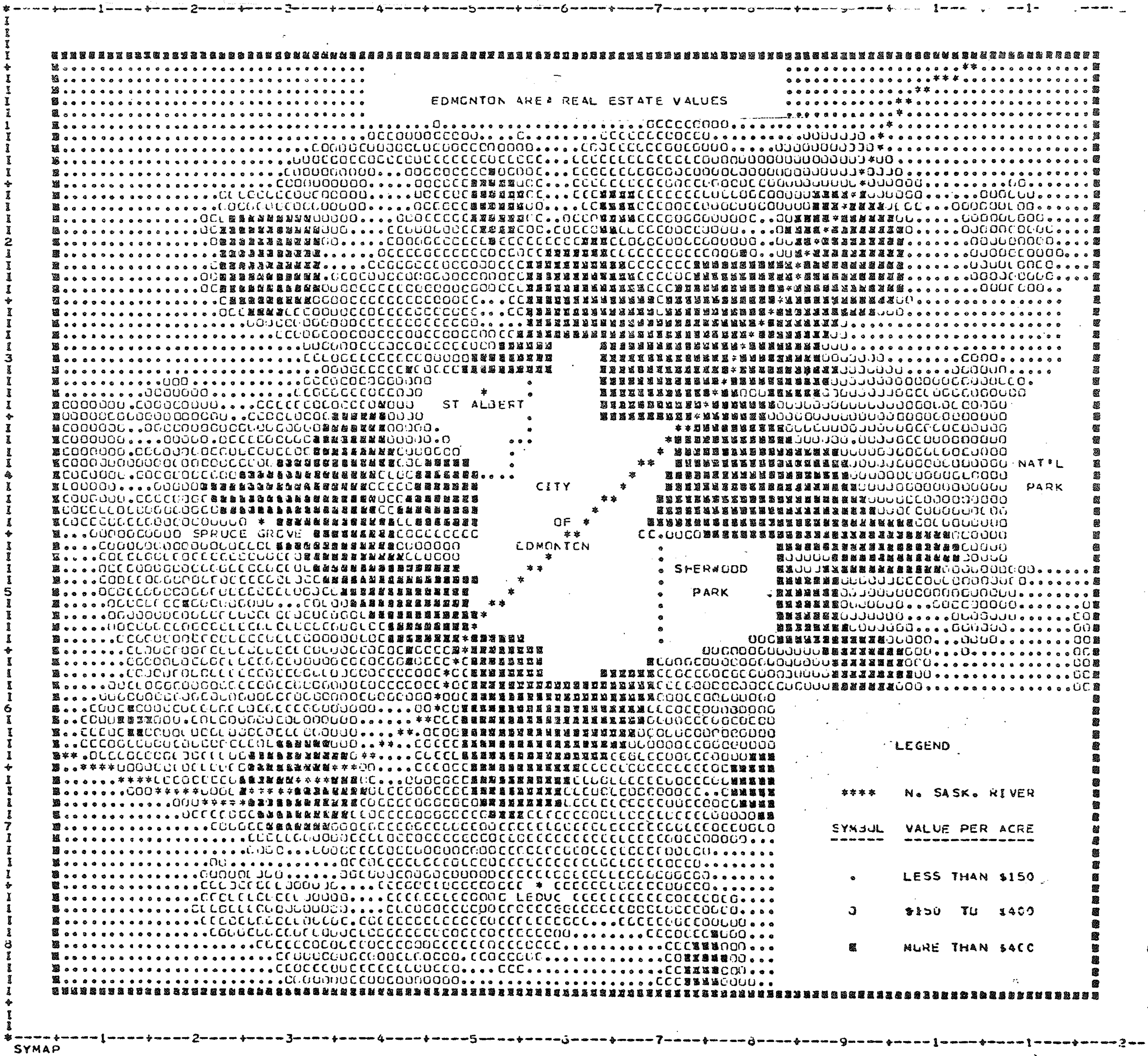


FIGURE 2 - EDMONTON AREA REAL ESTATE VALUES

PLATE I - OLDER FARM BUILDINGS - NORTH END OF SETTLED AREA T. 72, R. 17, W4.

PLATE 2 - OPEN GRAZING, NORTH END OF SETTLED AREA T. 72, R. 17, W4.

PLATE 3 - TYPICAL TRAPPERS CABINS ON NORTHERN ALBERTA RAILWAY - ONLY BUILDINGS AT MOST STATIONS - THESE ARE AT MARGIE, T. 74, R. 9,W4.

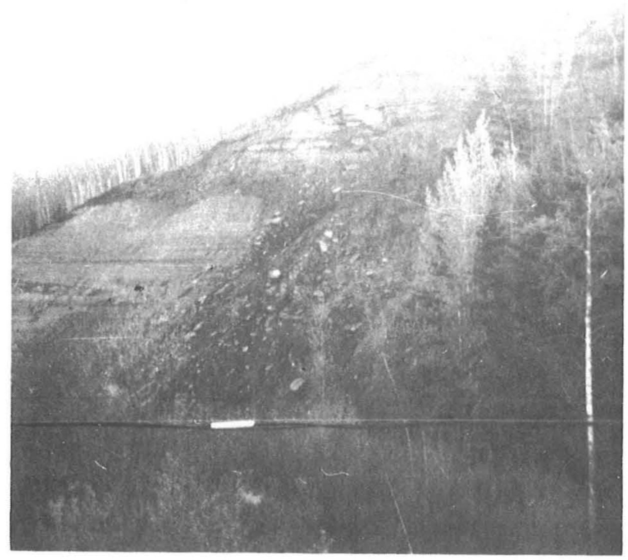


PLATE 4 - TAR SANDS OUTCROP NEAR FORT McMURRAY - DRAPER T. 88, R. 8, W4.