

ATHABASCA RIVER BASIN

LOW FLOW ANALYSIS



BY: HYDROLOGY BRANCH
TECHNICAL SERVICES DIVISION
WATER RESOURCES MANAGEMENT SERVICES
ALBERTA ENVIRONMENT

FOR: ATHABASCA RIVER
BASIN PLANNING PROGRAM
PLANNING DIVISION
WATER RESOURCES MANAGEMENT SERVICES
ALBERTA ENVIRONMENT

JANUARY, 1984

ATHABASCA RIVER BASIN

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January 27, 1984

R. Hicks, P. Eng.
Athabasca River Basin Planner
Planning Division
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Dear Sir:

We have the pleasure of submitting to you this report entitled, "Athabasca River Basin, Low Flow Analysis".

The report identifies and analyzes annual and open water, low flow sequences at 13 stations on the Athabasca River and its major tributaries.

The report was prepared by H. Biberhofer, E.I.T., and reviewed by R.A. Bothe, P. Eng.

Yours truly,


A.M. Mustapha, P. Eng.
Branch Head
Hydrology Branch

HB/sr

Enclosure

SYNOPSIS

This report identifies historical, annual and open water, low flow sequences for 13 stations in the Athabasca River Basin. Frequency curves are developed which provide an estimate of droughts of a specified exceedance probability. Drought events recorded on the Athabasca River below McMurray with an exceedance probability greater than 0.90 are identified and discussed. The analysis provides low flow information which can be used to determine general management guidelines for the Athabasca River Basin.

TABLE OF CONTENTS

	<u>Page Number</u>
Letter of Transmittal	i
Synopsis	ii
Table of Contents	iii
List of Figures	v
List of Tables	v
1. INTRODUCTION	1
1.1 Objective	1
1.2 Scope	1
1.3 Prior Studies	1
2. STUDY SITES	2
3. ANNUAL ANALYSIS	5
3.1 Time Frame	5
3.2 Methodology	5
3.3 Summary of Results	5
4. OPEN WATER ANALYSIS	8
4.1 Time Frame	8
4.2 Methodology	8
4.3 Summary of Results	8
5. HISTORICAL EVENTS	10
5.1 1981-82 Low Flow Event	10
5.2 1970-71 Low Flow Event	11
5.3 1967-68 Low Flow Event	11
5.4 1961-62 Low Flow Event	11
6. DISCUSSION	16
6.1 Spatial Variation Throughout the Basin	16
6.2 Use	19

TABLE OF CONTENTS

	<u>Page Number</u>
7. SUMMARY	20
8. REFERENCES	21
APPENDIX A - Annual Data	22
APPENDIX B - Frequency of Annual, 7 and 90 Day, Low Flow Runoff	40
APPENDIX C - Open Water Data	54
APPENDIX D - Frequency of the Open Water, 7 Day, Low Flow Runoff	72

LIST OF FIGURES

<u>Figure Number</u>	<u>Figure Name</u>	<u>Page Number</u>
2-1	Location of Study Sites	4
6-1	1:10 Year Return Period, Annual 7 Day Low Flows in the Athabasca River Basin	17

LIST OF TABLES

<u>Table Number</u>	<u>Table Name</u>	
2-1	Study Sites	3
3-1	1:10 Year Return Period, Annual Low Flows (90% Exceedance)	7
4-1	1:10 Year Return Period, Open Water Low Flows (90% Exceedance)	9
5-1	1981-82 - 7 Day Low Flow Event for Athabasca River Below McMurray and Corresponding Flows for Upstream Stations	12
5-2	1970-71 - 7 Day Low Flow Event for Athabasca River Below McMurray and Corresponding Flows for Upstream Stations	13
5-3	1967-68 - 7 Day Low Flow Event for Athabasca River Below McMurray and Corresponding Flows for Upstream Stations	14
5-4	1961-62 - 7 Day Low Flow Event for Athabasca River Below McMurray and Corresponding Flows for Upstream Stations	15
6-1	Mean Annual and Annual 1:2 Year and 1:10 Year Return Period Low Flows ...	16

1. INTRODUCTION

The Athabasca Low Flow Analysis constitutes one part of the hydrology component of the Athabasca River Basin Planning Project. The data provided within this report will assist in determining management guidelines for the Athabasca River Basin.

1.1 Objective

The objective of this study is to identify historic low flow sequences for sites in the Athabasca Basin and to determine frequency distributions of drought events.

1.2 Scope

The low flow analysis is limited to Water Survey of Canada hydrometric stations. Sufficient data must be available to first; identify the low flow sequence in a given time frame, and second; to develop a frequency curve for the given station.

Two time frames are analyzed. One analysis is an annual analysis based on a water year and the other analysis is based on open water conditions.

1.3 Prior Studies

Hydrology Branch prepared a study in 1982 entitled, Athabasca River Basin Historical Natural Flows, 1912 to 1980, which provides hydrologic analyses detailing monthly natural flows at 21 locations on the Athabasca River and its major tributaries. Data files were void filled and synthesized to provide mean annual flow figures for the period 1912 to 1980. Water Survey of Canada sites, or C-files which were reviewed in the previous study are analyzed in the Athabasca Low Flow Analysis.

2. STUDY SITES

Low flows have been identified and analyzed for 13 locations within the Athabasca River Basin. The analysis is based on recorded streamflow data and as a result, is limited to Water Survey of Canada hydrometric stations with sufficient recorded data.

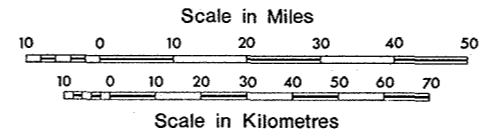
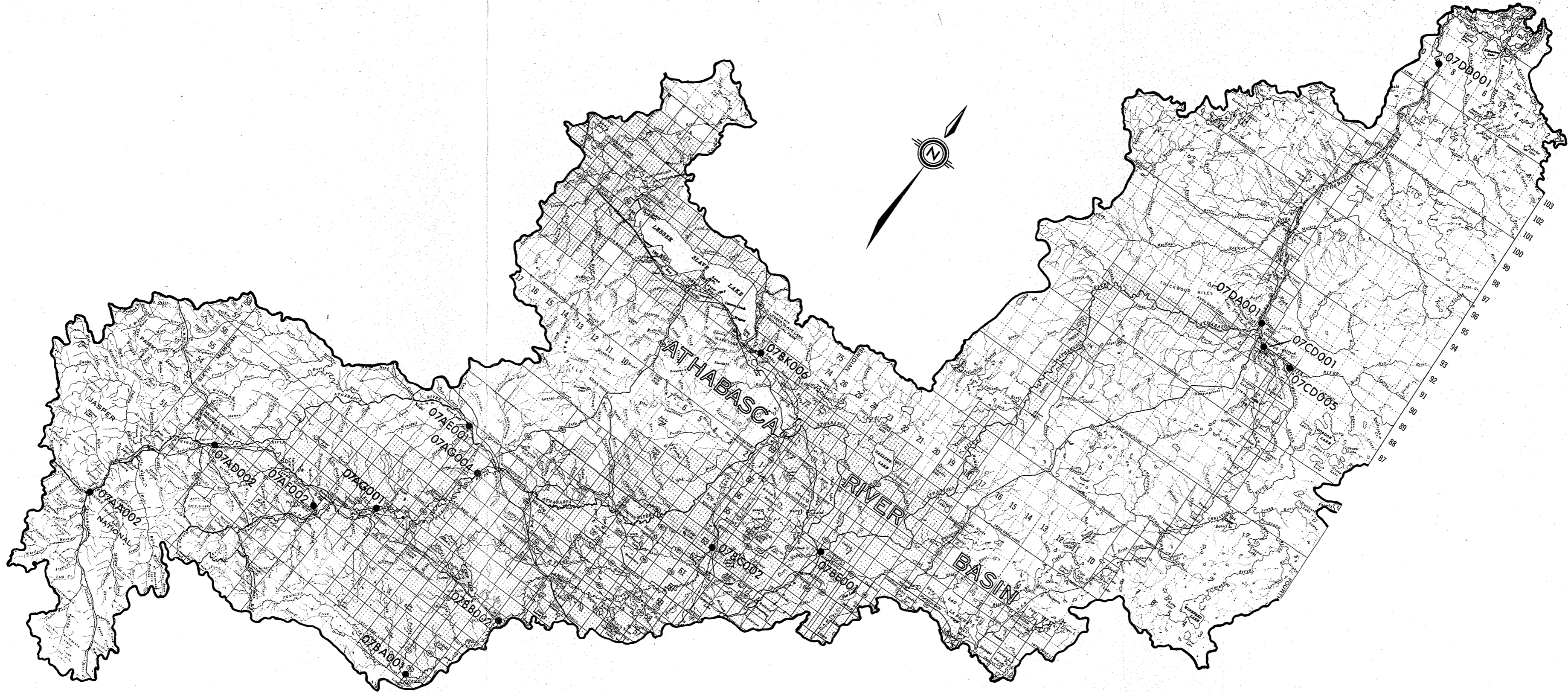
The C files which are outlined in the Athabasca River Basin Historical Natural Flows Study (Alberta Environment, 1982) are based primarily on Water Survey of Canada recorded streamflow data and have been incorporated in the low flow analysis on the basis of the above data. Pembina River below Paddy Creek and McLeod River near Whitecourt, stations 07BA001 and 05AG004, however, are not included due to lack of data. Study sites which comprise the low flow analysis are listed in Table 2-1 and their location within the Athabasca River Basin is presented in Figure 2-1.

In two cases, the data set analyzed reflects recorded flows from a combination of two stations. For the period 1915 to 1961, data from Lesser Slave River at Slave Lake are used to estimate flows for Lesser Slave River at Highway #2. Similarly data from Athabasca River at Entrance are used to estimate flows for Athabasca River at Hinton for the period 1915 to 1961. In both of the above cases, the difference in flows at the combined stations is expected to be minimal.

Stations which are referred to as G files in the 1982 report, consist of void filled, synthetic monthly flows and are not appropriate for inclusion in the low flow analysis. The stations referred to as G files are; Athabasca-Oldman Dam Site, McLeod Valley Dam Site, Berland River at the Mouth, Pembina Dam Site, Moose Portage Dam Site, and Christina River at the Mouth.

TABLE 2-1
STUDY SITES

Station Name	Water Survey of Canada Station Number
Athabasca River near Jasper	07AA002
Athabasca River at Hinton	07AD002
Athabasca River near Windfall	07AE001
McLeod River above Embarras River	07AF002
McLeod River near Wolf Creek	07AG001
Pembina River near Entwistle	07BB002
Pembina River at Jarvie	07BC002
Athabasca River at Athabasca	07BE001
Lesser Slave River at Highway #2	07BK006
Clearwater River at Draper	07CD001
Clearwater River above Christina River	07CD005
Athabasca River below McMurray	07DA001
Athabasca River at Embarras Airport	07DD001



	TECHNICAL SERVICES DIVISION	LOCATION OF STUDY SITES	
	HYDROLOGY BRANCH		
SUBMITTED R. BOTHE, P. ENG.	DESIGNED H. BIBERHOFER, E.I.T.	SCALE AS SHOWN	
DATE JAN, 1984	CHECKED		
APPROVED M. MUSTAPHA, P. ENG.	DRAWN V. DA SILVA	DATE JAN., 1984	
DATE JAN, 1984	CHECKED H. BIBERHOFER, E.I.T.		
		FIGURE No. 2-1	

3. ANNUAL ANALYSIS

7 and 90 day, annual low flows are identified, and associated frequency curves are determined for each of the study sites.

3.1 Time Frame

The annual analysis is based on a water year from July 1 to June 30 to ensure that all low flow sequences remain intact. The period from June 1 to July 31 is generally a period of high flow within the Athabasca Basin and therefore it is unlikely that a minimum flow sequence would be interrupted by incorporating this time frame.

3.2 Methodology

7 and 90 day minimum flows are identified for each year of available data. Minimum flows are not identified for years of incomplete data unless it could be assumed that the minimum flow sequence would not occur within the period of missing records. For example, data for the period June to August, 1913 is not available for Athabasca River near Jasper. However, it is unlikely that a minimum flow sequence would occur during the above period and therefore the 1913-14 water year was included in the analysis. Similarly, 1954-55 data for McLeod River above Embarras River, 1957-58 data for McLeod River near Wolf Creek, 1954-55 data for Pembina River near Entwistle are included.

Frequency curves are developed using a modified Pearson III frequency distribution for each station, based on the low flow sequences identified. A frequency curve was not developed for Athabasca River at Embarras Airport due to a lack of data.

3.3 Summary of Results

7 and 90 day annual minimum flows and dates of occurrence are presented in Appendix A. It is noted that on an annual basis all minimum flow sequences occur within the period November 1 to May 1.

Frequency curves are presented in Appendix B. The 7 and 90 day, 1:10 year droughts, which are defined as low flows with a 90% exceedance probability, are summarized in Table 3-1.

TABLE 3-1
1:10 YEAR RETURN PERIOD ANNUAL LOW FLOWS (90% EXCEEDANCE)

Station	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
Athabasca River near Jasper	5.56	8.58
Athabasca River at Hinton	16.0	23.0
Athabasca River near Windfall	29.0	40.7
McLeod River above Embarras River	1.06	1.70
McLeod River near Wolf Creek	1.56	2.45
Pembina River near Entwistle	0.510	1.07
Pembina River at Jarvie	1.27	1.81
Athabasca River at Athabasca	52.3	62.6
Lesser Slave River at Highway #2	11.3	14.1
Clearwater River at Draper	34.3	40.3
Clearwater River above Christina River	28.5	34.9
Athabasca River below McMurray	119.	141.

Based on a water year of July 1 to June 30

4. OPEN WATER ANALYSIS

7 day minimum flow sequences are identified and analyzed for the open water period. Ice covered low flow conditions are not analyzed as the analysis based on a water year generally identifies the ice covered low flow sequence.

4.1 Time Frame

The open water analysis is based on flow data from May 1 to November 30. Generally spring break-up occurs in April and freeze-up occurs in November. Inclusion of data in years when freeze-up occurs prior to November 30 is conservative as flows generally continue to decrease during the latter period.

4.2 Methodology

The methodology is similar to the annual analysis with several exceptions. The analysis incorporates a time frame from May 1 to November 30 and only 7 day low flow sequences were identified. In addition a frequency curve is developed for Athabasca River at Embarras Airport, based on seven years of flow data.

4.3 Summary of Results

7 day, open-water minimum flows and dates of occurrence are presented in Appendix C. The analysis indicates that open-water 7 day minimum flows generally occur just prior to freeze up.

Frequency curves of 7 day open-water minimum flows are presented in Appendix D and the 7 day 1:10 year droughts for the open-water period are summarized in Table 4-1.

TABLE 4-1
1:10 YEAR RETURN PERIOD OPEN WATER LOW FLOWS (90% EXCEEDANCE)

Station	7 Day Low Flow (m ³ /s)
Athabasca River near Jasper	12.6
Athabasca River at Hinton	29.1
Athabasca River near Windfall	40.3
McLeod River above Embarras River	1.97
McLeod River near Wolf Creek	4.36
Pembina River near Entwistle	1.52
Pembina River at Jarvie	2.96
Athabasca River at Athabasca	83.0
Lesser Slave River at Highway #2	15.5
Clearwater River at Draper	45.2
Clearwater River above Christina River	35.5
Athabasca River below McMurray	141
Athabasca River at Embarras Airport	197

Based on flow data from May 1 to November 30th

5. HISTORICAL EVENTS

Historical low flow events are identified for the Athabasca River Basin based on 7 day minimum annual flow sequences for Athabasca River below McMurray. Due to a lack of data, low flow events could not be identified using data for Athabasca River at Embarras Airport, however, it is assumed that extreme minimum flows occur coincidentally at the above stations.

The 1:10 year, 7 day drought for Athabasca River below McMurray is determined to be 119 cms based on 21 years of flow data. Within the period of record, 1957 to 1968 and 1970 to 1982, the 1:10 year return period was equalled or exceeded 4 times. 7 day low flows less than or equal to 119 cms were recorded in 1961-62, 1967-68, 1970-71, and 1981-82.

5.1 1981-82 Low Flow Event

The average flow of 95.1 cms recorded for the period December 16-22 is the lowest 7 day flow sequence recorded for the Athabasca River below McMurray station. Corresponding flows for upstream stations indicate that in 1981-82, simultaneous low flows with exceedance probabilities greater than 0.70 for the Athabasca River from Hinton to McMurray, the Lesser Slave River at Highway #2, and Clearwater River at Draper resulted in a drought event with a return period greater than 1:100 years for the Athabasca River below McMurray station. Corresponding flows were estimated for upstream stations by incorporating factors for travel time (Alberta Environment, 1983) which were extrapolated for low flow conditions. Based on the data listed in Table 5-1, factors for travel time do not significantly alter the corresponding flows identified at stations upstream of Athabasca River below McMurray. Thus, for simplicity, travel time is not considered for the remaining low flow events.

5.2 1970-71 Low Flow Event

Simultaneous occurrence of an approximately 1:2 year low flow sequence at a number of stations in the Athabasca River Basin resulted in the 1970-71 low flow for the Athabasca River below McMurray station. An average flow of 115 cms, with an exceedance probability of 0.93, was recorded during the period November 22 to 28, 1970. Table 5-2 lists the corresponding flows and exceedance probabilities.

5.3 1967-68 Low Flow Event

A low flow sequence with an exceedance probability of 0.95 and an average flow of 111 cms, was recorded for Athabasca River below McMurray during the period January 2 to 8, 1968. Corresponding flows and exceedance probabilities for upstream stations are provided in Table 5-3. The data indicates that simultaneous low flows in the Pembina River at Jarvie, Lesser Slave River at Highway #2, and Clearwater River at Draper contributed to a low flow event at the Athabasca River below McMurray. Flows upstream of the Athabasca River at Windfall station do not appear to be contributory to the extremeness of the drought event.

It is also noted that recorded flows at Hinton are greater than flows recorded downstream at Windfall. This indicates that ice production on the Athabasca River may have been a factor which contributed to low flow conditions. This phenomenon, however, could also be explained by errors in recorded flow data.

5.4 1961-62 Low Flow Event

The average flow of 119 cms which occurred in the 7 day period from March 30 to April 5, 1962 at Athabasca River below McMurray has an exceedance probability of 0.90. Corresponding flows and exceedance probabilities for upstream stations are presented in Table 5-1. Similar to the 1967-68 drought, low flows with high exceedance probabilities occurred simultaneously in several of the major tributaries; the Pembina River at Jarvie, Lesser Slave River at Highway #2, and Clearwater River at Draper.

TABLE 5-1

1981-82 - 7 DAY LOW FLOW EVENT FOR ATHABASCA RIVER BELOW McMURRAY
AND CORRESPONDING FLOWS FOR UPSTREAM STATIONS

	Date	7 Day Low Flow m ³ /s	Date	7 Day Low Flow m ³ /s	Exceedance Probability
Athabasca River below McMurray	December 16	95.1	December 16	95.1	>0.99
Athabasca River at Athabasca	December 15	58.6	December 16	58.7	0.82
Athabasca River near Windfall	December 13	N.D.	December 16	N.D.	--
Athabasca River at Hinton	December 12	18.2	December 16	19.3	0.70
Athabasca River near Jasper	December 10	13.4	December 16	13.7	<.01
Clearwater River at Draper	December 15	37.1	December 16	37.9	0.82
Clearwater River above Christina	December 13	34.5	December 16	34.6	0.70
Lesser Slave River at Highway #2	December 15	14.0	December 16	14.0	0.82
Pembina River at Jarvie	December 13	3.99	December 16	3.84	0.30
Pembina River near Entwistle	December 07	1.94	December 16	1.41	0.40
McLeod River near Wolf Creek	December 11	3.53	December 16	2.83	0.60
McLeod River above Embarras River	December 09	2.01	December 16	1.70	0.45

NOTE: N.D. - no data available for the period indicated.

TABLE 5-2

1970-71 - 7 DAY LOW FLOW EVENT FOR ATHABASCA RIVER BELOW McMURRAY
AND CORRESPONDING FLOWS FOR UPSTREAM STATIONS

Station	Starting Date of the 7 Day Low Flow Sequence	7 Day Low Flow (m ³ /s)	Exceedance Probability
Athabasca River below McMurray	November 22	115.	0.93
Athabasca River at Athabasca	November 22	72.0	0.55
Athabasca River near Windfall	November 22	39.1	0.35
Athabasca River at Hinton	November 22	21.0	0.55
Athabasca River near Jasper	November 22	10.2	0.10
Clearwater River at Draper	November 22	57.3	0.15
Clearwater River above Christina River	November 22	N.D.	--
Lesser Slave River at Highway #2	November 22	22.4	0.53
Pembina River at Jarvie	November 22	2.09	0.70
Pembina River near Entwistle	November 22	1.52	0.35
McLeod River near Wolf Creek	November 22	4.52	0.25
McLeod River above Embarras River	November 22	2.01	0.30

NOTE: N.D. - no data available for the period indicated.

TABLE 5-3

1967-68 - 7 DAY LOW FLOW EVENT FOR ATHABASCA RIVER BELOW McMURRAY
AND CORRESPONDING FLOWS FOR UPSTREAM STATIONS

Station	Starting Date of the 7 Day Low Flow Sequence	7 Day Low Flow (m ³ /s)	Exceedance Probability
Athabasca River below McMurray	January 02	111.0	0.95
Athabasca River at Athabasca	January 02	53.0	0.89
Athabasca River near Windfall	January 02	46.0	0.10
Athabasca River at Hinton	January 02	55.0	<.01
Athabasca River near Jasper	January 02	N.D.	--
Clearwater River at Draper	January 02	40.5	0.75
Clearwater River above Christina River	January 02	N.D.	--
Lesser Slave River at Highway #2	January 02	16.7	0.75
Pembina River at Jarvie	January 02	0.659	0.97
Pembina River near Entwistle	January 02	1.15	0.55
McLeod River near Wolf Creek	January 02	3.24	0.53
McLeod River above Embarras River	January 02	1.70	0.45

NOTE: N.D. - no data available for the period indicated.

TABLE 5-4

1961-62 - 7 DAY LOW FLOW EVENT FOR ATHABASCA RIVER BELOW McMURRAY
AND CORRESPONDING FLOWS FOR UPSTREAM STATIONS

Station	Starting Date of the 7 Day Low Flow Sequence	7 Day Low Flow (m ³ /s)	Exceedance Probability
Athabasca River below McMurray	March 30	119.	0.90
Athabasca River at Athabasca	March 30	70.1	0.60
Athabasca River near Windfall	March 30	57.9	<.01
Athabasca River at Hinton	March 30	40.4	<.01
Athabasca River near Jasper	March 30	N.D.	--
Clearwater River at Draper	March 30	41.9	0.70
Clearwater River above Christina River	March 30	N.D.	--
Lesser Slave River at Highway #2	March 30	14.5	0.80
Pembina River at Jarvie	March 30	0.853	0.96
Pembina River near Entwistle	March 30	4.96	<.01
McLeod River near Wolf Creek	March 30	6.37	0.08
McLeod River above Embarras River	March 30	10.6	<.01

NOTE: N.D. - No data available for the period indicated

6. DISCUSSION

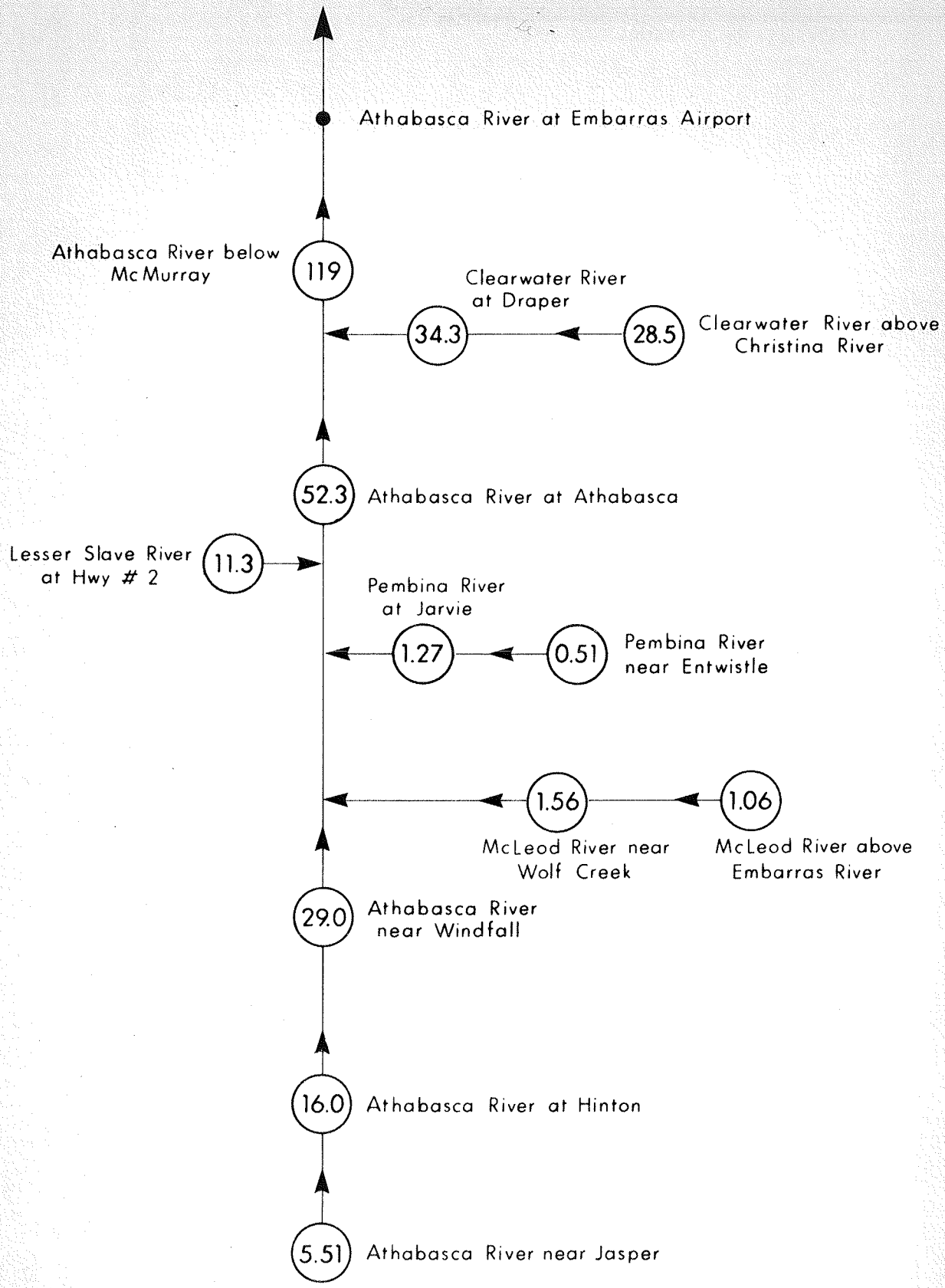
The 1:10 year, 7 day droughts, based on a water year, for the Athabasca River Basin are shown on a schematic of the basin in Figure 6-1.

6.1 Spatial Variation Throughout the Basin

Flows from the headwater region of the Athabasca River Basin are depicted by flows recorded at Athabasca River at Hinton and at Jasper. On an annual basis, this region exhibits large variability such that low flows are substantially less than estimated mean annual flows in any given year of recorded data. Clearly it is the headwater region which instigates an annual low flow condition in the Athabasca River system downstream of Hinton. The resulting annual low flow condition, which is identified by the 90 day annual low flow, occurs within the period November 1 to May 10 for the data analyzed.

Given that the headwaters are experiencing a low flow condition, the extremeness of the low flow event is governed by the stations with large flow variability in the low flow frequency curve. For example, a 1:10 year drought for the Clearwater River at Draper is estimated at 12 cms less than the 1:2 year drought. Table 6-1 illustrates both the annual variability of recorded flows by comparison with mean annual flows, and the variability in estimated droughts by comparison of 1:2 year and 1:10 year low flows.

In summary, the headwater region initiates an annual low flow condition. Given a low flow condition, the severity of the drought experienced on the Athabasca River below McMurray is governed by the extremeness of drought events on the Lesser Slave and Clearwater Rivers. This phenomena is depicted in the historical low flows discussed in Section 5.



TECHNICAL SERVICES DIVISION
HYDROLOGY BRANCH

**1:10 YEAR ANNUAL, 7 DAY LOW FLOWS
IN THE ATHABASCA RIVER BASIN**
(m³/sec)

SUBMITTED R. BOTHE, P. ENG.
DATE JAN., 1984

DESIGNED H. BIBERHOFER, E. I. T.
CHECKED

SCALE AS SHOWN
DATE JAN., 1984

APPROVED M. MUSTAPHA, P. ENG.
DATE JAN., 1984

DRAWN V. DA SILVA
CHECKED R. BOTHE, P. ENG.

FIGURE No. 6-1

TABLE 6-1
MEAN ANNUAL AND ANNUAL 1:2 YEAR AND 1:10 YEAR RETURN PERIOD LOW FLOWS

Station	Mean Annual Flow ¹ (m ³ /s)	Annual 7 Day Drought	
		1:2 Year (50% exceedance) (m ³ /s)	1:10 Year (90% exceedance) (m ³ /s)
Athabasca River near Jasper	89	7.63	5.51
Athabasca River at Hinton	181	21.8	16.0
Athabasca River near Windfall	248	36.7	29.0
McLeod River above Embarras River	20	1.68	1.06
McLeod River near Wolf Creek	39	3.31	1.56
Pembina River near Entwistle	20	1.22	0.510
Pembina River at Jarvie	32	2.86	1.27
Athabasca River at Athabasca	428	74.1	52.3
Lesser Slave River at Highway #2	45	23.0	11.3
Clearwater River at Draper	130	46.4	34.3
Clearwater River above Christina River	85	38.7	28.5
Athabasca River below McMurray	653	150	119

1 - The mean annual flows are taken from Athabasca River Basin Historical Natural Flows 1912-1980 (Environment 1982). The data base of the mean annual and 7 day minimum flows are not identical and therefore the above figures are only to indicate general variability in flows.

6.2 Use

Appendix A and C provide annual and open-water recorded minimum flow data from Water Survey of Canada records for the period indicated. The values can be used to identify historical low flow sequences within the error of measurement of the discharge data.

The accuracy of the frequency curves provided in Appendices B and D, however, depends on the number of years of data used in the analysis, the applicability of the Pearson III frequency distribution to describe the events, as well as the accuracy of the discharge measurements. In particular, the accuracy is questionable for the frequency curves developed for Clearwater River above Christina River, and Athabasca River at Embarras Airport.

7. SUMMARY

This study identifies historical annual and open-water low flow sequences for 13 stations in the Athabasca River Basin. Frequency curves are developed, based on the historical low flow sequences, which provide an indication of droughts of specified exceedance probabilities.

Low flow events with an exceedance probability greater than 0.90 recorded on the Athabasca River below McMurray are identified and corresponding upstream flow conditions are examined. The analysis indicates that low flows from the headwater region results in an annual low flow condition, whereas the severity of drought events on the Lesser Slave and Clearwater Rivers affects the severity of the drought experienced on the Athabasca River below McMurray.

This analysis provides low flow information which can be used to determine general management guidelines for the Athabasca River Basin.

8. REFERENCES

1. Alberta Environment, Technical Services Division, Athabasca Basin, Historical Natural Flows 1912 to 1980, October 1982.
2. Alberta Environment, Technical Services Division, River Forecasting Manual, 1983.
3. Water Survey of Canada, Hydrometric Data Tapes, Inland Waters Directorate, Environment Canada, 1983.

A P P E N D I X A

ANNUAL DATA

APPENDIX A
ANNUAL DATA

Station Name	Water Survey of Canada Station Number	Table Number
Athabasca River near Jasper	07AA002	A-1
Athabasca River at Hinton	07AD002	A-2
Athabasca River near Windfall	07AE001	A-3
McLeod River above Embarras River	07AF002	A-4
McLeod River near Wolf Creek	07AG001	A-5
Pembina River near Entwistle	07BB002	A-6
Pembina River at Jarvie	07BC002	A-7
Athabasca River at Athabasca	07BE001	A-8
Lesser Slave River at Highway #2	07BK006	A-9
Clearwater River at Draper	07CD001	A-10
Clearwater River above Christina River	07CD005	A-11
Athabasca River below McMurray	07DA001	A-12
Athabasca River at Embarras Airport	07DD001	A-13

TABLE A-1

ATHABASCA RIVER NEAR JASPER

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1913-14	8.21	Mar 23	10.5	Jan 08
1914-15	11.6	Mar 24	13.4	Jan 03
1915-16	3.88	Jan 19	11.1	Jan 03
1916-17	6.88	Mar 18	9.54	Feb 06
1917-18	7.63	Feb 27	12.3	Jan 24
1918-19	8.40	Feb 24	10.8	Jan 14
1919-20	6.23	Jan 14	9.32	Jan 07
1920-21	8.34	Mar 09	10.7	Jan 09
1921-22	5.34	Mar 27	10.2	Jan 21
1923-24	7.36	Jan 26	9.71	Dec 31
1925-26	9.22	Dec 31	10.9	Dec 23
1926-27	6.93	Mar 06	8.15	Jan 11
1927-28	5.02	Mar 13	7.56	Jan 24
1928-29	4.04	Jan 28	7.04	Jan 15
1929-30	5.06	Jan 25	8.08	Jan 02
1930-31	7.42	Apr 20	9.01	Jan 28
1970-71	8.09	Jan 13	10.3	Jan 06
1971-72	9.47	Apr 17	11.9	Jan 16
1972-73	8.78	Mar 12	11.4	Jan 11
1973-74	9.10	Mar 18	11.3	Jan 10
1974-75	9.30	Mar 27	11.5	Jan 18
1975-76	9.84	Mar 02	12.2	Jan 09
1976-77	8.46	Mar 27	10.7	Jan 08
1977-78	8.74	Mar 18	11.3	Jan 10
1978-79	8.47	Apr 06	10.9	Jan 24
1979-80	8.05	Mar 24	10.5	Jan 15
1980-81	9.43	Feb 12	11.6	Jan 22
1981-82	8.58	Mar 24	9.91	Jan 23

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-2

ATHABASCA RIVER AT HINTON

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1915-16	23.1	Feb 24	25.7	Dec 15
1916-17	24.1	Feb 20	29.9	Jan 17
1917-18	29.0	Feb 14	44.5	Dec 23
1918-19	27.3	Jan 16	29.7	Dec 08
1919-20	22.0	Apr 12	27.1	Jan 19
1920-21	26.3	Jan 10	38.1	Dec 31
1923-24	25.7	Jan 10	29.8	Dec 24
1924-25	21.4	Dec 26	24.1	Dec 16
1925-26	29.4	Feb 11	34.0	Dec 21
1926-27	23.7	Jan 16	28.7	Dec 06
1927-28	21.5	Dec 28	32.6	Dec 05
1928-29	20.9	Jan 24	28.5	Dec 03
1929-30	24.6	Jan 17	27.8	Dec 28
1930-31	21.5	Dec 21	30.5	Dec 21
1931-32	20.1	Dec 26	25.2	Dec 16
1932-33	18.6	Jan 30	20.8	Jan 03
1933-34	21.5	Feb 21	26.8	Dec 25
1934-35	23.8	Mar 04	37.5	Dec 16
1935-36	8.9	Feb 24	15.4	Jan 14
1936-37	10.7	Apr 20	20.9	Dec 25
1937-38	17.0	Mar 25	23.4	Jan 27
1938-39	17.6	Jan 31	29.6	Dec 20
1955-56	23.8	Mar 26	30.0	Jan 02
1956-57	23.6	Jan 09	30.7	Nov 25
1957-58	21.5	Jan 31	29.1	Dec 28
1958-59	17.4	Feb 08	27.3	Dec 25
1959-60	28.6	Mar 11	37.4	Dec 29
1960-61	12.8	Jan 13	22.5	Jan 11
1961-62	12.0	Feb 27	20.1	Jan 02
1962-63	12.1	Mar 13	36.5	Feb 10
1963-64	18.8	Mar 22	28.1	Jan 05
1964-65	21.7	Dec 15	29.2	Dec 13
1965-66	18.6	Mar 03	28.5	Dec 26

Athabasca River At Hinton

Page 2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1966-67	29.0	Mar 09	41.7	Jan 24
1967-68	27.1	Nov 26	37.2	Jan 28
1968-69	28.6	Dec 06	34.2	Jan 04
1969-70	24.9	Mar 31	29.9	Jan 09
1970-71	20.7	Nov 24	27.4	Nov 19
1971-72	27.7	Dec 26	30.7	Dec 08
1972-73	29.4	Nov 26	33.4	Nov 20
1973-74	27.0	Mar 05	32.6	Dec 28
1974-75	28.4	Feb 22	32.0	Jan 06
1975-76	24.0	Mar 02	30.7	Jan 04
1976-77	26.2	Mar 27	32.5	Jan 05
1977-78	21.5	Nov 19	33.2	Dec 25
1978-79	24.9	Apr 02	32.3	Jan 17
1979-80	18.6	Dec 15	24.0	Dec 14
1980-81	24.4	Dec 02	30.1	Jan 20
1981-82	18.2	Dec 12	26.7	Dec 08

Note: The above analysis is based on a water year from July 1st to June 30th.

Low flows identified for the years 1915-16 to 1960-61 are based on data from Athabasca River at Entrance, station 07AD001.

TABLE A-3

ATHABASCA RIVER NEAR WINDFALL

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1960-61	44.8	Nov 21	59.6	Jan 01
1961-62	34.5	Mar 05	54.0	Jan 06
1962-63	33.4	Mar 30	53.5	Jan 16
1963-64	24.6	Mar 26	43.5	Jan 05
1964-65	32.4	Mar 24	40.7	Jan 08
1965-66	43.3	Dec 11	56.6	Dec 31
1966-67	30.8	Mar 08	42.7	Jan 14
1967-68	30.2	Feb 14	43.9	Dec 06
1968-69	32.1	Jan 20	43.0	Dec 26
1969-70	37.9	Dec 06	44.9	Nov 14
1970-71	33.1	Jan 13	37.9	Dec 22
1971-72	38.1	Feb 21	53.3	Dec 11
1972-73	49.9	Nov 27	56.4	Dec 31
1973-74	42.5	Feb 25	48.1	Jan 06
1974-75	39.6	Mar 11	43.4	Jan 10
1975-76	42.2	Mar 07	48.4	Jan 01
1976-77	45.8	Mar 25	52.2	Jan 05
1977-78	32.8	Nov 20	54.0	Dec 24

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-4

MCLEOD RIVER ABOVE EMBARRAS RIVER

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1954-55	1.85	Dec 28	2.69	Dec 25
1955-56	1.73	Mar 11	2.39	Jan 04
1956-57	1.82	Jan 16	2.79	Dec 16
1957-58	2.52	Mar 10	4.25	Jan 07
1958-59	1.18	Dec 04	2.20	Nov 30
1959-60	2.28	Mar 27	3.34	Jan 08
1960-61	1.24	Jan 24	2.00	Dec 22
1961-62	1.29	Mar 02	2.90	Dec 21
1962-63	1.85	Jan 14	2.49	Jan 09
1963-64	1.86	Jan 12	2.29	Nov 22
1964-65	1.77	Jan 10	2.66	Jan 04
1965-66	2.79	Jan 10	3.46	Dec 28
1966-67	1.61	Jan 24	2.97	Jan 01
1967-68	0.50	Jan 30	1.52	Nov 25
1968-69	1.35	Feb 06	2.27	Dec 03
1969-70	1.67	Jan 15	2.45	Dec 18
1970-71	1.39	Jan 16	1.70	Dec 18
1971-72	2.17	Feb 20	2.36	Jan 04
1972-73	3.18	Mar 04	3.66	Jan 09
1973-74	2.66	Jan 07	2.95	Dec 31
1974-75	1.44	Feb 25	1.57	Jan 13
1975-76	1.51	Mar 07	1.91	Dec 27
1976-77	1.55	Mar 22	2.15	Jan 04
1977-78	1.93	Mar 05	2.75	Dec 30
1978-79	1.11	Jan 19	2.44	Dec 17
1979-80	1.37	Jan 08	1.97	Dec 31
1980-81	1.98	Feb 09	3.27	Jan 01
1981-82	1.18	Feb 24	1.36	Dec 26

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-5

McLEOD RIVER NEAR WOLF CREEK

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1914-15	2.33	Mar 04	3.24	Dec 23
1915-16	1.75	Mar 01	2.72	Dec 23
1916-17	2.21	Feb 19	3.31	Jan 08
1917-18	5.16	Mar 10	9.47	Jan 09
1918-19	2.00	Mar 15	3.26	Jan 04
1919-20	3.56	Feb 16	4.29	Jan 28
1920-21	2.15	Feb 13	2.91	Dec 20
1921-22	0.60	Feb 16	1.32	Jan 01
1922-23	0.10	Mar 03	0.44	Jan 12
1957-58	8.59	Dec 26	9.75	Dec 29
1958-59	2.49	Jan 05	3.69	Dec 09
1959-60	4.02	Mar 19	7.06	Dec 28
1960-61	3.64	Mar 13	5.00	Dec 27
1961-62	4.41	Jan 27	6.46	Dec 31
1962-63	2.39	Mar 20	3.65	Jan 11
1963-64	2.50	Jan 29	3.09	Dec 19
1964-65	4.31	Mar 30	6.40	Jan 11
1965-66	5.26	Mar 09	5.81	Jan 03
1966-67	4.98	Mar 17	6.87	Jan 07
1967-68	2.23	Feb 14	4.06	Nov 25
1970-71	3.40	Jan 21	4.44	Nov 15
1971-72	5.41	Feb 02	5.97	Jan 15
1972-73	8.02	Jan 22	9.16	Jan 02
1973-74	5.50	Jan 22	6.60	Jan 01
1974-75	3.59	Mar 26	4.00	Jan 09
1975-76	3.92	Mar 05	4.83	Dec 30
1976-77	3.43	Jan 09	4.74	Dec 29
1977-78	4.29	Feb 11	6.61	Dec 24
1978-79	2.99	Jan 20	6.06	Dec 20
1979-80	4.18	Mar 05	4.90	Jan 02
1980-81	3.94	Feb 07	7.72	Dec 30
1981-82	2.10	Jan 04	2.72	Dec 13

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-6

PEMBINA RIVER NEAR ENTWISTLE

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1914-15	0.413	Jan 30	1.09	Dec 13
1915-16	1.08	Feb 05	1.38	Dec 25
1916-17	1.58	Feb 22	1.96	Jan 13
1917-18	1.88	Mar 03	2.72	Jan 07
1918-19	0.195	Mar 02	0.660	Jan 07
1919-20	0.565	Apr 02	1.37	Jan 23
1920-21	0.319	Dec 24	1.97	Nov 23
1921-22	0.0	Feb 13	0.493	Jan 04
1954-55	1.73	Jan 05	2.69	Dec 27
1955-56	0.713	Jan 16	1.35	Nov 05
1956-57	1.02	Mar 16	1.61	Dec 30
1957-58	1.26	Jan 05	3.90	Dec 17
1958-59	0.389	Feb 16	1.08	Dec 21
1959-60	2.11	Mar 02	2.66	Dec 20
1960-61	0.668	Mar 05	1.24	Dec 15
1961-62	1.09	Dec 22	1.62	Dec 20
1962-63	1.28	Jan 29	2.23	Jan 31
1963-64	0.747	Mar 23	1.62	Nov 23
1964-65	0.878	Jan 25	1.56	Dec 12
1965-66	1.42	Jan 16	2.51	Dec 16
1966-67	1.42	Jan 25	3.17	Dec 30
1967-68	0.719	Feb 02	1.07	Nov 30
1968-69	0.850	Feb 18	1.25	Jan 01
1969-70	1.84	Jan 19	2.52	Dec 30
1970-71	1.27	Nov 29	1.98	Nov 20
1971-72	1.19	Feb 28	1.94	Dec 18
1972-73	3.23	Feb 28	4.01	Dec 30
1973-74	2.84	Feb 01	3.40	Dec 29
1974-75	1.75	Apr 06	2.53	Jan 15
1975-76	1.71	Nov 19	2.18	Nov 15
1976-77	1.78	Feb 26	2.29	Jan 03
1977-78	2.36	Mar 02	3.15	Dec 17
1978-79	2.00	Feb 11	3.28	Dec 09
1979-80	2.11	Mar 02	2.49	Dec 30
1980-81	2.36	Feb 08	4.03	Dec 11
1981-82	1.38	Dec 24	1.66	Dec 10

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-7

PEMBINA RIVER AT JARVIE

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1961-62	0.838	Mar 29	1.85	Jan 11
1962-63	2.49	Mar 27	3.65	Jan 14
1963-64	1.04	Nov 18	1.8	Nov 14
1964-65	3.83	Feb 12	5.62	Jan 11
1965-66	4.38	Feb 01	5.85	Dec 31
1966-67	3.85	Mar 27	4.70	Jan 05
1967-68	0.590	Feb 02	0.763	Nov 30
1968-69	1.58	Jan 08	1.70	Jan 02
1969-70	4.15	Mar 16	5.00	Jan 03
1970-71	1.53	Jan 13	1.93	Nov 28
1971-72	4.08	Mar 12	4.64	Dec 27
1972-73	3.98	Mar 20	5.21	Dec 30
1973-74	3.34	Feb 04	4.53	Jan 10
1974-75	3.48	Mar 31	4.21	Jan 15
1975-76	3.11	Dec 19	4.32	Dec 11
1976-77	3.06	Mar 04	4.38	Dec 15
1977-78	5.86	Feb 09	7.18	Dec 26
1978-79	3.55	Feb 08	6.72	Dec 17
1979-80	3.44	Mar 12	4.41	Jan 01
1980-81	7.50	Feb 13	10.9	Dec 18
1981-82	0.847	Feb 11	2.11	Dec 14

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-8

ATHABASCA RIVER AT ATHABASCA

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1914-15	79.7	Dec 24	93.9	Dec 09
1915-16	64.8	Jan 28	73.6	Jan 01
1916-17	57.5	Feb 26	68.4	Jan 11
1917-18	77.5	Feb 15	90.6	Jan 11
1918-19	52.9	Mar 05	64.3	Jan 08
1919-20	72.9	Mar 06	80.4	Jan 23
1920-21	88.2	Dec 25	110.	Dec 05
1921-22	68.6	Jan 12	77.3	Dec 26
1922-23	48.3	Feb 19	51.8	Jan 19
1923-24	53.9	Jan 05	78.0	Jan 03
1924-25	49.5	Feb 01	59.0	Dec 20
1925-26	118.	Feb 21	139.	Jan 08
1926-27	103.	Jan 20	107.	Dec 21
1927-28	95.4	Jan 26	104.	Dec 20
1928-29	74.7	Jan 29	89.2	Dec 30
1929-30	56.2	Jan 16	67.4	Dec 17
1951-52	68.7	Jan 15	73.5	Jan 04
1952-53	48.5	Dec 04	64.3	Dec 01
1953-54	65.7	Jan 26	84.7	Jan 14
1954-55	57.1	Mar 02	81.9	Jan 01
1955-56	64.7	Nov 19	89.0	Jan 06
1956-57	46.9	Dec 10	60.9	Dec 06
1957-58	117.	Mar 21	131.	Jan 04
1958-59	62.8	Jan 11	70.4	Dec 28
1959-60	58.7	Mar 05	71.7	Dec 28
1960-61	62.7	Feb 02	73.8	Dec 23
1961-62	63.3	Mar 10	76.3	Jan 11
1962-63	93.0	Dec 06	102.	Dec 30
1963-64	67.6	Mar 27	78.1	Jan 10
1964-65	101.	Mar 31	120.	Jan 12
1965-66	82.7	Mar 25	113.	Jan 04
1966-67	93.0	Feb 22	104.	Jan 12
1967-68	52.3	Jan 01	68.9	Dec 07
1968-69	55.3	Jan 13	59.3	Dec 22
1969-70	73.6	Mar 06	82.8	Jan 03
1970-71	69.7	Jan 26	74.4	Dec 28

Athabasca River At Athabasca
Page 2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1971-72	86.6	Feb 19	96.9	Dec 23
1972-73	95.6	Dec 13	128.	Jan 02
1973-74	101.	Mar 16	108.	Jan 06
1974-75	97.9	Feb 08	105.	Jan 09
1975-76	89.9	Mar 15	114.	Jan 03
1976-77	93.4	Dec 14	114.	Nov 08
1977-78	95.5	Feb 06	119.	Dec 27
1978-79	93.4	Feb 17	109.	Dec 21
1979-80	87.3	Dec 17	98.1	Dec 01
1980-81	95.0	Dec 07	127.	Dec 25
1981-82	58.6	Dec 15	64.2	Dec 14

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-9

LESSER SLAVE RIVER AT HIGHWAY #2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1915-16	15.8	Jan 04	18.6	Nov 12
1916-17	15.4	Feb 19	16.8	Jan 11
1917-18	15.3	Dec 07	17.4	Jan 10
1918-19	16.7	Feb 15	17.6	Jan 10
1919-20	24.5	Jan 30	27.1	Jan 10
1920-21	39.2	Dec 28	45.9	Nov 25
1921-22	27.8	Jan 20	30.4	Dec 31
1922-23	16.5	Jan 17	19.9	Dec 14
1923-24	12.0	Jan 22	15.9	Nov 29
1924-25	18.2	Feb 14	19.7	Dec 06
1925-26	22.6	Apr 08	23.9	Jan 20
1926-27	17.1	Feb 13	20.6	Dec 26
1927-28	35.2	Dec 28	41.1	Nov 16
1928-29	19.8	Mar 03	22.1	Jan 17
1929-30	19.2	Feb 27	22.4	Dec 09
1930-31	20.5	Feb 08	33.6	Dec 30
1935-36	50.1	Apr 01	56.5	Jan 31
1936-37	46.0	Mar 26	49.8	Jan 08
1937-38	30.0	Feb 13	35.2	Dec 01
1938-39	18.9	Feb 05	19.9	Dec 22
1939-40	12.7	Jan 18	14.5	Dec 28
1960-61	9.58	Nov 23	13.7	Nov 19
1961-62	7.80	Nov 17	12.6	Nov 05
1964-65	36.8	Jan 01	41.8	Dec 10
1965-66	43.7	Jan 14	47.9	Dec 05
1966-67	26.0	Mar 24	28.3	Jan 10
1967-68	6.82	Nov 27	14.8	Nov 21
1968-69	8.73	Nov 18	13.7	Nov 17
1969-70	14.1	Jan 06	15.6	Dec 19
1970-71	17.4	Jan 30	18.2	Dec 28
1971-72	29.7	Jan 25	30.8	Dec 15
1972-73	29.3	Dec 24	31.8	Dec 14
1973-74	31.2	Jan 14	34.1	Dec 30

Lesser Slave River At Highway #2

Page 2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1974-75	42.9	Feb 02	44.5	Dec 05
1975-76	32.1	Feb 28	38.1	Dec 07
1976-77	39.3	Jan 28	48.8	Nov 27
1977-78	43.2	Feb 12	46.7	Dec 09
1978-79	30.9	Feb 24	34.1	Dec 17
1979-80	38.5	Dec 18	44.4	Dec 14
1980-81	20.7	Dec 18	28.3	Dec 09
1981-82	13.2	Jan 02	14.3	Dec 14

Note: The above analysis is based on a water year from July 1st to June 30th.

Low flows identified for the years 1915-16 to 1961-62 are based on data from Lesser Slave River at Slave Lake, station 07BK001.

TABLE A-10

CLEARWATER RIVER AT DRAPER

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1959-60	59.1	Mar 23	65.8	Jan 10
1960-61	66.5	Mar 07	74.8	Jan 07
1961-62	33.0	Feb 10	38.5	Dec 27
1962-63	56.0	Feb 25	60.8	Jan 16
1963-64	41.9	Dec 16	45.2	Dec 15
1964-65	41.4	Feb 28	45.4	Jan 14
1965-66	40.2	Mar 08	49.6	Jan 02
1966-67	53.3	Mar 22	61.2	Jan 24
1967-68	30.9	Jan 14	36.9	Dec 28
1968-69	51.2	Feb 16	57.5	Jan 10
1969-70	37.7	Mar 15	43.2	Jan 15
1970-71	54.1	Nov 20	57.5	Jan 09
1971-72	34.6	Feb 09	39.9	Dec 21
1972-73	46.6	Feb 27	48.9	Dec 26
1973-74	55.5	Feb 24	63.6	Jan 12
1974-75	59.5	Mar 26	65.9	Jan 14
1975-76	52.9	Mar 16	64.2	Jan 09
1976-77	40.4	Nov 25	65.1	Jan 11
1977-78	55.9	Mar 08	58.1	Jan 05
1978-79	52.9	Mar 11	58.2	Jan 20
1979-80	50.0	Mar 23	57.8	Jan 10
1980-81	44.1	Dec 27	51.5	Dec 19
1981-82	26.5	Feb 18	32.0	Jan 10

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-11

CLEARWATER RIVER ABOVE CHRISTINA RIVER

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1975-76	48.8	Feb 18	53.6	Jan 08
1976-77	31.8	Nov 24	56.8	Jan 09
1977-78	44.6	Mar 05	50.0	Jan 13
1978-79	46.6	Mar 06	50.0	Jan 18
1979-80	43.5	Mar 15	47.9	Jan 09
1980-81	35.0	Dec 24	40.7	Dec 15
1981-82	25.0	Mar 13	28.1	Jan 13

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-12

ATHABASCA RIVER BELOW McMURRAY

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1957-58	164.	Feb 16	190.	Jan 08
1959-60	139.	Mar 13	158.	Jan 01
1960-61	167.	Mar 07	191.	Dec 26
1961-62	119.	Mar 30	126.	Jan 13
1962-63	184.	Mar 18	193.	Jan 16
1964-65	144.	Dec 01	184.	Jan 16
1965-66	184.	Dec 30	208.	Dec 26
1966-67	143.	Mar 22	178.	Jan 14
1967-68	111.	Jan 02	123.	Dec 10
1970-71	115.	Nov 22	147.	Jan 08
1971-72	156.	Feb 28	178.	Dec 13
1972-73	156.	Dec 11	175.	Jan 10
1973-74	183.	Mar 21	207.	Jan 13
1974-75	187.	Jan 28	200.	Jan 10
1975-76	172.	Mar 11	197.	Jan 04
1976-77	131.	Nov 26	196.	Nov 20
1977-78	146.	Nov 25	205.	Jan 01
1978-79	149.	Mar 07	185.	Dec 30
1979-80	178.	Nov 30	214.	Jan 09
1980-81	158.	Dec 13	191.	Dec 06
1981-82	95.1	Dec 16	105.	Dec 16

Note: The above analysis is based on a water year from July 1st to June 30th.

TABLE A-13

ATHABASCA RIVER AT EMBARRAS AIRPORT

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence	90 Day Low Flow (m ³ /s)	Starting Date of the 90 Day Low Flow Sequence
1971-72	126.	Feb 12	153.	Dec 15
1972-73	148.	Dec 03	202.	Jan 09
1974-75	190.	Nov 30	212.	Jan 11
1975-76	174.	Mar 08	212.	Jan 05

Note: The above analysis is based on a water year from July 1st to June 30th.

A P P E N D I X B

FREQUENCY OF ANNUAL 7 AND 90 DAY LOW FLOW RUNOFF

APPENDIX B

FREQUENCY OF ANNUAL 7 and 90 DAY LOW FLOW RUNOFF

Station Name	Water Survey of Canada Station Number	Table Number
Athabasca River near Jasper	07AA002	B-1
Athabasca River at Hinton	07AD002	B-2
Athabasca River near Windfall	07AE001	B-3
McLeod River above Embarras River	07AF002	B-4
McLeod River near Wolf Creek	07AG001	B-5
Pembina River near Entwistle	07BB002	B-6
Pembina River at Jarvie	07BC002	B-7
Athabasca River at Athabasca	07BE001	B-8
Lesser Slave River at Highway #2	07BK006	B-9
Clearwater River at Draper	07CD001	B-10
Clearwater River above Christina River	07CD005	B-11
Athabasca River below McMurray	07DA001	B-12

TABLE B-1
ATHABASCCA RIVER NEAR JASPER
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	12.7	14.2
0.02	12.0	13.7
0.04	11.3	13.1
0.05	11.0	13.0
0.10	10.2	12.3
0.20	9.26	11.6
0.30	8.62	11.1
0.40	8.10	10.7
0.50	7.63	10.3
0.60	7.18	9.97
0.70	6.73	9.59
0.80	6.22	9.16
0.90	5.56	8.58
0.95	5.06	8.12
0.99	4.22	7.31

Note: The above analysis is based on 28 years of flow data for a water year from July 1st to June 30th.

TABLE B-2
ATHABASCA RIVER AT HINTON
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	36.0	44.1
0.02	34.1	42.2
0.04	32.0	40.1
0.05	31.3	39.4
0.10	29.0	37.0
0.20	26.4	34.2
0.30	24.6	32.4
0.40	23.1	30.8
0.50	21.8	29.4
0.60	20.6	28.0
0.70	19.3	26.6
0.80	17.9	25.1
0.90	16.0	23.0
0.95	14.6	21.4
0.99	12.2	18.6

Note: The above analysis is based on 49 years of flow data for a water year from July 1st to June 30th.

TABLE B-3

ATHABASCA RIVER NEAR WINDFALL
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	54.4	64.9
0.02	52.1	62.8
0.04	49.5	60.5
0.05	48.7	59.7
0.10	45.8	57.0
0.20	42.5	53.9
0.30	40.2	51.8
0.40	38.4	50.0
0.50	36.7	48.3
0.60	35.0	46.8
0.70	33.4	45.1
0.80	31.5	43.2
0.90	29.0	40.7
0.95	27.0	38.7
0.99	23.7	35.2

Note: The above analysis is based on 18 years of flow data for a water year from July 1st to June 30th.

TABLE B-4

McLEOD RIVER ABOVE EMBARRAS RIVER
FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	3.36	4.35
0.02	3.12	4.09
0.04	2.87	3.82
0.05	2.79	3.73
0.10	2.51	3.42
0.20	2.20	3.08
0.30	1.99	2.84
0.40	1.82	2.64
0.50	1.68	2.47
0.60	1.54	2.31
0.70	1.40	2.14
0.80	1.25	1.95
0.90	1.06	1.70
0.95	0.925	1.52
0.99	0.706	1.20

Note: The above analysis is based on 28 years of flow data for a water year from July 1st to June 30th.

TABLE B-5

McLEOD RIVER NEAR WOLF CREEK
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	9.09	11.6
0.02	8.22	10.6
0.04	7.32	9.53
0.05	7.01	9.17
0.10	6.04	8.01
0.20	4.98	6.74
0.30	4.30	5.91
0.40	3.77	5.25
0.50	3.31	4.69
0.60	2.89	4.16
0.70	2.49	3.65
0.80	2.06	3.11
0.90	1.56	2.45
0.95	1.22	1.99
0.99	0.724	1.30

Note: The above analysis is based on 32 years of flow data for a water year from July 1st to June 30th.

TABLE B-6

PEMBINA RIVER NEAR ENTWISTLE
FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	3.60	4.86
0.02	3.23	4.44
0.04	2.86	4.00
0.05	2.73	3.85
0.10	2.33	3.37
0.20	1.90	2.84
0.30	1.62	2.50
0.40	1.41	2.23
0.50	1.22	1.99
0.60	1.06	1.78
0.70	0.892	1.57
0.80	0.719	1.34
0.90	0.510	1.07
0.95	0.351	0.881
0.99	0.0	0.597

Note: The above analysis is based on 36 years of flow data for a water year from July 1st to June 30th.

TABLE B-7

PEMBINA RIVER AT JARVIE
FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	8.46	11.5
0.02	7.60	10.3
0.04	6.71	9.12
0.05	6.42	8.72
0.10	5.47	7.45
0.20	4.45	6.08
0.30	3.79	5.20
0.40	3.29	4.52
0.50	2.86	3.94
0.60	2.47	3.42
0.70	2.10	2.92
0.80	1.71	2.41
0.90	1.27	1.81
0.95	0.972	1.41
0.99	0.564	0.862

Note: The above analysis is based on 21 years of flow data for a water year from July 1st to June 30th.

TABLE B-8

ATHABASCA RIVER AT ATHABASCA
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	128.	150.
0.02	120.	141.
0.04	113.	132.
0.05	110.	129.
0.10	101.	119.
0.20	91.3	108.
0.30	84.6	99.9
0.40	79.1	93.6
0.50	74.1	87.9
0.60	69.4	82.4
0.70	64.6	76.8
0.80	59.2	70.7
0.90	52.3	62.6
0.95	47.0	56.5
0.99	38.0	46.2

Note: The above analysis is based on 47 years of flow data for a water year from July 1st to June 30th.

TABLE B-9

LESSER SLAVE RIVER AT HIGHWAY #2
FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	59.5	65.7
0.02	54.1	60.0
0.04	48.5	53.9
0.05	46.6	51.9
0.10	40.5	45.4
0.20	33.8	38.2
0.30	29.4	33.6
0.40	26.0	29.9
0.50	23.0	26.7
0.60	20.3	23.8
0.70	17.6	20.9
0.80	14.7	17.8
0.90	11.3	14.1
0.95	8.86	11.6
0.99	5.25	7.7

Note: The above analysis is based on 41 years of flow data for a water year from July 1st to June 30th.

TABLE B-10

CLEARWATER RIVER AT DRAPER
FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	74.3	83.2
0.02	70.6	79.2
0.04	66.7	75.0
0.05	65.3	73.5
0.10	60.8	68.7
0.20	55.6	63.1
0.30	52.0	59.3
0.40	49.1	56.1
0.50	46.4	53.2
0.60	43.9	50.5
0.70	41.2	47.6
0.80	38.3	44.5
0.90	34.3	40.3
0.95	31.3	37.0
0.99	26.1	31.4

Note: The above analysis is based on 23 years of flow data for a water year from July 1st to June 30th.

TABLE B-11

CLEARWATER RIVER ABOVE CHRISTINA RIVER
 FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	62.4	71.9
0.02	59.3	68.5
0.04	55.9	64.8
0.05	54.8	63.5
0.10	50.9	59.4
0.20	46.5	54.6
0.30	43.5	51.3
0.40	41.0	48.5
0.50	38.7	46.1
0.60	36.6	43.7
0.70	34.3	41.2
0.80	31.8	38.5
0.90	28.5	34.9
0.95	25.9	32.1
0.99	21.4	27.2

Note: The above analysis is based on 7 years of flow data for a water year from July 1st to June 30th.

TABLE B-12

ATHABASCA RIVER BELOW McMURRAY

FREQUENCY OF 7 AND 90 DAY LOW-FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)	90 Day Low Flow (m ³ /s)
0.01	219.	255.
0.02	210.	245.
0.04	200.	234.
0.05	197.	230.
0.10	186.	218.
0.20	173.	203.
0.30	164.	193.
0.40	157.	185.
0.50	150.	177.
0.60	144.	170.
0.70	137.	162.
0.80	129.	153.
0.90	119.	141.
0.95	111.	132.
0.99	96.0	115.

Note: The above analysis is based on 21 years of flow data for a water year from July 1st to June 30th.

A P P E N D I X C

OPEN WATER DATA

APPENDIX C
OPEN WATER DATA

Station Name	Water Survey of Canada Station Number	Table Number
Athabasca River near Jasper	07AA002	C-1
Athabasca River at Hinton	07AD002	C-2
Athabasca River near Windfall	07AE001	C-3
McLeod River above Embarras River	07AF002	C-4
McLeod River near Wolf Creek	07AG001	C-5
McLeod River near Whitecourt	07AG004	C-6
Pembina River near Entwistle	07BB002	C-7
Pembina River at Jarvie	07BC002	C-8
Athabasca River at Athabasca	07BE001	C-9
Lesser Slave River at Highway #2	07BK006	C-10
Clearwater River at Draper	07CD001	C-11
Clearwater River above Christina River	07CD005	C-12
Athabasca River below McMurray	07DA001	C-13
Athabasca River at Embarras Airport	07DD001	C-14

TABLE C-1

ATHABASCA RIVER NEAR JASPER

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1914	19.4	Nov 14
1915	17.8	Nov 23
1916	23.0	Nov 24
1917	13.5	May 01
1918	19.3	Nov 24
1919	20.4	Nov 01
1920	20.3	Nov 24
1921	23.4	Nov 17
1923	17.6	Nov 24
1924	17.8	Nov 24
1925	17.2	Nov 24
1926	13.0	Nov 20
1927	12.4	Nov 19
1928	15.2	May 01
1929	15.6	Nov 18
1930	14.6	Nov 14
1970	10.1	Nov 24
1971	19.7	Nov 24
1972	15.0	Nov 24
1973	12.0	Nov 10
1974	20.8	Nov 21
1975	15.6	May 01
1976	21.4	Nov 24
1977	18.1	Nov 19
1978	20.5	Nov 21
1979	10.6	Nov 24
1980	15.9	Nov 24
1981	16.2	Nov 24
1982	15.6	Nov 18

NOTE: The above analysis is based on flow data from May 1st to
to November 30th.

TABLE C-2

ATHABASCA RIVER AT HINTON

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1915	56.6	Nov 24
1916	46.7	Nov 23
1917	50.8	Nov 16
1918	31.7	Nov 23
1919	39.9	Nov 24
1920	42.7	Nov 24
1921	55.0	Nov 24
1923	47.7	May 02
1924	38.3	Nov 24
1925	36.3	Nov 24
1926	37.0	Nov 24
1927	28.5	Nov 18
1928	36.7	Nov 24
1929	53.5	May 06
1930	50.4	Nov 14
1931	40.8	Nov 24
1932	30.4	Nov 13
1933	71.9	May 01
1934	59.7	Nov 21
1935	38.8	Nov 09
1936	49.0	Sep 16
1937	41.2	Nov 14
1938	55.8	Nov 12
1939	52.7	Nov 21
1955	34.0	Nov 13
1956	37.3	Nov 24
1957	43.0	Nov 16
1958	48.9	Nov 14
1959	38.8	Nov 14
1960	45.3	Nov 21
1961	38.4	Nov 24
1962	36.2	Nov 24
1963	43.9	Nov 19

Athabasca River at Hinton
Page 2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1964	53.9	Nov 21
1965	70.2	May 03
1966	49.2	Nov 24
1967	31.4	Nov 24
1968	39.6	Nov 18
1969	48.4	Nov 24
1970	20.2	Nov 24
1971	38.0	Nov 24
1972	29.7	Nov 24
1973	33.7	Nov 06
1974	44.8	Nov 21
1975	42.3	May 01
1976	38.1	Nov 14
1977	21.5	Nov 19
1978	46.1	Nov 24
1979	25.5	Nov 24
1980	29.1	Nov 24
1981	32.4	Nov 24
1982	41.6	Nov 20

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

Low flows identified for the years 1915 to 1960 are based on data from Athabasca River at Entrance, station 07AD001.

TABLE C-3

ATHABASCA RIVER NEAR WINDFALL

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1960	44.9	Nov 21
1961	95.9	Nov 24
1962	94.3	Nov 24
1963	73.5	Nov 20
1964	64.2	Nov 24
1965	93.2	Nov 24
1966	103.	Nov 24
1967	80.3	Nov 24
1968	56.0	Nov 15
1969	37.9	Nov 16
1970	39.1	Nov 22
1971	71.4	Nov 24
1972	51.2	Nov 24
1973	51.3	Nov 09
1974	67.1	Nov 21
1975	57.4	Nov 24
1976	68.0	Nov 18
1977	32.8	Nov 20

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-4

McLEOD RIVER ABOVE EMBARRAS RIVER

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1955	3.57	Nov 12
1956	6.61	Nov 14
1957	7.25	Nov 20
1958	1.85	Nov 24
1959	7.95	Aug 13
1960	2.96	Nov 23
1961	6.46	Jul 09
1962	7.15	Nov 24
1963	2.17	Nov 23
1964	6.95	Nov 24
1965	8.50	Nov 24
1966	8.64	Nov 24
1967	1.56	Nov 24
1968	2.28	Nov 24
1969	9.49	Nov 24
1970	1.95	Nov 24
1971	5.01	Nov 24
1972	4.50	Nov 24
1973	3.03	Nov 01
1974	4.99	Nov 24
1975	1.52	Nov 19
1976	3.20	Nov 19
1977	3.29	Nov 21
1978	4.59	Nov 21
1979	2.48	Nov 20
1980	12.0	Nov 16
1981	4.62	Nov 24
1982	9.24	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-5

MCLEOD RIVER NEAR WOLF CREEK

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1914	7.16	Nov 15
1915	10.4	Nov 24
1916	11.6	Nov 23
1917	12.2	Nov 15
1918	4.57	Nov 24
1919	8.23	Nov 24
1920	8.84	Nov 24
1921	3.37	Nov 24
1922	3.73	Nov 24
1923	10.5	Nov 17
1930	10.2	Nov 23
1958	2.93	Nov 24
1959	11.2	Nov 12
1960	5.59	Nov 24
1961	11.5	Sep 13
1962	16.2	Nov 24
1963	6.35	Nov 21
1964	14.7	Nov 24
1965	10.8	Nov 13
1966	8.16	Nov 11
1967	4.16	Nov 24
1968	9.55	Nov 21
1970	4.52	Nov 20
1971	14.3	Nov 24
1972	12.1	Nov 24
1973	9.63	Nov 22
1974	6.11	Nov 12
1975	4.03	Nov 24
1976	5.23	Nov 24
1977	5.63	Nov 23
1978	9.25	Nov 22
1979	4.64	Nov 18
1980	8.60	Nov 17
1981	8.49	Nov 24
1982	15.7	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-6

McLEOD RIVER NEAR WHITECOURT

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1968	9.61	Nov 17
1969	15.62	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-7
PEMBINA RIVER NEAR ENTWISTLE
 ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1914	3.29	Nov 15
1915	2.70	Nov 24
1916	6.56	Nov 24
1917	6.03	Nov 24
1918	3.10	Nov 21
1919	0.845	May 01
1920	2.74	Nov 24
1921	4.04	Nov 24
1922	3.16	Nov 24
1955	1.02	Nov 23
1956	2.70	Oct 25
1957	4.01	Nov 15
1958	0.704	Nov 23
1959	4.73	Nov 03
1960	1.44	Nov 24
1961	2.29	Nov 18
1962	6.43	Nov 14
1963	1.31	Nov 23
1964	5.24	Nov 21
1965	4.66	Nov 06
1966	2.83	Nov 14
1967	1.97	Nov 24
1968	3.84	Nov 19
1969	8.82	Nov 15
1970	1.42	Nov 24
1971	5.75	Oct 28
1972	4.60	Nov 20
1973	5.37	Nov 24
1974	4.01	Nov 24
1975	1.71	Nov 19
1976	2.26	Nov 22
1977	3.61	Nov 20
1978	7.25	Nov 21
1979	2.72	Nov 19
1980	3.64	Nov 14
1981	4.07	Nov 24
1982	4.51	Nov 11

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-8

PEMBINA RIVER AT JARVIE

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1961	2.58	Nov 24
1962	11.4	Nov 24
1963	1.04	Nov 18
1964	10.6	Nov 24
1965	18.1	Nov 12
1966	8.86	Nov 24
1967	2.47	Nov 24
1968	3.90	Nov 24
1969	9.23	Jun 19
1970	1.83	Nov 24
1971	12.6	Nov 05
1972	8.40	Nov 24
1973	8.38	Nov 24
1974	8.95	Nov 24
1975	5.10	Nov 07
1976	5.41	Nov 24
1977	6.63	Nov 20
1978	15.0	Nov 11
1979	4.60	Nov 24
1980	13.7	Nov 24
1981	4.69	Nov 23
1982	10.5	Nov 16

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-9

ATHABASCA RIVER AT ATHABASCA

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1914	113.	Nov 15
1915	120.	Nov 24
1916	96.5	Nov 24
1917	120.	Nov 24
1918	103.	Nov 24
1919	140.	Nov 08
1920	138.	Nov 20
1921	126.	Nov 24
1922	102.	Nov 24
1923	215.	Nov 24
1924	173.	Nov 24
1925	163.	Nov 24
1926	185.	Nov 24
1927	149.	Nov 24
1928	134.	Nov 15
1929	121.	Nov 19
1930	190.	Nov 15
1951	87.9	Nov 22
1952	99.8	Nov 24
1953	124.	Nov 22
1954	200.	May 01
1955	64.7	Nov 19
1956	77.3	Nov 18
1957	213.	Nov 20
1958	66.0	Nov 22
1959	68.7	Nov 18
1960	89.7	Nov 24
1961	115.	Nov 21
1962	121.	Nov 14
1963	93.9	Nov 19
1964	173.	Nov 24
1965	181.	Nov 24
1966	177.	Nov 10
1967	107.	Nov 24
1968	88.4	Nov 24
1969	150.	Nov 24
1970	71.0	Nov 23

Athabasca River At Athabasca
Page 2

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1971	172.	Nov 24
1972	153.	Nov 23
1973	119.	Nov 12
1974	130.	Nov 24
1975	155.	Nov 24
1976	112.	Nov 24
1977	167.	Nov 21
1978	114.	Nov 24
1979	117.	Nov 24
1980	166.	Nov 24
1981	88.5	Nov 24
1982	129.	Nov 13

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-10
LESSER SLAVE RIVER AT HIGHWAY #2
 ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1916	21.0	Nov 20
1917	27.2	May 01
1918	19.9	Nov 24
1919	22.6	May 01
1920	32.1	May 01
1921	33.5	Nov 23
1922	23.6	Nov 23
1923	22.7	Nov 13
1924	19.4	May 11
1925	27.2	Oct 28
1926	29.1	May 02
1927	35.3	May 01
1928	30.0	Nov 04
1929	30.9	Nov 24
1930	44.2	May 01
1936	74.3	May 01
1937	41.6	Nov 24
1938	23.2	Nov 10
1929	19.6	Oct 08
1961	7.79	Nov 17
1964	47.4	May 01
1965	64.0	Nov 24
1966	32.6	Nov 24
1967	8.29	Nov 24
1968	8.73	Nov 18
1969	17.3	Nov 11
1970	22.1	Nov 24
1971	37.7	Nov 24
1972	38.1	Nov 22
1973	42.3	Nov 24
1974	50.1	Nov 24
1975	48.5	Nov 24
1976	60.3	Nov 24
1977	63.1	Nov 24
1978	50.8	Nov 24
1979	64.9	May 02
1980	44.5	Nov 24
1981	27.1	Nov 15
1982	20.1	Nov 23

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

Low flows identified for the years 1916 to 1961 are based on data from Lesser Slave River at Slave Lake, station 07BK001.

TABLE C-11

CLEARWATER RIVER AT DRAPER

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1958	65.6	Aug 19
1959	90.4	Aug 12
1960	92.7	Nov 24
1961	45.8	Nov 24
1962	101.	Nov 24
1963	66.9	Nov 24
1964	60.0	Nov 18
1965	78.3	Nov 24
1966	70.0	Nov 06
1967	65.7	Nov 24
1968	74.8	Aug 26
1969	58.8	Nov 14
1970	54.1	Nov 20
1971	49.7	Nov 04
1972	59.8	Sep 09
1973	116.	Nov 24
1974	73.0	Nov 23
1975	106.	Nov 24
1976	41.9	Nov 24
1977	57.0	Nov 22
1978	74.1	Nov 16
1979	99.1	Nov 24
1980	70.4	Jul 13
1981	35.1	Nov 24
1982	50.7	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-12

CLEARWATER RIVER ABOVE CHRISTINA RIVER
 ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1968	55.8	Nov 24
1969	49.2	Nov 12
1975	71.2	Nov 24
1976	31.8	Nov 24
1977	46.9	Nov 22
1978	61.3	Nov 14
1979	58.5	Nov 23
1980	50.0	Nov 24
1981	32.0	Nov 24
1982	47.3	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-13

ATHABASCA RIVER BELOW McMURRAY

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1958	141.	Nov 24
1959	216.	Nov 20
1960	304.	Nov 24
1961	172.	Nov 23
1962	298.	Nov 16
1963	185.	Nov 24
1964	158.	Nov 24
1965	256.	Nov 24
1966	262.	Nov 18
1967	189.	Nov 24
1968	227.	Nov 24
1970	115.	Nov 22
1971	249.	Nov 24
1972	168.	Nov 23
1973	294.	Nov 15
1974	219.	Nov 24
1975	242.	Nov 24
1976	135.	Nov 24
1977	147.	Nov 24
1978	330.	Nov 24
1979	257.	Nov 24
1980	383.	Nov 24
1981	178.	Nov 24
1982	220.	Nov 18

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

TABLE C-14

ATHABASCA RIVER AT EMBARRAS AIRPORT

ATHABASCA LOW FLOW ANALYSIS - OPEN WATER CONDITIONS

Year	7 Day Low Flow (m ³ /s)	Starting Date of the 7 Day Low Flow Sequence
1971	298.	Nov 24
1972	255.	Nov 24
1973	359.	Nov 24
1974	346.	Nov 24
1975	263.	Nov 24
1977	164.	Nov 24
1978	361.	Nov 24

NOTE: The above analysis is based on flow data for the period May 1st to November 30th.

A P P E N D I X D

FREQUENCY OF THE OPEN WATER, 7 DAY, LOW FLOW RUNOFF

APPENDIX D

FREQUENCY OF THE OPEN WATER, 7 DAY, LOW FLOW RUNOFF

Station Name	Water Survey of Canada Station Number	Table Number
Athabasca River near Jasper	07AA002	D-1
Athabasca River at Hinton	07AD002	D-2
Athabasca River near Windfall	07AE001	D-3
McLeod River above Embarras River	07AF002	D-4
McLeod River near Wolf Creek	07AG001	D-5
Pembina River near Entwistle	07BB002	D-6
Pembina River at Jarvie	07BC002	D-7
Athabasca River at Athabasca	07BE001	D-8
Lesser Slave River at Highway #2	07BK006	D-9
Clearwater River at Draper	07CD001	D-10
Clearwater River above Christina River	07CD005	D-11
Athabasca River below McMurray	07DA001	D-12
Athabasca River at Embarras Airport	07DD001	D-13

TABLE D-1

ATHABASCA RIVER NEAR JASPER

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	26.2
0.02	25.0
0.04	23.6
0.05	23.2
0.10	21.6
0.20	19.9
0.30	18.6
0.40	17.6
0.50	16.7
0.60	15.9
0.70	15.0
0.80	13.9
0.90	12.6
0.95	11.6
0.99	9.8

NOTE: The above analysis is based on 29 years of flow data for the period May 1st to November 30th.

TABLE D-2
ATHABASCA RIVER AT HINTON
FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	71.0
0.02	67.0
0.04	62.7
0.05	61.2
0.10	56.4
0.20	50.9
0.30	47.1
0.40	44.0
0.50	41.3
0.60	38.7
0.70	36.0
0.80	33.0
0.90	29.1
0.95	26.2
0.99	21.2

NOTE: The above analysis is based on 52 years of flow data for the period May 1st to November 30th.

TABLE D-3

ATHABASCA RIVER NEAR WINDFALL

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	126.
0.02	117.
0.04	108.
0.05	105.
0.10	94.1
0.20	82.5
0.30	74.8
0.40	68.6
0.50	63.1
0.60	58.0
0.70	52.9
0.80	47.3
0.90	40.3
0.95	35.2
0.99	27.0

NOTE: The above analysis is based on 18 years of flow data for the period May 1st to November 30th.

TABLE D-4
MCLEOD RIVER ABOVE EMBARRAS RIVER
FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	14.0
0.02	12.5
0.04	11.0
0.05	10.5
0.10	8.96
0.20	7.26
0.30	6.18
0.40	5.34
0.50	4.62
0.60	3.97
0.70	3.35
0.80	2.71
0.90	1.97
0.95	1.48
0.99	0.800

NOTE: The above analysis is based on 28 years of flow data for the period May 1st to November 30th.

TABLE D-5
MCLEOD RIVER NEAR WOLF CREEK

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	19.4
0.02	17.8
0.04	16.0
0.05	15.4
0.10	13.5
0.20	11.4
0.30	10.0
0.40	8.96
0.50	8.03
0.60	7.17
0.70	6.33
0.80	5.43
0.90	4.36
0.95	3.60
0.99	2.48

NOTE: The above analysis is based on 35 years of flow data for the period May 1st to November 30th.

TABLE D-6
PEMBINA RIVER NEAR ENTWISTLE
FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	9.40
0.02	8.49
0.04	7.54
0.05	7.22
0.10	6.21
0.20	5.10
0.30	4.38
0.40	3.83
0.50	3.35
0.60	2.91
0.70	2.48
0.80	2.04
0.90	1.52
0.95	1.16
0.99	0.641

NOTE: The above analysis is based on 37 years of flow data for the period May 1st to November 30th.

TABLE D-7

PEMBINA RIVER AT JARVIE

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	22.2
0.02	19.9
0.04	17.4
0.05	16.6
0.10	14.0
0.20	11.2
0.30	9.48
0.40	8.14
0.50	7.01
0.60	6.00
0.70	5.04
0.80	4.06
0.90	2.96
0.95	2.25
0.99	1.31

NOTE: The above analysis is based on 22 years of flow data for the period May 1st to November 30th.

TABLE D-8

ATHABASCA RIVER AT ATHABASCA

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	236.
0.02	223.
0.04	206.
0.05	201.
0.10	182.
0.20	162.
0.30	148.
0.40	136.
0.50	126.
0.60	117.
0.70	107.
0.80	96.5
0.90	83.0
0.95	72.9
0.99	56.3

NOTE: The above analysis is based on 49 years of flow data for the period May 1st to November 30th.

TABLE D-9

LESSER SLAVE RIVER AT HIGHWAY #2

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	84.1
0.02	76.2
0.04	67.9
0.05	65.2
0.10	56.3
0.20	46.7
0.30	40.5
0.40	35.6
0.50	31.5
0.60	27.7
0.70	24.0
0.80	20.1
0.90	15.5
0.95	12.4
0.99	7.93

NOTE: The above analysis is based on 39 years of flow data for the period May 1st to November 30th.

TABLE D-10

CLEARWATER RIVER AT DRAPER
FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	128.
0.02	119.
0.04	111.
0.05	108.
0.10	97.9
0.20	86.9
0.30	79.5
0.40	73.5
0.50	68.2
0.60	63.1
0.70	58.0
0.80	52.4
0.90	45.2
0.95	39.9
0.99	31.1

NOTE: The above analysis is based on 25 years of flow data for the period May 1st to November 30th.

TABLE D-11

CLEARWATER RIVER ABOVE CHRISTINA RIVERFREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	83.3
0.02	78.7
0.04	73.8
0.05	72.2
0.10	66.6
0.20	60.3
0.30	56.0
0.40	52.5
0.50	49.4
0.60	46.4
0.70	43.3
0.80	39.9
0.90	35.5
0.95	32.1
0.99	26.5

NOTE: The above analysis is based on 10 years of flow data for the period May 1st to November 30th.

TABLE D-12

ATHABASCA RIVER BELOW McMURRAY

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	409.
0.02	383.
0.04	354.
0.05	344.
0.10	313.
0.20	277.
0.30	253.
0.40	233.
0.50	216.
0.60	200.
0.70	183.
0.80	165.
0.90	141.
0.95	124.
0.99	95.0

NOTE: The above analysis is based on 24 years of flow data for the period May 1st to November 30th.

TABLE D-13

ATHABASCA RIVER AT EMBARRAS AIRPORT

FREQUENCY OF THE OPEN WATER,
7 DAY, LOW FLOW RUNOFF

Exceedance Probability	7 Day Low Flow (m ³ /s)
0.01	463.
0.02	437.
0.04	410.
0.05	401.
0.10	370.
0.20	335.
0.30	311.
0.40	292.
0.50	274.
0.60	258.
0.70	241.
0.80	222.
0.90	197.
0.95	178.
0.99	147.

NOTE: The above analysis is based on 7 years of flow data for the period May 1st to November 30th.

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